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(54) **COPYRIGHT PROTECTION SYSTEM, RECORDING DEVICE, AND REPRODUCTION DEVICE**

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(57) **ABSTRACT**

A copyright protection system includes a recording device and a reproduction device. The recording device writes encrypted content, an encrypted content key for decrypting the encrypted content, and license information on a recording medium on which a unique media number has been recorded in an unrewritable state. The license information is generated using both the media number and the encrypted content key, and therefore reflects both values. The reproduction device reads the media number, the encrypted content key, and the license information from the recording medium, and judges whether the license information reflects both the media number and the encrypted content key. The reproduction device decrypts the encrypted content key, and decrypts the encrypted content using the content key only if the license information reflects both values. Thus, the copyright protection system allows only original recording media to be reproduced, and prohibits reproduction of copy recording media.

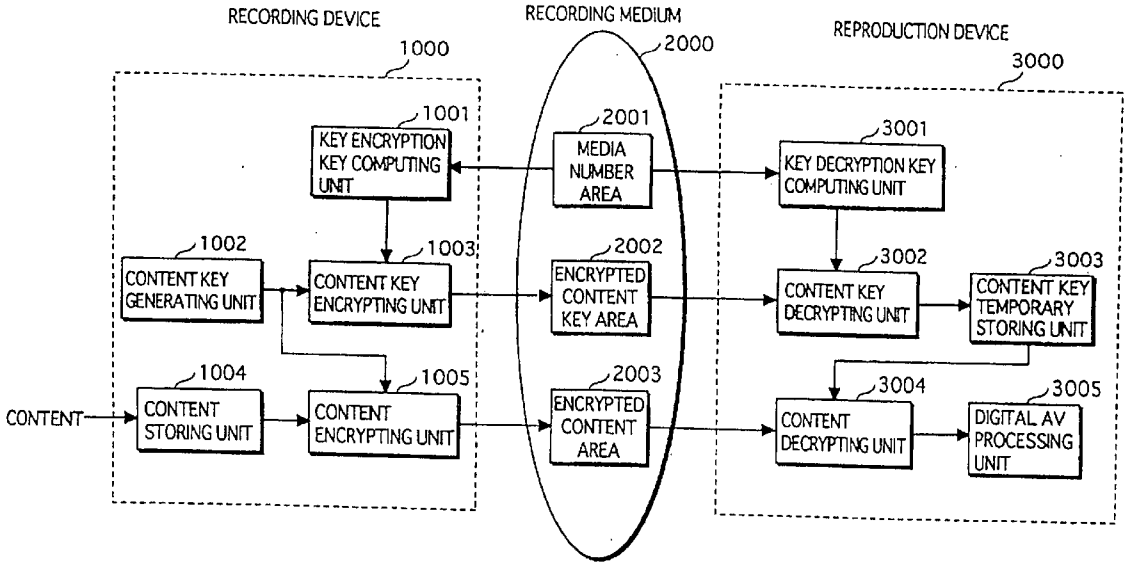


FIG. 1

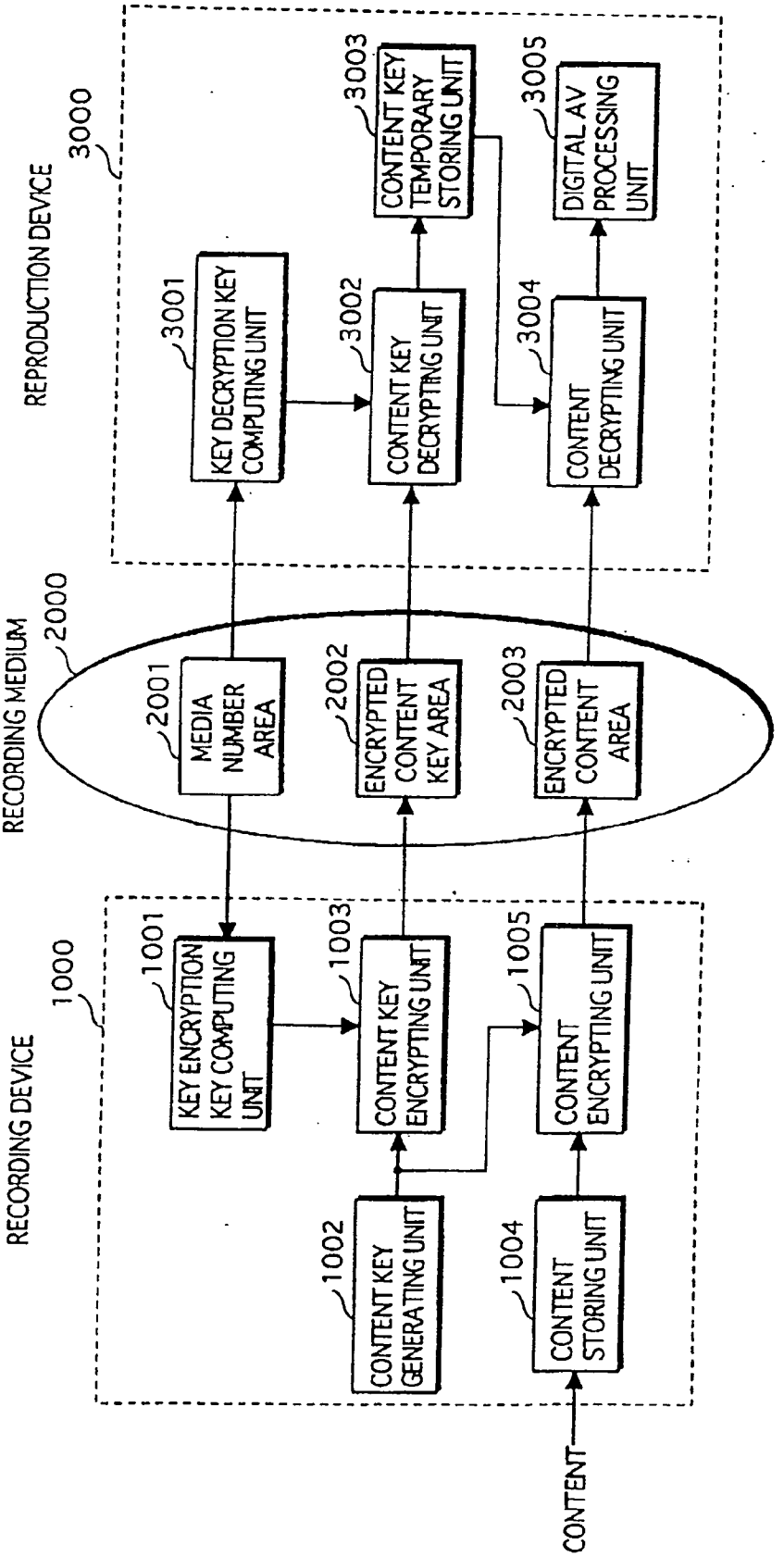

REPRODUCTION DEVICE
3000
3001
KEY DECRYPTION KEY COMPUTING UNIT
3002
CONTENT KEY DECRYPTING UNIT
3003
CONTENT KEY TEMPORARY STORING UNIT
3004
CONTENT DECRYPTING UNIT
3005
DIGITAL AV PROCESSING UNIT
RECORDING MEDIUM
2000
2001
MEDIA NUMBER AREA
2002
ENCRYPTED CONTENT KEY AREA
2003
ENCRYPTED CONTENT AREA
RECORDING DEVICE
1000
1001
KEY ENCRYPTION KEY COMPUTING UNIT
1002
CONTENT KEY GENERATING UNIT
1003
CONTENT KEY ENCRYPTING UNIT
1004
CONTENT STORING UNIT
1005
CONTENT ENCRYPTING UNIT
CONTENT

FIG.2

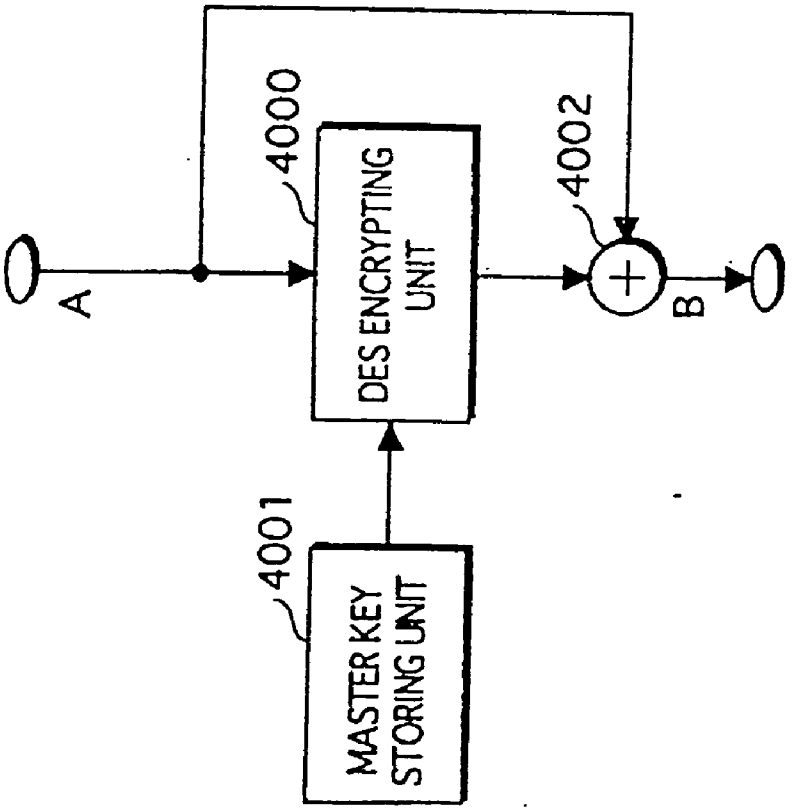

4000
4002
A
DES ENCRYPTING UNIT
B
4001
MASTER KEY STORING UNIT

FIG.3

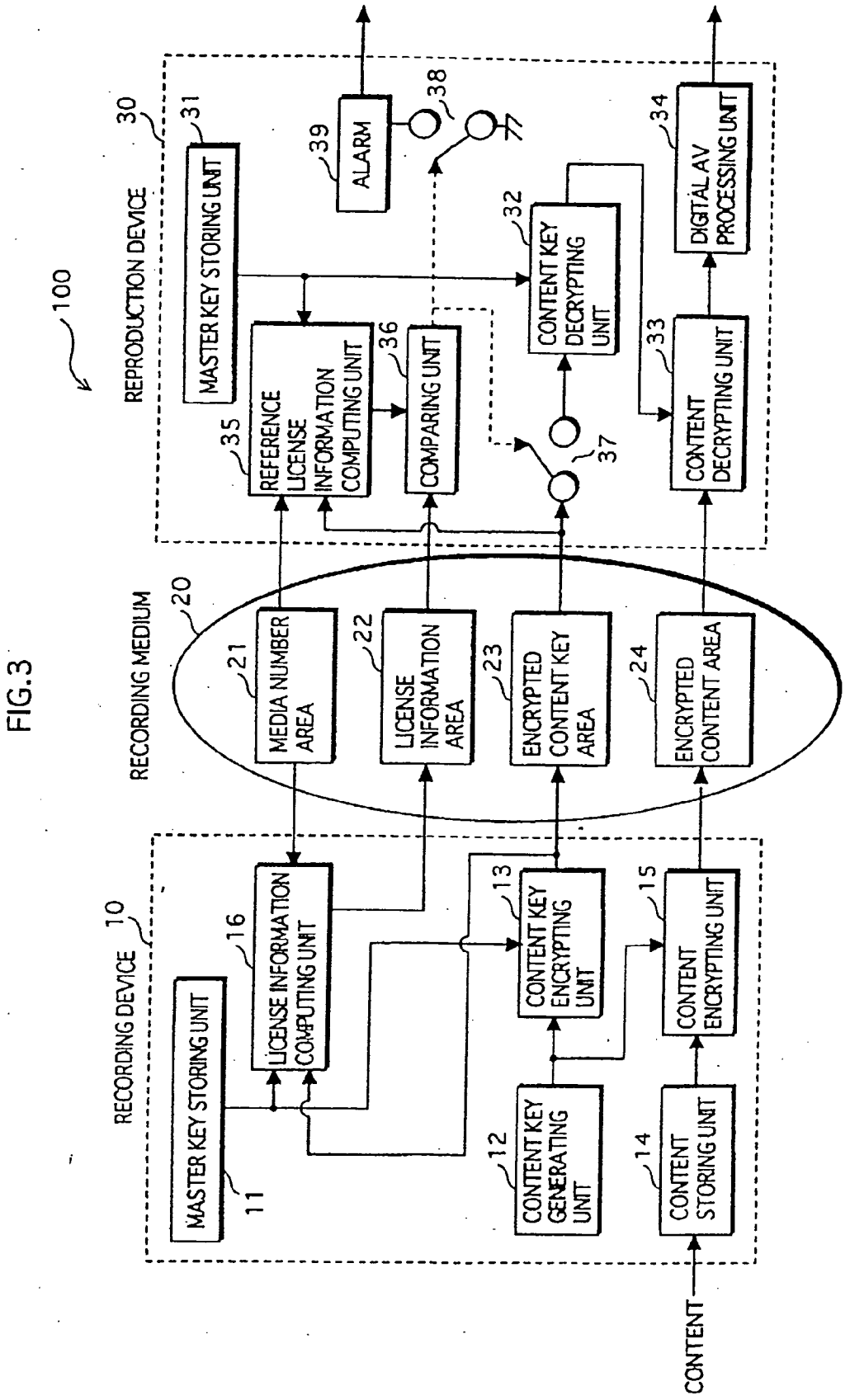

100
REPRODUCTION DEVICE
30
MASTER KEY STORING UNIT
31
ALARM
39
38
DIGITAL AV PROCESSING UNIT
34
CONTENT KEY DECRYPTING UNIT
32
REFERENCE LICENSE INFORMATION COMPUTING UNIT
35
COMPARING UNIT
36
37
CONTENT DECRYPTING UNIT
33
RECORDING MEDIUM
20
MEDIA NUMBER AREA
21
LICENSE INFORMATION AREA
22
ENCRYPTED CONTENT KEY AREA
23
ENCRYPTED CONTENT AREA
24
RECORDING DEVICE
10
MASTER KEY STORING UNIT
11
LICENSE INFORMATION COMPUTING UNIT
16
CONTENT KEY GENERATING UNIT
12
CONTENT KEY ENCRYPTING UNIT
13
CONTENT STORING UNIT
14
CONTENT ENCRYPTING UNIT
15
CONTENT

FIG.4

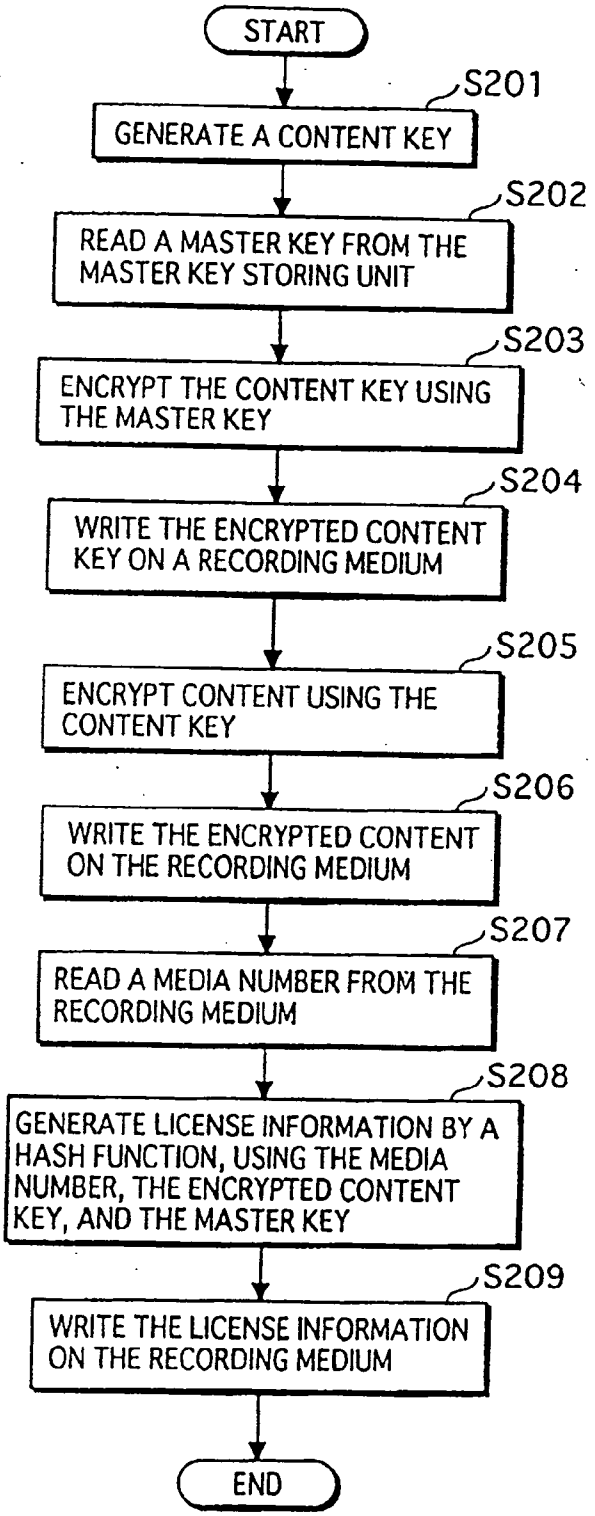

START
S201
GENERATE A CONTENT KEY
S202
READ A MASTER KEY FROM THE MASTER KEY STORING UNIT
S203
ENCRYPT THE CONTENT KEY USING THE MASTER KEY
S204
WRITE THE ENCRYPTED CONTENT KEY ON A RECORDING MEDIUM
S205
ENCRYPT CONTENT USING THE CONTENT KEY
S206
WRITE THE ENCRYPTED CONTENT ON THE RECORDING MEDIUM
S207
READ A MEDIA NUMBER FROM THE RECORDING MEDIUM
S208
GENERATE LICENSE INFORMATION BY A HASH FUNCTION, USING THE MEDIA NUMBER, THE ENCRYPTED CONTENT KEY, AND THE MASTER KEY
S209
WRITE THE LICENSE INFORMATION ON THE RECORDING MEDIUM
END

FIG.5

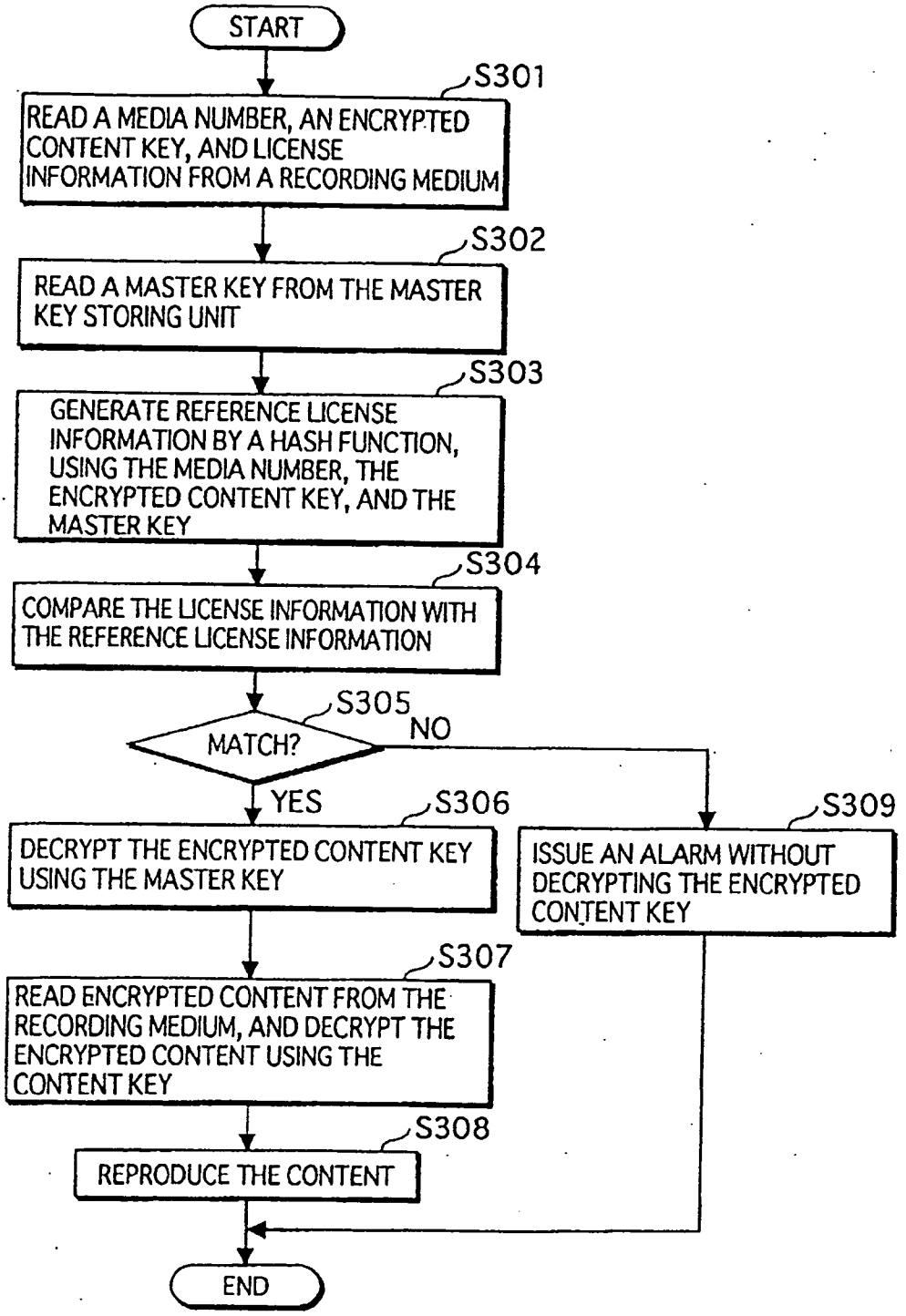

START
S301
READ A MEDIA NUMBER, AN ENCRYPTED CONTENT KEY, AND LICENSE INFORMATION FROM A RECORDING MEDIUM
S302
READ A MASTER KEY FROM THE MASTER KEY STORING UNIT
S303
GENERATE REFERENCE LICENSE INFORMATION BY A HASH FUNCTION, USING THE MEDIA NUMBER, THE ENCRYPTED CONTENT KEY, AND THE MASTER KEY
S304
COMPARE THE LICENSE INFORMATION WITH THE REFERENCE LICENSE INFORMATION
S305
MATCH?
NO
YES
S306
DECRYPT THE ENCRYPTED CONTENT KEY USING THE MASTER KEY
S309
ISSUE AN ALARM WITHOUT DECRYPTING THE ENCRYPTED CONTENT KEY
S307
READ ENCRYPTED CONTENT FROM THE RECORDING MEDIUM, AND DECRYPT THE ENCRYPTED CONTENT USING THE CONTENT KEY
S308
REPRODUCE THE CONTENT
END

FIG.6

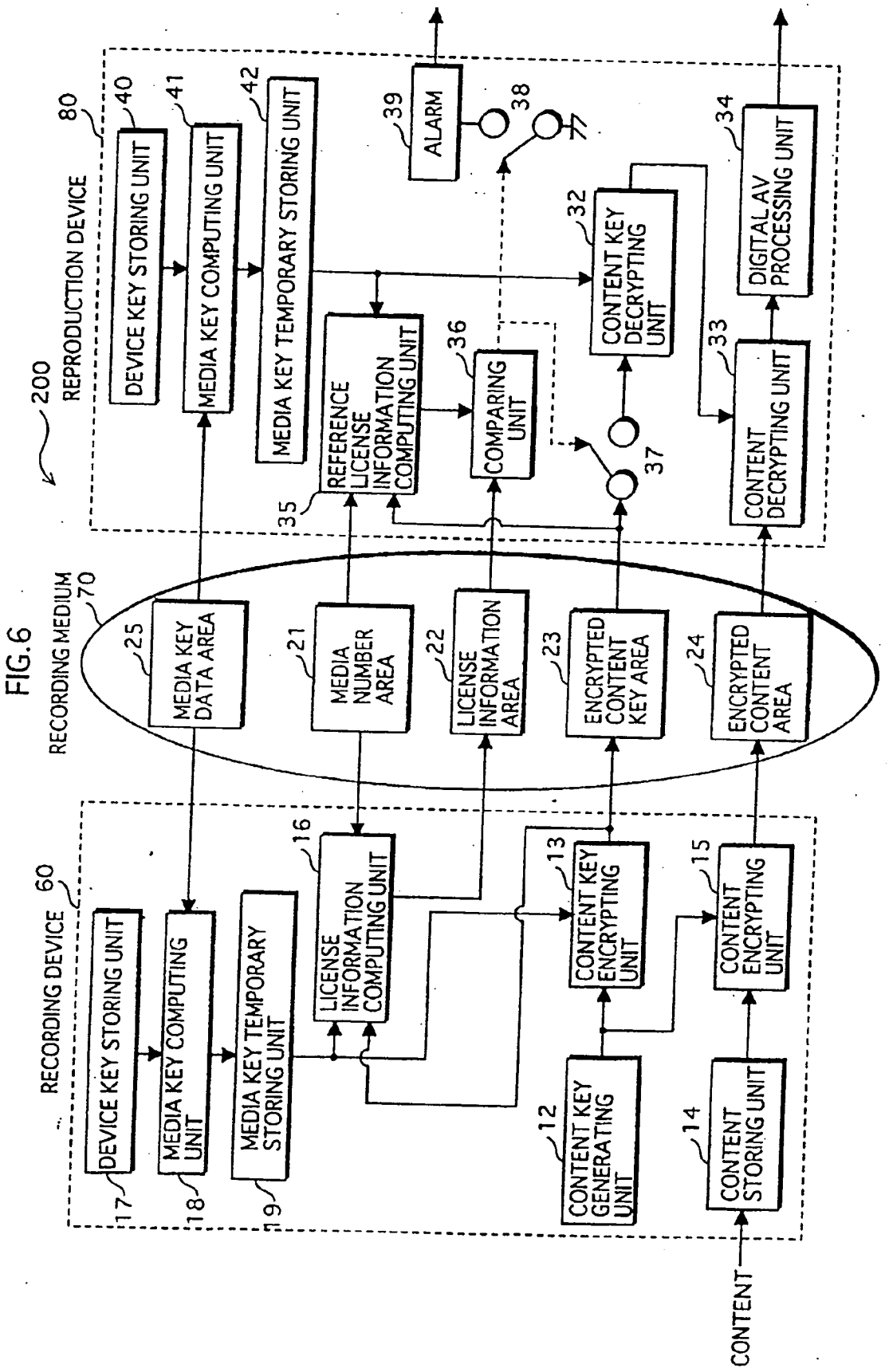

200
REPRODUCTION DEVICE
80
DEVICE KEY STORING UNIT
40
MEDIA KEY COMPUTING UNIT
41
MEDIA KEY TEMPORARY STORING UNIT
42
ALARM
39
38
37
REFERENCE LICENSE INFORMATION COMPUTING UNIT
35
COMPARING UNIT
36
CONTENT KEY DECRYPTING UNIT
32
CONTENT DECRYPTING UNIT
33
DIGITAL AV PROCESSING UNIT
34
RECORDING MEDIUM
70
MEDIA KEY DATA AREA
25
MEDIA NUMBER AREA
21
LICENSE INFORMATION AREA
22
ENCRYPTED CONTENT KEY AREA
23
ENCRYPTED CONTENT AREA
24
RECORDING DEVICE
60
DEVICE KEY STORING UNIT
17
MEDIA KEY COMPUTING UNIT
18
MEDIA KEY TEMPORARY STORING UNIT
19
LICENSE INFORMATION COMPUTING UNIT
16
CONTENT KEY ENCRYPTING UNIT
13
CONTENT ENCRYPTING UNIT
15
CONTENT KEY GENERATING UNIT
12
CONTENT STORING UNIT
14
CONTENT

FIG.7

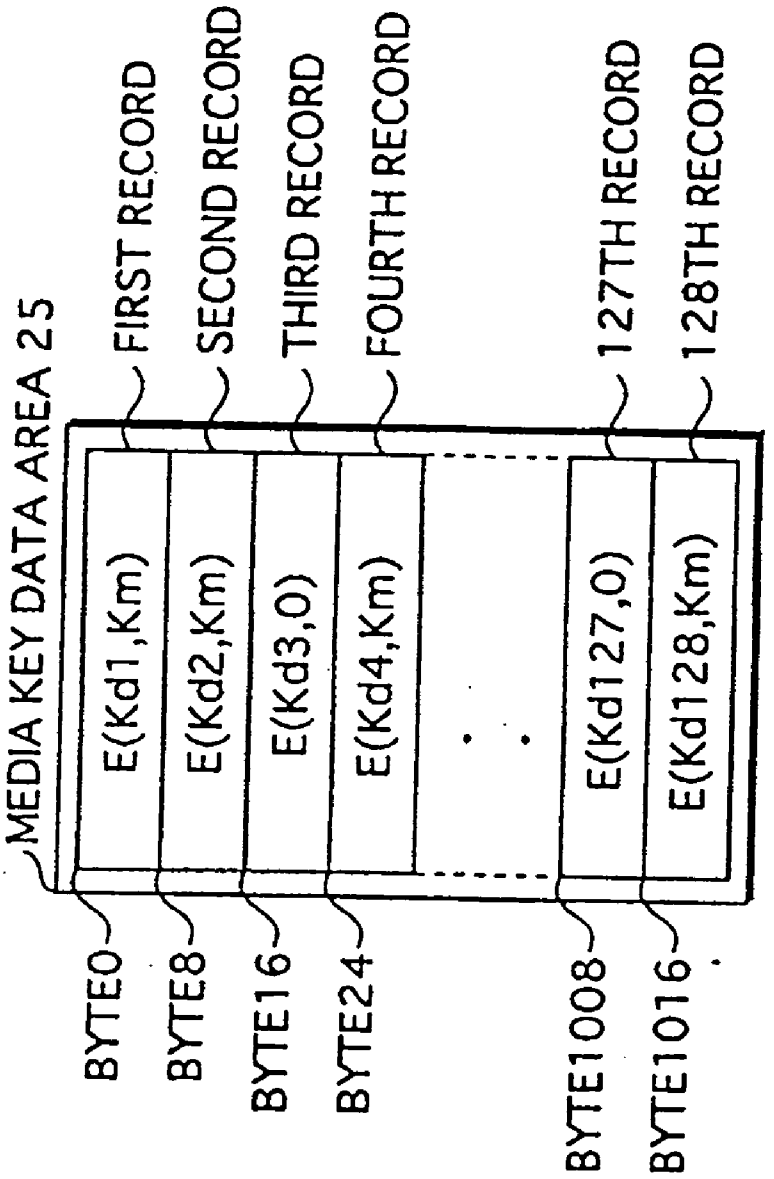

MEDIA KEY DATA AREA 25
FIRST RECORD
SECOND RECORD
THIRD RECORD
FOURTH RECORD
127TH RECORD
128TH RECORD
E(Kd1,Km)
E(Kd2,Km)
E(Kd3,0)
E(Kd4,Km)
E(Kd127,0)
E(Kd128,Km)
BYTE0
BYTE8
BYTE16
BYTE24
BYTE1008
BYTE1016

FIG.8

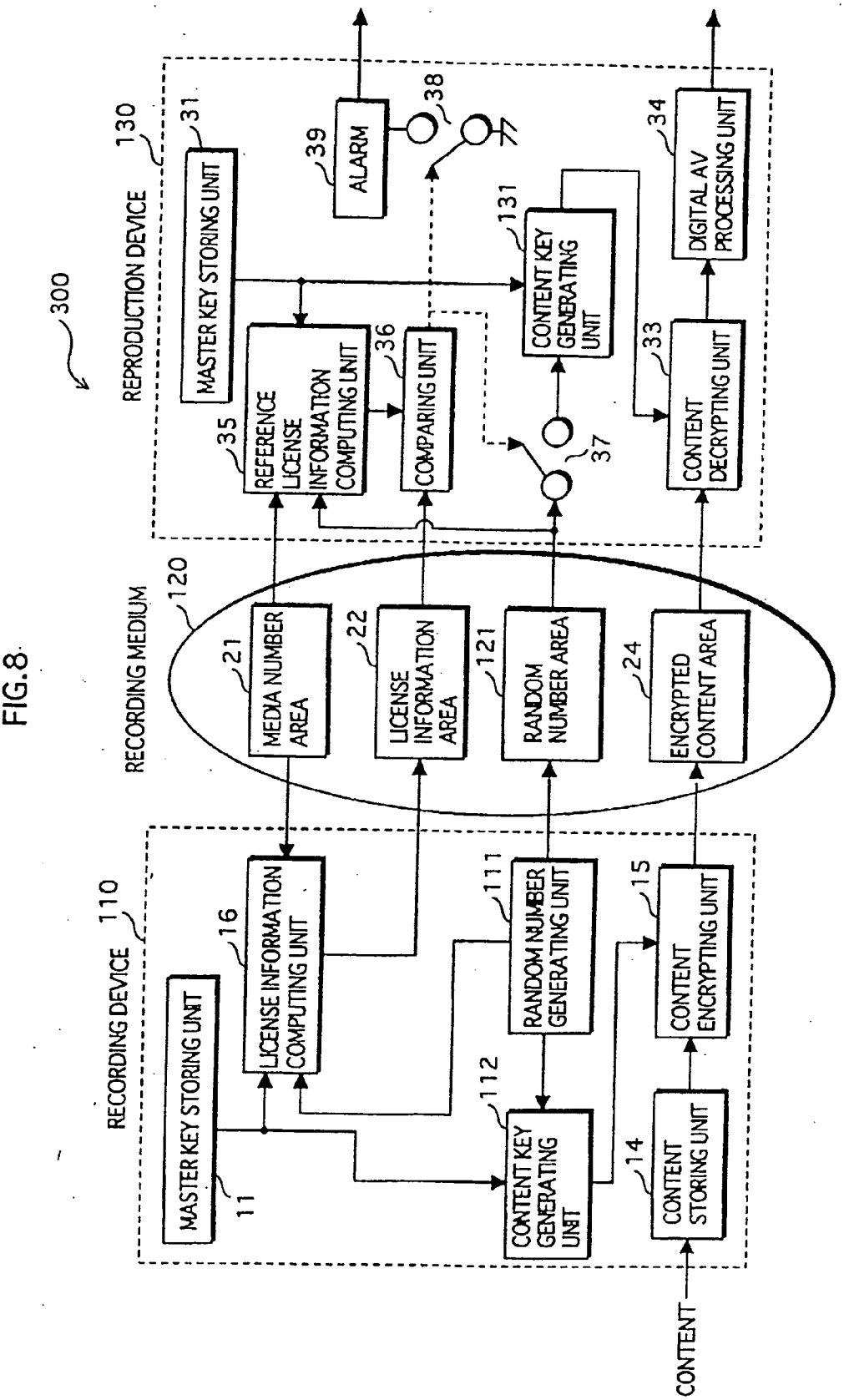

300
RECORDING DEVICE
110
MASTER KEY STORING UNIT
11
LICENSE INFORMATION COMPUTING UNIT
16
CONTENT KEY GENERATING UNIT
112
RANDOM NUMBER GENERATING UNIT
111
CONTENT ENCRYPTING UNIT
15
CONTENT STORING UNIT
14
CONTENT
RECORDING MEDIUM
120
MEDIA NUMBER AREA
21
LICENSE INFORMATION AREA
22
RANDOM NUMBER AREA
121
ENCRYPTED CONTENT AREA
24
REPRODUCTION DEVICE
130
MASTER KEY STORING UNIT
31
REFERENCE LICENSE INFORMATION COMPUTING UNIT
35
COMPARING UNIT
36
CONTENT KEY GENERATING UNIT
131
CONTENT DECRYPTING UNIT
33
DIGITAL AV PROCESSING UNIT
34
ALARM
39
37
38

FIG.9

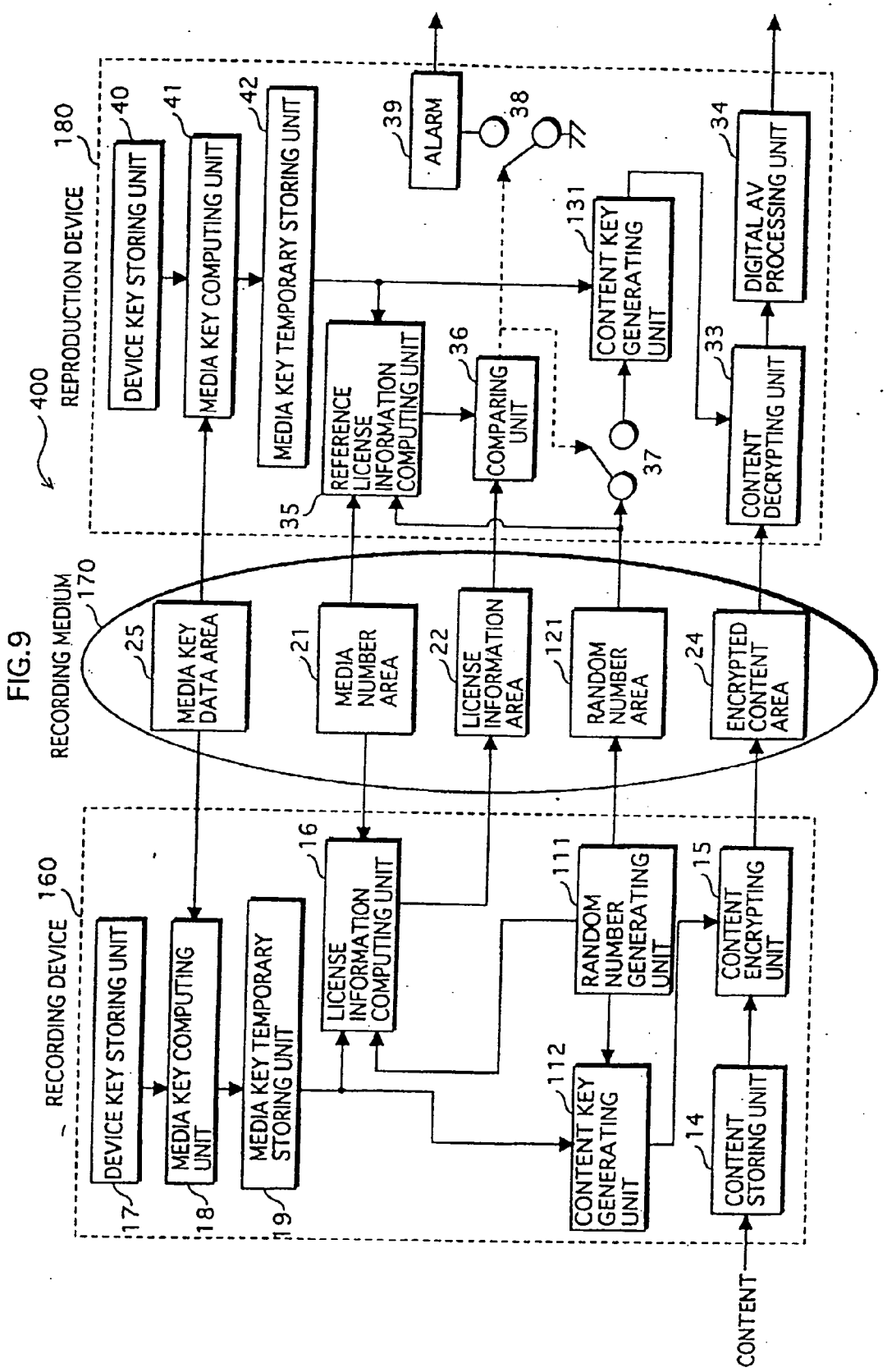

400
REPRODUCTION DEVICE
180
DEVICE KEY STORING UNIT
40
MEDIA KEY COMPUTING UNIT
41
MEDIA KEY TEMPORARY STORING UNIT
42
ALARM
39
38
77
DIGITAL AV PROCESSING UNIT
34
CONTENT KEY GENERATING UNIT
131
REFERENCE LICENSE INFORMATION COMPUTING UNIT
35
COMPARING UNIT
36
37
CONTENT DECRYPTING UNIT
33
RECORDING MEDIUM
170
MEDIA KEY DATA AREA
25
MEDIA NUMBER AREA
21
LICENSE INFORMATION AREA
22
RANDOM NUMBER AREA
121
ENCRYPTED CONTENT AREA
24
RECORDING DEVICE
160
DEVICE KEY STORING UNIT
17
MEDIA KEY COMPUTING UNIT
18
MEDIA KEY TEMPORARY STORING UNIT
19
LICENSE INFORMATION COMPUTING UNIT
16
RANDOM NUMBER GENERATING UNIT
111
CONTENT ENCRYPTING UNIT
15
CONTENT KEY GENERATING UNIT
112
CONTENT STORING UNIT
14
CONTENT

FIG. 10

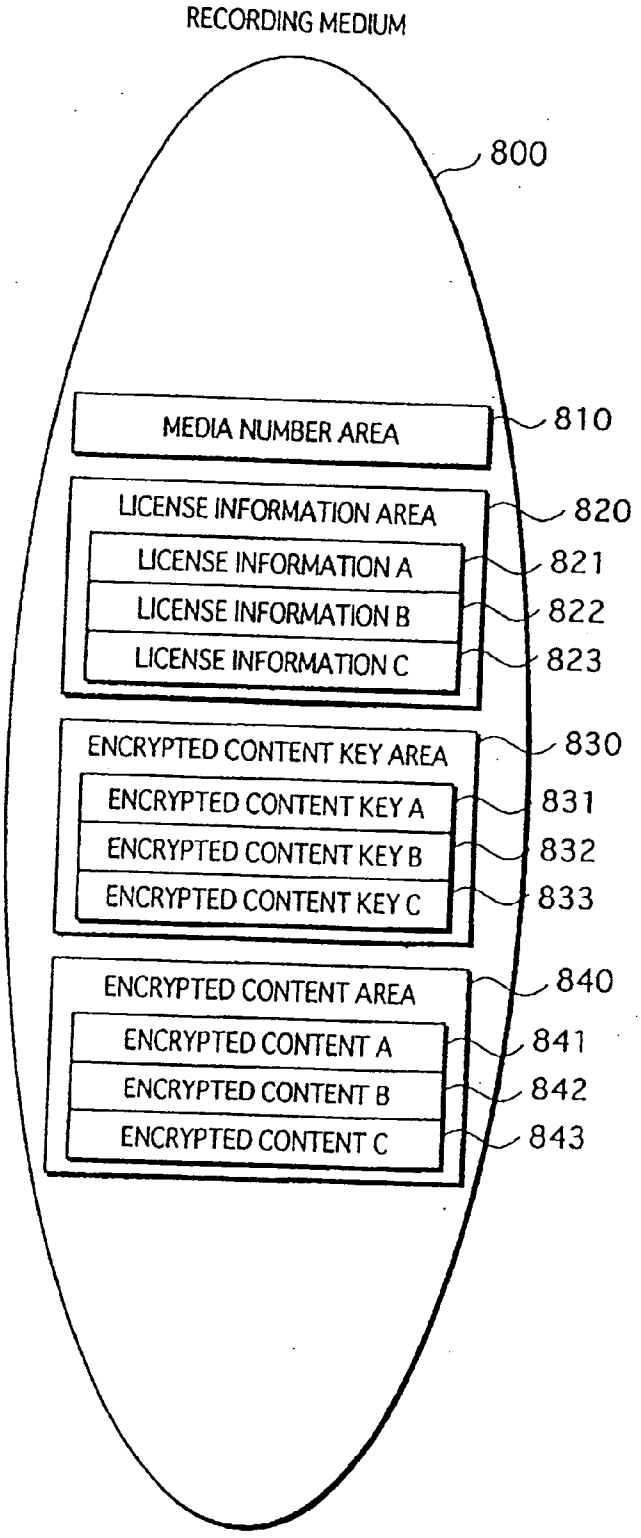
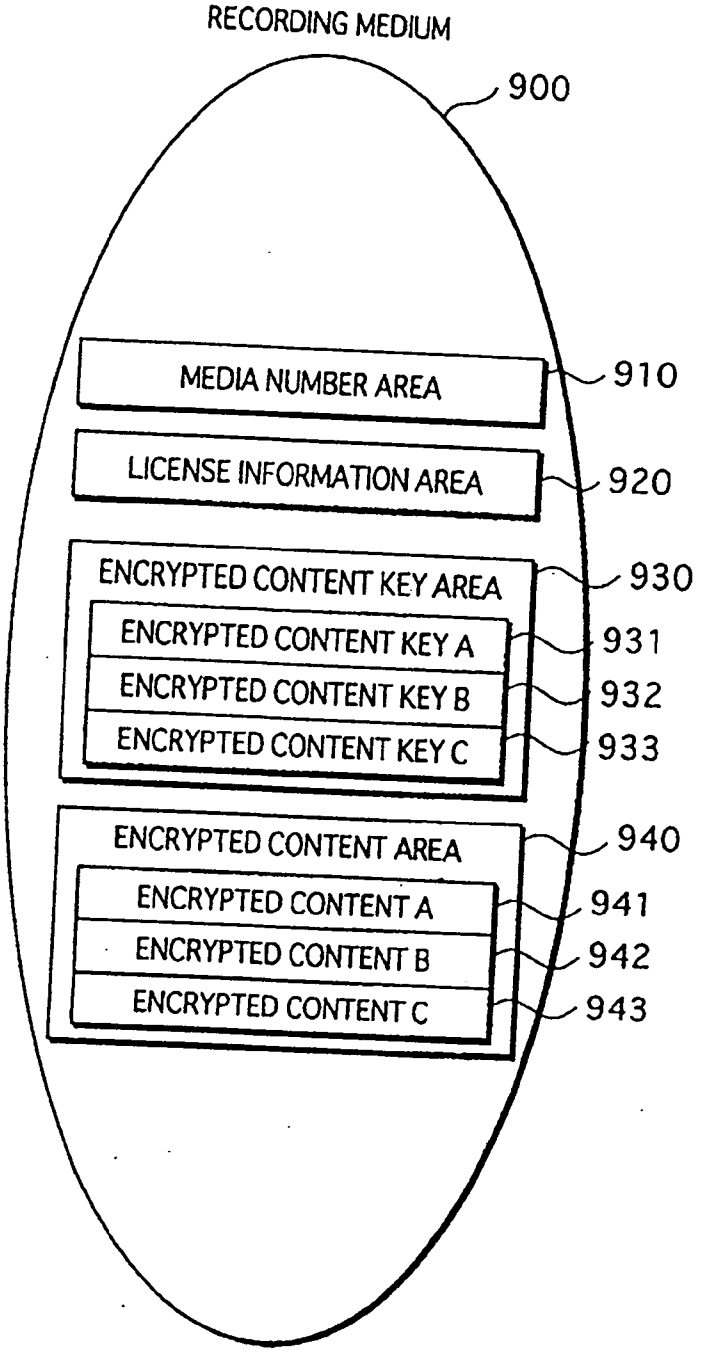

RECORDING MEDIUM
800
MEDIA NUMBER AREA
810
LICENSE INFORMATION AREA
820
LICENSE INFORMATION A
821
LICENSE INFORMATION B
822
LICENSE INFORMATION C
823
ENCRYPTED CONTENT KEY AREA
830
ENCRYPTED CONTENT KEY A
831
ENCRYPTED CONTENT KEY B
832
ENCRYPTED CONTENT KEY C
833
ENCRYPTED CONTENT AREA
840
ENCRYPTED CONTENT A
841
ENCRYPTED CONTENT B
842
ENCRYPTED CONTENT C
843

FIG. 11


RECORDING MEDIUM
900
MEDIA NUMBER AREA
910
LICENSE INFORMATION AREA
920
ENCRYPTED CONTENT KEY AREA
930
ENCRYPTED CONTENT KEY A
931
ENCRYPTED CONTENT KEY B
932
ENCRYPTED CONTENT KEY C
933
ENCRYPTED CONTENT AREA
940
ENCRYPTED CONTENT A
941
ENCRYPTED CONTENT B
942
ENCRYPTED CONTENT C
943

COPYRIGHT PROTECTION SYSTEM, RECORDING DEVICE, AND REPRODUCTION DEVICE

[0001] This application is a divisional of U.S. application Ser. No. 10/213,154, filed Aug. 7, 2002, which is based on applications Nos. 2001-240778 and 2001-260932 filed in Japan, the contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to techniques for protecting a copyright of content recorded on a writable recording medium on which a media number unique to the recording medium has been recorded.

[0004] 2. Prior Art

[0005] A content distribution form of receiving content such as a movie film that is broadcast by digital broadcasting, recording the content on a recording medium such as an optical disk, and reproducing the content from the recording medium is becoming widespread in recent years. On the other hand, unauthorized distribution and reproduction of such content by copying the content through a personal computer and the like without license is also increasing.

[0006] To block unauthorized copying, a copyright protection system shown in FIG. **1** is conventionally known as a technique of restricting distribution and reproduction of content.

[0007] In FIG. **1**, the copyright protection system is roughly made up of a recording device **1000** and a reproduction device **3000**. The recording device **1000** encrypts content and records the encrypted content on a recording medium **2000**. The reproduction device **3000** decrypts the encrypted content recorded on the recording medium **2000**, and reproduces the decrypted content. The recording device **1000** includes a key encryption key computing unit **1001**, a content key generating unit **1002**, a content key encrypting unit **1003**, a content storing unit **1004**, and a content encrypting unit **1005**. The reproduction device **3000** includes a key decryption key computing unit **3001**, a content key decrypting unit **3002**, a content key temporary storing unit **3003**, a content decrypting unit **3004**, and a digital AV processing unit **3005**.

[0008] The recording medium **2000** is a recording medium such as an optical disk, and has a media number area **2001** in which a media number has been recorded. A media number is an identifier that is unique to each recording medium, and is written at the time of manufacturing the recording medium. The media number area **2001** is protected so that the media number recorded at the time of manufacturing cannot be rewritten thereafter.

[0009] The recording device **1000** acquires content from the outside, and stores the acquired content in the content storing unit **1004**.

[0010] When the recording medium **2000** is connected to the recording device **1000**, the content encrypting unit **1005** reads the content from the content storing unit **1004**, and encrypts the content by using a content key. The content encrypting unit **1005** records the encrypted content in an encrypted content area **2003** of the recording medium **2000**. Here, the content key is a random number generated by the content key generating unit **1002**. The content key encrypting unit **1003** encrypts the content key by using a content key encryption key, and records the encrypted content key in an encrypted content key area **2002** of the recording medium **2000**. Here, the content key encryption key is a key computed by the key encryption key computing unit **1001**. The key encryption key computing unit **1001** computes the content key encryption key according to a hash function, by using a master key and the media number recorded in the media number area **2001**. The master key is a key which is held commonly by the recording device **1000** and the reproduction device **3000** in secrecy from third parties.

[0011] FIG. **2** shows an inner computational mechanism of the key encryption key computing unit **1001**.

[0012] The media number is input from a point A, and is encrypted by a DES encrypting unit **4000** using the master key held in a master key storing unit **4001** according to DES (Data Encryption Standard). After this, an exclusive-OR operation is performed on the encrypted media number and the media number by an exclusive-OR circuit **4002**. The outcome is output from a point B as the content key encryption key.

[0013] On the other hand, when the recording medium **2000** is connected to the reproduction device **3000**, the key decryption key computing unit **3001** reads the media number from the media number area **2001** of the recording medium **2000**. The key decryption key computing unit **3001** performs the same computation as the key encryption key computing unit **1001** in the recording device **1000**, to obtain a content key decryption key. Here, if the key decryption key computing unit **3001** uses the same master key and media number as the key encryption key computing unit **1001**, the content key decryption key will end up being the same as the content key encryption key.

[0014] The content key decrypting unit **3002** reads the encrypted content key from the encrypted content key area **2002**, and decrypts the encrypted content key by using the content key decryption key to obtain the content key. The content key decrypting unit **3002** temporarily stores the content key in the content key temporary storing unit **3003**.

[0015] The content decrypting unit **3004** reads the encrypted content from the encrypted content area **2003**, and decrypts the encrypted content by using the content key to obtain the content.

[0016] The digital AV processing unit **3005** converts the content to analog audio/video data, and outputs the converted data to external devices such as a speaker and a display.

[0017] Thus, the encrypted content key can be decrypted properly only if the reproduction device **3000** uses the same media number as that used for encrypting the content key.

[0018] In other words, if the reproduction device **3000** uses a media number which is different from the media number used for encrypting the content key, the encrypted content key cannot be decrypted properly.

[0019] Suppose an unauthorized party copies the encrypted content key and encrypted content recorded on the recording medium **2000**, to another recording medium. Even

if the reproduction device **3000** tries to reproduce this recording medium, the reproduction device **3000** cannot recover the correct content key from the encrypted content key copied on this recording medium, since a media number of this recording medium is different from that of the recording medium **2000**.

[**0020**] Thus, the conventional copyright protection system enables the reproduction device **3000** to properly decrypt an encrypted content key of an original recording medium which has been recorded by the recording device **1000**. On the other hand, the conventional copyright protection system makes it impossible for the reproduction device **3000** to properly decrypt an encrypted content key of a copy recording medium, thereby preventing content from being distributed by unauthorized copying.

[**0021**] The reproduction device **3000** reproduces a recording medium irrespective of whether the recording medium is an original or a copy. This being so, if the recording medium is a copy, the reproduction device **3000** will end up reproducing unintelligible data which is different from the original content, as video and audio.

[**0022**] A user who is using the recording medium without knowing it is a copy may suspect so, seeing that the reproduced video and audio are abnormal. However, abnormal reproduction can also be caused by other factors such as a malfunction of the device and an error of reading data from the recording medium. Therefore, even if an abnormal reproduction occurs, the user cannot determine right away that the recording medium is a copy.

SUMMARY OF THE INVENTION

[**0023**] The present invention has an object of providing a copyright protection system that can prevent content from being distributed by unauthorized copying. This is done by checking whether a recording medium is an original or a copy, and allowing the recording medium to be reproduced if the recording medium is an original, while prohibiting the recording medium from being reproduced if the recording medium is a copy.

[**0024**] The stated object can be achieved by a copyright protection system including a recording device for recording encrypted content on a recording medium and a decryption device for decrypting the encrypted content recorded on the recording medium. The recording medium has an unrewritable area in which a media number that is unique to the recording medium is recorded. The recording device includes: a generating unit operable to acquire the media number from the recording medium, and generate license information by performing a specific operation using the media number and decryption information so that the license information reflects both the media number and the decryption information, which is needed to decrypt the encrypted content; and a recording unit operable to record the license information, the decryption information, and the encrypted content on the recording medium. The decryption device includes: a judging unit operable to read the media number, the decryption information, and the license information from the recording medium, and judge whether the read license information can be obtained if the specific operation is performed using the read media number and the read decryption information; and a decrypting unit operable to read the encrypted content from the recording medium and decrypt the encrypted content by using the decryption information, only if the judgement by the judging unit is in the affirmative.

[**0025**] With this construction, the license information is generated by using the media number recorded on the recording medium and the decryption information for decrypting the encrypted content, so that the license information reflects both the media number and the decryption information. In more detail, the license information is a hash value that is generated by applying a hash function to input data which is a concatenated value of the media number and the decryption information. Since the hash function involves an irreversible one-way function, it is computationally infeasible to recover the media number and the decryption information from the license information. Also, it is computationally infeasible to generate different input data that hashes to the same license information. This property of the hash function prevents the license information from being obtained by using data other than the media number and decryption information which are used for generating the license information. In other words, if the recording medium is not a copy but an original, the license information recorded on the recording medium can be obtained by applying the hash function to the media number and decryption information recorded on the recording medium. Accordingly, the judging unit judges whether the recording medium is an original or a copy, by checking whether the license information can be obtained if the hash function is performed on the media number and decryption information recorded on the recording medium. If the recording medium is an original, the decrypting unit decrypts the encrypted content. On the other hand, if the recording medium is a copy, the decrypting unit does not decrypt the encrypted content. In this way, content can be protected from being copied to another recording medium and put to use by an unauthorized party.

BRIEF DESCRIPTION OF THE DRAWINGS

[**0026**] These and other objects, advantages and features of the present invention will become apparent from the following description thereof when taken in conjunction with the accompanying drawings which illustrate specific embodiments of the invention.

[**0027**] In the drawings:

[**0028**] FIG. **1** is a block diagram showing a construction of a conventional copyright protection system;

[**0029**] FIG. **2** shows an inner computational mechanism of a key encryption key computing unit shown in FIG. **1**;

[**0030**] FIG. **3** is a block diagram showing a construction of a copyright protection system to which the first embodiment of the present invention relates;

[**0031**] FIG. **4** is a flowchart showing an operation of a recording device shown in FIG. **3**;

[**0032**] FIG. **5** is a flowchart showing an operation of a reproduction device shown in FIG. **3**;

[**0033**] FIG. **6** is a block diagram showing a construction of a copyright protection system to which the second embodiment of the present invention relates;

[**0034**] FIG. **7** shows one example of media key data recorded in a media key data area shown in FIG. **6**;

[0035] FIG. **8** is a block diagram showing a construction of a copyright protection system to which the third embodiment of the present invention relates;

[0036] FIG. **9** is a block diagram showing a construction of a copyright protection system to which the fourth embodiment of the present invention relates;

[0037] FIG. **10** shows an example construction of a recording medium; and

[0038] FIG. **11** shows another example construction of a recording medium.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

First Embodiment

[0039] The following describes the first embodiment of the present invention with reference to drawings.

(Construction)

[0040] FIG. **3** is a block diagram showing a construction of a copyright protection system **100** to which the first embodiment of the present invention relates.

[0041] The copyright protection system **100** is roughly made up of a recording device **10** and a reproduction device **30**. The recording device **10** records encrypted content on a recording medium **20**. The reproduction device **30** decrypts the encrypted content recorded on the recording medium **20**, and reproduces the decrypted content. The following explanation begins with the recording medium **20**, followed by the constructions of the recording device **10** and reproduction device **30**.

(Recording Medium **20**)

[0042] The recording medium **20** is an optical disk. The recording medium **20** has an unrewritable media number area **21** in which a media number has been recorded, and a recordable area.

[0043] A media number is a 64-bit identifier that is unique to each recording medium, and is written in the media number area **21** at the time of manufacturing the recording medium. The media number area **21** is protected so that the media number written at the time of manufacturing cannot be rewritten thereafter.

[0044] The recordable area is used by the recording device **10** to reserve a license information area **22**, an encrypted content key area **23**, and an encrypted content area **24**. The recording device **10** records various data to these reserved areas.

[0045] The encrypted content area **24** is used by the recording device **10** to record encrypted content.

[0046] The encrypted content key area **23** is used by the recording device **10** to record an encrypted content key.

[0047] The encrypted content key is information which is needed when the reproduction device **30** decrypts the encrypted content. That is, the encrypted content key is a content key in encrypted form. The content key is a secret key of a secret key cipher, and is used for both encrypting and decrypting content.

[0048] The license information area **22** is used by the recording device **10** to record license information.

[0049] The license information is information used for verifying whether or not the data recorded on the recording medium **20** is original data recorded by the recording device **10**. In other words, the license information is used for verifying whether the recording medium **20** is an original or a copy. The reproduction device **30** can determine whether the recording medium **20** is an original or a copy, by checking this license information. The license information is explained in detail later.

(Construction of the Recording Device **10**)

[0050] The recording device **10** is constructed as follows.

[0051] The recording device **10** includes a master key storing unit **11**, a content key generating unit **12**, a content key encrypting unit **13**, a content storing unit **14**, a content encrypting unit **15**, and a license information computing unit **16**.

[0052] The master key storing unit **11** is a memory in which a 56-bit master key has been stored in advance. The master key is possessed commonly by the recording device **10** and the reproduction device **30**, in secrecy from outside the recording device **10**.

[0053] The content key generating unit **12** is a random number generator for generating a random number as a content key. Upon receiving a start signal from a control circuit (not illustrated) in the recording device **10**, the content key generating unit **12** generates 56-bit random data, and outputs the generated 56-bit random data as a content key.

[0054] The content key encrypting unit **13** encrypts the content key by using the master key, and records the encrypted content key on the recording medium **20**. Here, an encryption algorithm such as DES is used. In detail, the content key encrypting unit **13** acquires the content key generated by the content key generating unit **12** and the master key stored in the master key storing unit **11**, and encrypts the content key by using the master key to obtain the encrypted content key of 64 bits in length. The content key encrypting unit **13** reserves the encrypted content key area **23** in the recordable area of the recording medium **20**, and records the encrypted content key to the encrypted content key area **23**.

[0055] The content storing unit **14** is a storage device such as a hard disk, and stores content which is input from outside the recording device **10**. As one example, a satellite broadcast reception device receives digital content of a movie film that is broadcast by digital satellite broadcasting, and inputs the content to the recording device **10** so that the content is stored in the content storing unit **14**.

[0056] The content encrypting unit **15** encrypts the content by using the content key, and records the encrypted content on the recording medium **20**. Here, an encryption algorithm such as DES is used. In detail, the content encrypting unit **15** acquires the content key generated by the content key generating unit **12** and the content stored in the content storing unit **14**. The content encrypting unit **15** divides the content into 64-bit blocks, and encrypts each block by using the content key. The content encrypting unit **15** then reserves the encrypted content area **24** in the recordable area of the

recording medium **20**, and records the encrypted content which is made up of the encrypted blocks to the encrypted content area **24**.

[**0057**] The license information computing unit **16** has a computational mechanism for generating license information. The license information computing unit **16** acquires the media number stored in the media number area **21** of the recording medium **20**, the encrypted content key generated by the content key encrypting unit **13**, and the master key stored in the master key storing unit **11**. The license information computing unit **16** concatenates the media number, the master key, and the encrypted content key into one bit string. The license information computing unit **16** takes this bit string as input, and performs a computation according to a hash function such as SHA-1 (Secure Hash Algorithm 1). As a result, the license information computing unit **16** obtains a hash value of 160 bits in length, and sets this hash value as license information. The license information computing unit **16** reserves the license information area **22** in the recordable area of the recording medium **20**, and records the license information to the license information area **22**.

[**0058**] The SHA-1 hash function is as follows.

[**0059**] The SHA-1 hash function is a hash function that is used for authentication, digital signatures, and the like. This hash function generates a 160-bit hash value from data of no more than 264 bits in length. Since the SHA-1 hash function involves an irreversible one-way function, it is computationally infeasible to recover the original data from the hash value. Also, it is computationally infeasible to generate data which is different from the original data but which hashes to the same value as the original data. This property can be utilized in the following manner. The sender sends data and a hash value generated from the data to the recipient. The recipient receives the data and the hash value, generates a hash value from the received data, and compares the generated hash value with the received hash value. This enables the recipient to detect whether or not the data has been tampered during communication.

[**0060**] Due to the property of the SHA-1 hash function, it is difficult to obtain the license information by using values other than the media number, encrypted content key, and master key which have been used by the license information computing unit **16** to generate the license information. In other words, the license information reflects all of the media number, encrypted content key, and master key that were used for generating the license information.

[**0061**] Accordingly, when the media number, encrypted content key, and master key which are reflected by the license information recorded in the license information area **22** are respectively the same as the media number recorded in the media number area **21**, the encrypted content key recorded in the encrypted content key area **23**, and the master key possessed by the recording device **10**, the license information verifies that the data recorded on the recording medium **20** is authentic.

(Construction of the Reproduction Device **30**)

[**0062**] The reproduction device **30** is constructed as follows.

[**0063**] The reproduction device **30** includes a master key storing unit **31**, a content key decrypting unit **32**, a content decrypting unit **33**, a digital AV processing unit **34**, a reference license information computing unit **35**, a comparing unit **36**, a first switch **37**, a second switch **38**, and an alarm **39**.

[**0064**] The master key storing unit **31** is a memory in which a 56-bit master key has been stored in advance. This master key is the same as the master key stored in the master key storing unit **11** in the recording device **10**.

[**0065**] The content key decrypting unit **32** decrypts the encrypted content key recorded on the recording medium **20**, by using the master key. In detail, the content key decrypting unit **32** acquires the encrypted content key recorded in the encrypted content key area **23** and the master key stored in the master key storing unit **31**, and decrypts the encrypted content key by using the master key to obtain the content key.

[**0066**] The content decrypting unit **33** decrypts the encrypted content recorded on the recording medium **20**, by using the content key. The content decrypting unit **33** outputs the decrypted content to the digital AV processing unit **34**. In detail, the content decrypting unit **33** acquires the content key decrypted by the content key decrypting unit **32** and the encrypted content recorded in the encrypted content area **24**. The content decrypting unit **33** divides the encrypted content into 64-bit blocks, and decrypts each block by using the content key. The content decrypting unit **33** then outputs the content which is made up of the decrypted blocks, to the digital AV processing unit **34**.

[**0067**] The digital AV processing unit **34** receives the content from the content decrypting unit **33**, and converts the content to analog audio/video data. The digital AV processing unit **34** outputs the analog audio/video data to external devices such as a speaker and a display.

[**0068**] The first switch **37** is opened or closed under control of the comparing unit **36**. When the first switch **37** is closed, the content key decrypting unit **32** is permitted to read the encrypted content key from the encrypted content key area **23**. When the first switch **37** is opened, the content key decrypting unit **32** is inhibited from reading the encrypted content key from the encrypted content key area **23**.

[**0069**] The second switch **38** is opened or closed under control of the comparing unit **36**. When the second switch **38** is closed, power is supplied to the alarm **39**. When the second switch **38** is opened, power is not supplied to the alarm **39**.

[**0070**] The alarm **39** is a circuit that operates to produce a warning sound when supplied with power.

[**0071**] The reference license information computing unit **35** has a computational mechanism that performs the same computation as the license information computing unit **16**, to compute reference license information. In detail, the reference license information computing unit **35** acquires the media number recorded in the media number area **21**, the encrypted content key recorded in the encrypted content key area **23**, and the master key stored in the master key storing unit **31**. The reference license information computing unit **35** concatenates the media number, the master key, and the encrypted content key into one bit string. The order of concatenating these data is the same as the order used by the

license information computing unit **16**. The reference license information computing unit **35** takes this bit string as input, and performs a computation using a hash function such as SHA-1. As a result, the reference license information computing unit **35** obtains a hash value of 160 bits in length, and sets the hash value as reference license information.

[**0072**] The comparing unit **36** acquires the license information recorded in the license information area **22** and the reference license information generated by the reference license information computing unit **35**, and compares the two values. If they match, the comparing unit **36** exercises control so that the encrypted content can be decrypted. On the other hand, if they do not match, the comparing unit **36** exercises control so that the decryption of the encrypted content is inhibited and the alarm **39** produces a warning sound.

[**0073**] In more detail, if the license information and the reference license information match, the comparing unit **36** closes the first switch **37** so that the content key decrypting unit **32** reads the encrypted content key from the encrypted content key area **23**. As a result, the encrypted content key is decrypted, and the encrypted content is decrypted and reproduced.

[**0074**] If the license information and the reference license information do not match, the comparing unit **36** opens the first switch **37**, and closes the second switch **38**. Since the first switch **37** is opened, the content key decrypting unit **32** cannot read the encrypted content key from the encrypted content key area **23**. Therefore, the encrypted content key is not decrypted, and so the encrypted content is neither decrypted nor reproduced. Also, since the second switch **38** is closed, power is supplied to the alarm **39** which accordingly produces a warning sound.

[**0075**] Thus, the reference license information computing unit **35** and the comparing unit **36** determine whether or not the media number recorded in the media number area **21**, the encrypted content key recorded in the encrypted content key area **23**, and the master key stored in the master key storing unit **31** are all reflected in the license information recorded in the license information area **22**. If they are, the reference license information computing unit **35** and the comparing unit **36** exercise control so that the encrypted content is decrypted. Otherwise, the reference license information computing unit **35** and the comparing unit **36** exercise control so that the encrypted content is not decrypted and, instead, a warning sound is produced from the alarm **39**.

[**0076**] Only when the media number, encrypted content key, and master key used for generating the reference license information are respectively the same as the media number, encrypted content key, and master key used for generating the license information, the reference license information and the license information will end up being the same. In other words, if any of the media number, encrypted content key, and master key used for generating the reference license information is different from the corresponding one of the media number, encrypted content key, and master key used for generating the license information, the reference license information will be different from the license information.

(Operation)

[**0077**] Operations of the above-constructed recording device **10** and reproduction device **30** are explained below.

[**0078**] FIG. **4** is a flowchart showing an operation of the recording device **10**.

[**0079**] First, the content key generating unit **12** generates a content key (S**201**).

[**0080**] The content key encrypting unit **13** reads a master key from the master key storing unit **11** (S**202**).

[**0081**] The content key encrypting unit **13** encrypts the content key by using the master key (S**203**).

[**0082**] The content key encrypting unit **13** reserves the encrypted content key area **23** in the recordable area of the recording medium **20**, and records the encrypted content key to the encrypted content key area **23** (S**204**).

[**0083**] The content encrypting unit **15** reads content from the content storing unit **14**. The content encrypting unit **15** divides the content into blocks of 64 bits, and encrypts each block by using the content key (S**205**).

[**0084**] The content encrypting unit **15** reserves the encrypted content area **24** in the recordable area of the recording medium **20**, and records the encrypted content to the encrypted content area **24** (S**206**).

[**0085**] The license information computing unit **16** reads a media number from the media number area **21** of the recording medium **20** (S**207**).

[**0086**] The license information computing unit **16** generates license information by a hash function, by using the read media number, the master key stored in the master key storing unit **11**, and the encrypted content key generated by the content key encrypting unit **13** (S**208**).

[**0087**] The license information computing unit **16** reserves the license information area **22** in the recordable area of the recording medium **20**, and records the license information to the license information area **22** (S**209**).

[**0088**] FIG. **5** is a flowchart showing an operation of the reproduction device **30**.

[**0089**] The reference license information computing unit **35** reads a media number from the media number area **21** of the recording medium **20**, and an encrypted content key from the encrypted content key area **23** of the recording medium **20**. The comparing unit **36** reads license information from the license information area **22** of the recording medium **20** (S**301**).

[**0090**] The reference license information computing unit **35** reads a master key from the master key storing unit **31** (S**302**).

[**0091**] The reference license information computing unit **35** generates reference license information by a hash function, by using the media number, the encrypted content key, and the master key. The hash function used here is the same as the hash function used in step S**208** (S**303**).

[**0092**] The comparing unit **36** compares the reference license information with the license information read from the recording medium **20** (S**304**).

[**0093**] If the license information and the reference license information match, steps S**306**-S**308** are performed. Otherwise, step S**309** is performed.

[0094] In more detail, if the license information and the reference license information match, the comparing unit **36** closes the first switch **37**. As a result, the content key decrypting unit **32** reads the encrypted content key from the encrypted content key area **23**, and decrypts the encrypted content key by using the master key stored in the master key storing unit **31** to obtain a content key (S**306**).

[0095] The content decrypting unit **33** reads encrypted content from the encrypted content area **24**, and decrypts the encrypted content by using the content key to obtain content (S**307**).

[0096] The digital AV processing unit **34** reproduces the content as an audio/video signal, and outputs the audio/video signal to a speaker, a display, and the like (S**308**).

[0097] On the other hand, if the license information and the reference license information do not match, the comparing unit **36** opens the first switch **37**, and closes the second switch **38**. As a result, the content key decrypting unit **32** is inhibited form decrypting the encrypted content key, so that the encrypted content will be neither decrypted nor reproduced. Meanwhile, power is supplied to the alarm **39**, which accordingly produces a warning sound and outputs the warning sound to a speaker or the like (S**309**).

(Conclusion)

[0098] According to the above construction of the copyright protection system **100**, the reproduction device **30** does not reproduce a recording medium in any of the following Cases 1 to 3.

[0099] (Case 1) A media number used for generating license information which is recorded on a recording medium is different from a media number used for generating reference license information.

[0100] Suppose license information, an encrypted content key, and encrypted content which have been recorded on the recording medium **20** by the recording device **10** are copied to another recording medium. This being so, Case 1 applies when the reproduction device **30** tries to reproduce this recording medium, because a media number of this other recording medium is different from a media number of the recording medium **20**.

[0101] (Case 2) An encrypted content key used for generating license information which is recorded on a recording medium is different from an encrypted content key used for generating reference license information.

[0102] Suppose an encrypted content key and encrypted content of another recording medium are copied to the encrypted content key area **23** and encrypted content area **24** of the recording medium **20** over an existing encrypted content key and encrypted content. This being so, Case 2 applies when the reproduction device **30** tries to reproduce the recording medium **20**, because the encrypted content key copied from the other recording medium is usually different from the encrypted content key originally recorded on the recording medium **20**. It is extremely rare that the copied encrypted content key and the original encrypted content key have the same value.

[0103] (Case 3) A master key used for generating license information which is recorded on a recording medium is different from a master key used for generating reference license information.

[0104] Suppose another recording device that does not have a master key possessed by the recording device **10** and reproduction device **30** records data on a recording medium. This being so, Case 3 applies when the reproduction device **30** tries to reproduce this recording medium. Since the master key is concealed from outside devices that do not belong to the copyright protection system **100**, unless the master key is stolen, it is impossible for the outside devices to make a recording medium that can be reproduced by the reproduction device **30**.

[0105] As described above, the reproduction device **30** reproduces only original recording media recorded by the recording device **10**, and does not reproduce recording media made by unauthorized copying and the like. Thus, the copyright protection system **100** can keep content from being distributed by unauthorized copying and the like.

Second Embodiment

[0106] The following describes the second embodiment of the present invention.

[0107] The first embodiment has a construction in which the recording device **10** and the reproduction device **30** prestore the same master key that is necessary for encrypting and decrypting a content key and content. This being so, when there are a plurality of recording devices **10** and reproduction devices **30**, each of these devices stores the same master key. In this construction, if one device is physically attacked, i.e., if one device is analyzed by an unauthorized party to reveal the master key stored in that device, not only the attacked device but also the rest of the devices become inoperative.

[0108] To overcome this problem, the second embodiment makes improvements to the copyright protection system **100** of the first embodiment, so that even when one recording device or reproduction device is physically attacked, the rest of the devices can be kept from becoming inoperative.

[0109] The following points are the main improvements in the second embodiment.

[0110] (1) A different device key is assigned to and stored in each of the plurality of recording devices and reproduction devices.

[0111] (2) A media key is processed and stored in the recording medium at the time of manufacturing. The media key is a key that is necessary for encrypting and decrypting a content key and content. Here, the media key is processed in such a way that the media key can be recovered from the processed media key only when a media key-acquirable device key is used and not when a media key-unacquirable device key is used (as will be described in detail later). The media key-acquirable device key is a device key assigned to a device that is not reported, at the time of manufacturing the recording medium, as having been physically attacked. The media key-unacquirable device key is a device key assigned to a device that is reported as having been physically attacked.

[0112] (3) A recording device tries to acquire the media key from the recording medium by using a device key held in the recording device. If the recording device has succeeded in acquiring the media key, the recording device

performs encryption on a content key and content by using the media key. Otherwise, the recording device does not perform the encryption.

[0113] (4) Likewise, a reproduction device tries to acquire the media key from the recording medium by using a device key held in the reproduction device. If the reproduction device has succeeded in acquiring the media key, the reproduction device performs decryption on an encrypted content key and encrypted content recorded on the recording medium by using the media key. Otherwise, the reproduction device does not perform the decryption.

[0114] A construction and operation of such an improved copyright protection system are described below.

(Construction)

[0115] FIG. **6** is a block diagram showing a construction of a copyright protection system **200** to which the second embodiment of the present invention relates.

[0116] In FIG. **6**, the copyright protection system **200** is roughly made up of a recording device **60** and a reproduction device **80**. The recording device **60** records encrypted content on a recording medium **70**. The reproduction device **80** decrypts the encrypted content recorded on the recording medium **70**, and reproduces the decrypted content.

[0117] Note here that construction elements which are the same as those in the first embodiment shown in FIG. **3** have been given the same reference numerals. Accordingly, the following explanation will focus on the differences with the first embodiment.

(Recording Medium **70**)

[0118] The recording medium **70** is an optical disk similar to the recording medium **20**. The recording medium **70** has a media key data area **25**, in addition to the same construction as the recording medium **20**.

[0119] The media key data area **25** is a read-only area. Media key data is recorded in the media key data area **25** at the time of manufacturing the recording medium **70**.

[0120] The media key data is a result of processing a media key as explained in the above point (2).

[0121] FIG. **7** shows one example of media key data recorded in the media key data area **25**. In FIG. **7**, the media key data is made up of 128 records of 8 bytes in length. Each record contains ciphertext data which is expressed as either E(Kdi,Km) or E(Kdi,**0**) (i being an integer from 1 to 128).

[0122] Km denotes the media key which is a 56-bit random value. Here, a plurality of recording media **70** have been divided into groups of at least one recording medium **70**, and a unique media key has been assigned to each group. The media key takes a value other than 0, to distinguish it from 0 in E(Kdi,**0**).

[0123] Kdi (i being an integer from 1 to 128) denotes a 56-bit device key. There are 128 device keys Kd**1**, Kd**2**, . . . , Kd**128**, which are respectively assigned to and held in 128 devices (including recording devices **60** and reproduction devices **80**) which have device numbers **1**, **2**, . . . , **128**. The device numbers **1**, **2**, . . . , **128** have been respectively assigned to the 128 devices beforehand. The first to 128th records correspond to the device keys Kd**1** to Kd**128** respectively, and so correspond to the devices of the device numbers **1** to **128** respectively.

[0124] E( ) denotes an encryption algorithm such as DES. That is, E(Kdi,Km) denotes ciphertext obtained by encrypting the media key Km as plain text by using the device key Kdi as an encryption key, according to DES. For example, E(Kd**2**,Km) in the second record is ciphertext obtained by encrypting the media key Km by using a device key Kd**2**. Meanwhile, E(Kdi,**0**) denotes ciphertext obtained by encrypting the value 0 by using the device key Kdi. For example, E(Kd**3**,**0**) in the third record is ciphertext obtained by encrypting 0 by using a device key Kd**3**.

[0125] On the other hand, when E(Kdi,Km) is decrypted by using the device key Kdi, the outcome is the media key Km. For instance, when E(Kd**2**,Km) in the second record is decrypted by using the device key Kd**2**, the media key Km is obtained. Meanwhile, when E(Kdi,**0**) is decrypted by using the device key Kdi, the outcome is 0. For instance, when E(Kd**3**,**0**) in the third record is decrypted by using the device key Kd**3**, 0 is obtained.

[0126] Thus, by setting the contents of the records corresponding to the 128 device keys as either E(Kdi,Km) or E(Kdi,**0**), the 128 device keys can be distinguished between the device keys with which the media key can be acquired (media key-acquirable device keys) and the device keys with which the media key cannot be acquired (media key-unacquirable device keys).

[0127] At the time of manufacturing, a manufacturer of the recording medium **70** obtains information concerning devices which have been physically attacked, and classifies the device keys into the media key-acquirable type and the media key-unacquirable type according to the obtained information. The manufacturer then generates media key data in which the contents of a record corresponding to each media key-acquirable device key are set as E (Kdi,Km), whereas the contents of a record corresponding to each media key-unacquirable device key are set as E(Kdi,**0**). The manufacturer records the media key data in the media key data area **25** of the recording medium **70**. In this way, the media key can be acquired only when a media key-acquirable device key is used, and cannot be acquired when a media key-unacquirable device key is used.

(Construction of the Recording Device **60**)

[0128] The recording device **60** differs from the recording device **10** in that a device key storing unit **17**, a media key computing unit **18**, and a media key temporary storing unit **19** are included in place of the master key storing unit **11**.

[0129] The device key storing unit **17** is a memory in which a device key assigned to the recording device **60** has been stored in advance. The recording device **60** holds the device key in secrecy from outside the recording device **60**.

[0130] The media key computing unit **18** reads the device key from the device key storing unit **17**, and ciphertext data of a record corresponding to a device number of the recording device **60** from the media key data area **25**. The media key computing unit **18** decrypts the ciphertext data by using the read device key. Since the ciphertext data is either E(Kdi,Km) or E(Kdi,**0**), decrypting the ciphertext data by using the device key Kdi produces the outcome which is either the media key Km or the value 0. The media key

computing unit **18** judges whether or not the outcome is 0. If the outcome is 0, the recording device **60** terminates subsequent processing, that is, processing such as encrypting a content key and content is aborted.

[**0131**] If the outcome is the media key Km, the media key computing unit **18** temporarily stores the media key Km in the media key temporary storing unit **19**. Here, temporarily storing the media key Km means that the media key Km is held in the media key temporary storing unit **19** only until the media key Km has been used for encrypting a content key and as a result has become unnecessary. After this, the media key temporary storing unit **19** is initialized to erase the media key Km. By erasing the media key Km once it has become unnecessary, damage caused by physical attack to the recording device **60** is minimized.

[**0132**] The media key temporary storing unit **19** is a memory for temporarily storing the media key Km which is acquired by the media key computing unit **18**.

[**0133**] The license information computing unit **16** and the content key encrypting unit **13** are similar to those in the first embodiment, but differ in that the media key Km held in the media key temporary storing unit **19** is used instead of the master key.

(Construction of the Reproduction Device **80**)

[**0134**] The reproduction device **80** differs from the reproduction device **30** in that a device key storing unit **40**, a media key computing unit **41**, and a media key temporary storing unit **42** are included in place of the master key storing unit **31**.

[**0135**] The device key storing unit **40** is a memory in which a device key assigned to the reproduction device **80** has been stored in advance. The reproduction device **80** holds the device key in secrecy from outside the reproduction device **80**.

[**0136**] The media key computing unit **41** reads the device key from the device key storing unit **40**, and ciphertext data of a record corresponding to a device number of the reproduction device **80** from the media key data area **25**. The media key computing unit **41** decrypts the ciphertext data by using the device key. Since the ciphertext data is either E (Kdi,Km) or E (Kdi,**0**), decrypting the ciphertext data by using the device key Kdi produces the outcome which is either the media key Km or the value 0. The media key computing unit **41** judges whether or not the outcome is 0. If the outcome is 0, the reproduction device **80** terminates subsequent processing, that is, processing such as decrypting an encrypted content key and encrypted content is aborted.

[**0137**] If the outcome is the media key Km, the media key computing unit **41** temporarily stores the media key Km in the media key temporary storing unit **42**. Temporarily storing the media key Km means that the media key Km is held in the media key temporary storing unit **42** only until the media key Km has been used for decrypting an encrypted content key and as a result has become unnecessary. After this, the media key temporary storing unit **42** is initialized to erase the media key Km. By erasing the media key Km once it has become unnecessary, damage caused by physical attack to the reproduction device **80** is minimized.

[**0138**] The media key temporary storing unit **42** is a memory for temporarily storing the media key Km which is obtained by the media key computing unit **41**.

[**0139**] The reference license information computing unit **35** and the content key decrypting unit **32** are similar to those in the first embodiment, but differ in that the media key Km held in the media key temporary storing unit **42** is used instead of the master key.

(Operation)

[**0140**] Operations of the above constructed recording device **60** and reproduction device **80** are described below.

[**0141**] The recording device **60** operates as follows.

[**0142**] (1) The media key computing unit **18** reads a device key from the device key storing unit **17**, and ciphertext data of a record corresponding to the recording device **60** from the media key data area **25**.

[**0143**] (2) The media key computing unit **18** decrypts the ciphertext data by using the device key, and judges whether or not the outcome is 0.

[**0144**] (3) If the outcome is 0, the recording device **60** terminates the subsequent encryption processing.

[**0145**] (4) If the outcome is not 0, the media key computing unit **18** stores the outcome in the media key temporary storing unit **19** as a media key.

[**0146**] (5) Following this, the recording device **60** performs the operation shown in FIG. **4**, with "the master key storing unit **11**" and "the master key" in FIG. **4** and its explanation being changed respectively to "the media key temporary storing unit **19**" and "the media key".

[**0147**] (6) The recording device **60** initializes the media key temporary storing unit **19** to erase the media key.

[**0148**] On the other hand, the reproduction device **80** operates as follows.

[**0149**] (1) The media key computing unit **41** reads a device key from the device key storing unit **40**, and ciphertext data of a record corresponding to the reproduction device **80** from the media key data area **25**.

[**0150**] (2) The media key computing unit **41** decrypts the ciphertext data by using the device key, and judges whether or not the outcome is 0.

[**0151**] (3) If the outcome is 0, the reproduction device **80** terminates the subsequent decryption processing.

[**0152**] (4) If the outcome is not 0, the media key computing unit **41** stores the outcome in the media key temporary storing unit **42** as a media key.

[**0153**] (5) Following this, the reproduction device **80** performs the operation shown in FIG. **5**, with "the master key storing unit **31**" and "the master key" in FIG. **5** and its explanation being changed respectively to "the media key temporary storing unit **42**" and "the media key".

[**0154**] (6) The reproduction device **80** initializes the media key temporary storing unit **42** to erase the media key.

(Conclusion)

[**0155**] According to the above construction of the copyright protection system **200**, ciphertext data of each record in media key data is set as either E(Kdi,Km) or E(Kdi,**0**), so as to allow a media key to be acquired only when a media

key-acquirable device key is used and not when a media key-unacquirable device key is used.

[0156] Suppose one device was physically attacked by an unauthorized party and a device key of that device was revealed. Then, the manufacturer of the recording medium **70** generates media key data in which ciphertext data of a record corresponding to the attacked device is set as E(Kdi, **0**), and records the media key data on the recording medium **70**. In so doing, even when the unauthorized party tries to acquire the media key by using the revealed device key, the media key cannot be acquired. Without the media key, it is impossible to decrypt an encrypted content key and encrypted content which have been generated by using the media key. Hence, unauthorized use of content can be blocked.

[0157] Also, the copyright protection system **200** controls which devices can perform encryption and decryption and which devices cannot, by setting the ciphertext data of each record in the media key data either as E(Kdi,Km) or E(Kdi, **0**).

[0158] Suppose a device key of one device was revealed. Then, the manufacturer of the recording medium **70** sets ciphertext data of a record corresponding to that device as E (Kdi, **0**), with it being possible to make that device inoperative.

[0159] Furthermore, according to the above construction of the copyright protection system **200**, a plurality of recording devices and reproduction devices having different device keys can use the same recording medium, unless their ciphertext data is E(Kdi,**0**). This adds to the portability of the recording medium.

[0160] In the above example, the recording device **60** and the reproduction device **80** are each constructed to terminate encryption or decryption processing if the outcome of decrypting ciphertext data using a device key is 0. However, instead of terminating the processing, the recording device **60** and the reproduction device **80** may each be constructed to perform the encryption or decryption using the value 0 as a key. An encrypted by content key and encrypted content which are generated using 0 as a key cannot be decrypted by using the media key Km. Likewise, an encrypted content key and encrypted content which are generated by using the media key Km cannot be decrypted by using 0 as a key. Hence, unauthorized use of content through the use of an attacked device can be prevented.

[0161] Also, although a unique device key is assigned to each device, a unique device key may instead be assigned to each group that is made up of more than one device. In this case, if one device is physically attacked, ciphertext data corresponding to a group to which the attacked device belongs is set as E(Kdi,**0**). As a result, all devices belonging to that group are rendered inoperative. On the other hand, devices belonging to the rest of the groups remain operative.

Third Embodiment

[0162] The following describes the third embodiment of the present invention.

[0163] In the first and second embodiments, the recording device and the reproduction device have different construction elements, that is, the recording device has the content key encrypting unit, whereas the reproduction device has the content key decrypting unit. In the third embodiment, the recording device and the reproduction device are constructed to have the same content key generating unit, thereby reducing manufacturing costs when compared with the case where the two devices have different construction elements.

(Construction)

[0164] FIG. **8** is a block diagram showing a construction of a copyright protection system **300** to which the third embodiment of the present invention relates.

[0165] In FIG. **8**, the copyright protection system **300** is roughly made up of a recording device **110** and a reproduction device **130**. The recording device **110** records encrypted content on a recording medium **120**. The reproduction device **130** decrypts the encrypted content recorded on the recording medium **120**, and reproduces the decrypted content.

[0166] Note here that construction elements which are the same as those in the first embodiment shown in FIG. **3** have been given the same reference numerals. Accordingly, the following explanation will focus on the differences with the first embodiment.

(Recording Medium **120**)

[0167] The recording medium **120** differs from the recording medium **20** only in that a random number area **121** is provided instead of the encrypted content key area **23**.

[0168] The random number area **121** is reserved in the recordable area of the recording medium **120** by the recording device **110**, to record a random number. This random number is a source of a content key.

(Construction of the Recording Device **110**)

[0169] The recording device **110** differs from the recording device **10** only in that a random number generating unit **111** and a content key generating unit **112** are included in place of the content key generating unit **12** and the content key encrypting unit **13**.

[0170] The random number generating unit **111** generates a random number, and outputs the generated random number to the license information computing unit **16** and the content key generating unit **112**. The random number generating unit **111** also reserves the random number area **121** in the recordable area of the recording medium **120**, and records the random number in the random number area **121**.

[0171] The content key generating unit **112** performs a computation according to the SHA-1 hash function or the like, by using the random number received from the random number generating unit **111** and a master key stored in the master key storing unit **11**. As a result, the content key generating unit **112** generates a content key.

[0172] The content encrypting unit **15** encrypts content by using the content key generated by the content key generating unit **112**, and records the encrypted content in the encrypted content area **24**.

[0173] The license information computing unit **16** acquires a media number, the master key, and the random number generated by the random number generating unit **111**, and concatenates these data into one bit string. The

license information computing unit **16** takes this bit string as input, and performs a computation according to the SHA-1 hash function or the like to obtain a hash value. The license information computing unit **16** records the hash value in the license information area **22** as license information.

(Construction of the Reproduction Device **130**)

[**0174**] The reproduction device **130** differs from the reproduction device **30** only in that a content key generating unit **131** is included in place of the content key decrypting unit **32**.

[**0175**] The content key generating unit **131** is the same as the content key generating unit **112**. The content key generating unit **131** performs the same computation as the content key generating unit **112** by using the random number recorded in the random number area **121** and a master key stored in the master key storing unit **31**, to generate the content key.

[**0176**] The content decrypting unit **33** decrypts the encrypted content recorded in the encrypted content area **24**, by using the content key generated by the content key generating unit **131**.

[**0177**] The reference license information computing unit **35** acquires the media number, the master key, and the random number recorded in the random number area **121**, and performs the same computation as the license information computing unit **16** to generate reference license information.

(Conclusion)

[**0178**] To manufacture a recording device and a reproduction device, a content key encrypting unit and a content key decrypting unit need to be produced in the case of the copyright protection system **100**, whereas just two content key generating units need to be produced in the case of the copyright protection system **300**. Thus, the copyright protection system **300** of the third embodiment can reduce manufacturing costs when compared with the copyright protection system **100** of the first embodiment.

Fourth Embodiment

[**0179**] The following describes the fourth embodiment of the present invention.

[**0180**] A copyright protection system of the fourth embodiment is a combination of the construction elements of the copyright protection systems **200** and **300** of the second and third embodiments.

(Construction)

[**0181**] FIG. **9** is a block diagram showing a construction of a copyright protection system **400** to which the fourth embodiment of the present invention relates.

[**0182**] In FIG. **9**, the copyright protection system **400** is roughly made up of a recording device **160** and a reproduction device **180**. The recording device **160** records encrypted content on a recording medium **170**. The reproduction device **180** decrypts the encrypted content recorded on the recording medium **170**, and reproduces the decrypted content.

[**0183**] Note here that construction elements which are the same as those in the second and third embodiments shown in FIGS. **6** and **8** have been given the same reference numerals.

(Recording Medium **170**)

[**0184**] The recording medium **170** has a construction in which the media key data area **25** of the recording medium **70** has been added to the recording medium **120**.

(Construction of the Recording Device **160**)

[**0185**] The recording device **160** has a construction in which the master key storing unit **11** of the recording device **110** has been replaced with the device key storing unit **17**, media key computing unit **18**, and media key temporary storing unit **19** of the recording device **60**.

(Construction of the Reproduction Device **180**)

[**0186**] The reproduction device **180** has a construction in which the master key storing unit **31** of the reproduction device **130** has been replaced with the device key storing unit **40**, media key computing unit **41**, and media key temporary storing unit **42** of the reproduction device **80**.

(Conclusion)

[**0187**] According to the above construction, the copyright protection system **400** has the advantages of both the copyright protection systems **200** and **300**.

Modifications

[**0188**] The present invention has been described by way of the first to fourth embodiments. However, it should be understood that the present invention is not limited to the above. Example modifications of the present invention are given below.

[**0189**] (1) The above embodiments describe the case where the recording device records one set of encrypted content, one encrypted content key (or one random number), and one set of license information on the recording medium, but the present invention should not be limited thereto. For instance, the recording device may record a plurality of sets of encrypted content, a plurality of encrypted content keys, and a plurality of sets of license information, as shown in a recording medium **800** of FIG. **10**.

[**0190**] In more detail, the recording device encrypts a plurality of sets of content A, B, and C by using content keys A, B, and C, respectively. The recording device then records the encrypted sets of content A, B, and C in an encrypted content area **840**. The recording device also encrypts the content keys A, B, and C by using a master key, and records the encrypted content keys A, B, and C in an encrypted content key area **830**. The recording device further generates license information A by using a media number, the master key, and the encrypted content key A, and records the license information A in a license information area **820**. In a like manner, the recording device generates license information B and C by using the encrypted content keys B and C, respectively, and records the license information B and C in the license information area **820**.

[**0191**] The reproduction device generates reference license information A by using the media number, the master key, and the encrypted content key A in the encrypted content key area **830**, and compares the reference license information A with the license information A in the license information area **820**. If they match, the reproduction device decrypts the encrypted content key A in the encrypted content key area **830** by using the master key. The repro-

duction device then decrypts the encrypted content A in the encrypted content area **840** by using the decrypted content key A, and reproduces the decrypted content A. The reproduction device performs the same processing on the encrypted content B and C.

[**0192**] (2) As an alternative, the recording device may record data as shown in a recording medium **900** of FIG. **11**.

[**0193**] In more detail, the recording device generates the encrypted content A, B, and C and the encrypted content keys A, B, and C in the same way as the above (1), and records them in an encrypted content area **940** and an encrypted content key area **930**. The recording device then generates license information by using the media number, the master key, and all of the encrypted content keys A, B, and C, and records the license information in a license information area **920**.

[**0194**] The reproduction device generates reference license information by using the media number, the master key, and all of the encrypted content keys A, B, and C, and compares the reference license information with the license information in the license information area **920**. If they match, the reproduction device decrypts the encrypted content keys A, B, and C by using the master key. The reproduction device then decrypts the encrypted content A, B, and C by using the decrypted content keys A, B, and C, respectively, and reproduces the decrypted content A, B, and C.

[**0195**] (3) Although the above embodiments describe the case where the recording medium is an optical disk, the recording medium may be a different type of recording medium such as a magnetic disk, a magneto-optical disk, or a memory card on which a media number has been recorded in an unrewritable state.

[**0196**] (4) Also, so long as the media number is recorded in an unrewritable state but can be read by a reading mechanism, the media number may be recorded in an area other than the unrewritable area of the recording medium.

[**0197**] (5) Although the above embodiments describe the case where the SHA-1 hash function is used for generating license information and the like, hash functions other than SHA-1 or operations other than hashing are also applicable. Also, encryption algorithms other than DES may be used. Furthermore, the bit length of each value is not limited to above.

[**0198**] (6) The above embodiments describe the case where license information and reference license information are generated using a master key, a media number, and information relating to decryption, but they may be generated using only the media number and the decryption-relating information without using the master key.

[**0199**] (7) The above embodiments describe the case where the comparing unit **36** controls each construction element by opening or closing the first switch **37** and the second switch **38**. However, this can be modified so long as the digital AV processing unit **34** is allowed to reproduce content if and only if license information and reference license information match.

[**0200**] (8) The above embodiments describe the case where the alarm **39** produces a warning sound, but the alarm **39** may instead output data showing a warning message to a display.

[**0201**] (9) The present invention also applies to the methods corresponding to the operational procedures of the copyright protection systems of the first to fourth embodiments and the modifications (1) and (2).

[**0202**] (10) The operational procedures of the copyright protection systems of the first to fourth embodiments and the modifications (1) and (2) may be realized by computer programs that are executed by computers. Such computer programs may be distributed having been recorded onto a storage medium or by being transmitted via a communication path. Examples of such a storage medium include an IC card, an optical disk, a flexible disk, and a ROM.

[**0203**] (11) The construction elements described in the first to fourth embodiments and the modifications (1) to (10) may be freely combined.

[**0204**] Although the present invention has been fully described by way of examples with reference to the accompanying drawings, it is to be noted that various changes and modifications will be apparent to those skilled in the art.

[**0205**] Therefore, unless such changes and modifications depart from the scope of the present invention, they should be construed as being included therein.

What is claimed is:

1. A copyright protection system comprising a recording device for recording encrypted content on a recording medium and a reproduction device for decrypting the encrypted content recorded on the recording medium, the recording medium having an unrewritable area in which a media number unique to the recording medium is recorded,

the recording device including:

a generating unit operable to acquire the media number from the recording medium, and generate license information by performing a specific operation using the media number and decryption key so that the license information reflects both the media number and the decryption key, the decryption key being necessary to decrypt the encrypted content;

a recording unit operable to record the license information, a decryption information generated by using the decryption key, and the encrypted content on the recording medium, and

the reproduction device including:

a judging unit operable to read the media number, the decryption information, and the license information from the recording medium, and judge whether the read license information can be obtained if the specific operation is performed using the read media number and the decryption key which can be obtained from the read decryption information;

a decrypting unit operable to read the encrypted content from the recording medium and decrypt the encrypted content using the decryption key obtained from the decryption information;

a reproduction unit operable to reproduce the decrypted content; and

a suppressing unit operable to control the unit of the reproduction device not to reproduce the content, if the judgment by the judging unit is in the negative.

2. The copyright protection system of claim 1, wherein

the decrypting unit includes a decryption key computing unit operable to perform a predetermined computation on the decryption information, to obtain decryption key, and

the decrypting unit decrypts the encrypted content using the decryption key.

3. The copyright protection system of claim 2, wherein

the recording device further includes:

a recording device possessing unit operable to possess a secret key, by either acquiring the secret key from outside or storing the secret key in advance; and

a decryption key encrypting unit operable to encrypt the decryption key using the secret key according to a secret key cipher, to generate the decryption information,

the reproduction device further includes a reproduction device possessing unit operable to possess the same secret key as the recording device possessing unit, by either acquiring the secret key from outside or storing the secret key in advance, and

the decryption key computing unit decrypts the decryption information using the secret key according to the secret key cipher, to obtain the decryption key.

4. The copyright protection system of claim 3, wherein

the generating unit performs the specific operation using the secret key in addition to the media number and the decryption key, and

the judging unit makes the judgment using the secret key in addition to the read media number and the decryption key.

5. The copyright protection system of claim 3, wherein

secret key information has been recorded in the unrewritable area of the recording medium, the secret key information being an encrypted secret key which can be correctly decrypted when a specific device key is used,

each of the recording device possessing unit and the reproduction device possessing unit includes:

a device key storing unit operable to store a device key unique to a device to which the device key storing unit belongs, in advance;

a secret key decrypting unit operable to decrypt the secret key information recorded on the recording medium using the device key in the device key storing unit; and

a secret key storing unit operable to store, if the secret key decrypting unit has succeeded in correctly decrypting the secret key information to acquire the secret key, the acquired secret key, and each of the recording device, and

the suppressing unit is operable to stop subsequent processing if the secret key decrypting unit has failed to correctly decrypt the secret key information.

6. The copyright protection system of claim 1, wherein

the judging unit includes:

a reference license information generating unit operable to perform the specific operation using the read media number and the decryption key, to generate reference license information; and

a comparing unit operable to (a) compare the reference license information with the read license information, (b) judge in the affirmative if the reference license information matches the read license information, and (c) judge in the negative if the reference license information does not match the read license information.

7. The copyright protection system of claim 1, wherein

the generating unit generates a set of license information for each of a plurality of sets of encrypted content, by performing the specific operation on the media number and a set of decryption key which corresponds to the set of encrypted content,

the recording unit records the plurality of sets of encrypted content, a plurality of sets of decryption information which are in a one-to-one correspondence with the plurality of sets of encrypted content, and a plurality of sets of license information which are generated by the generating unit and are in a one-to-one correspondence with the plurality of sets of encrypted content, on the recording medium in combination, and

the judging unit and the decrypting unit respectively perform the judgment and the decryption on each combination recorded on the recording medium.

8. The copyright protection system of claim 1, wherein

the generating unit generates a set of license information for a plurality of sets of encrypted content, by performing the specific operation on the media number and a plurality of sets of decryption key which are in a one-to-one correspondence with the plurality of sets of encrypted content.

9. The recording device for recording encrypted content on a recording medium, the recording medium having an unrewritable area in which a media number unique to the recording medium is recorded, comprising:

a generating unit operable to acquire the media number from the recording medium, and generate license information by performing a specific operation using the media number and decryption key so that the license information reflects both the media number and the decryption key, the decryption key being necessary to decrypt the encrypted content; and

a recording unit operable to record the license information, a decryption information generated by using the decryption key, and the encrypted content on the recording medium.

10. A reproduction device for decrypting encrypted content recorded on a recording medium, wherein the encrypted content, decryption information necessary to decrypt the encrypted content, and license information used for judging whether the encrypted content is permitted to be decrypted are recorded on the recording medium, and the recording medium has an unrewritable area in which a media number unique to the recording medium is recorded, comprising:

a judging unit operable to read the media number, the decryption information, and the license information from the recording medium, and judge whether the read license information can be obtained if a specific operation is performed using the read media number and the decryption key which can be obtained from the read decryption information;

a decrypting unit operable to read the encrypted content from the recording medium and decrypt the encrypted content using the decryption information;

a reproduction unit operable to reproduces the decrypted content; and

a suppressing unit operable to control the unit of the reproduction device not to reproduce the content, if the judgement by the judging unit is in the negative.

11. A copyright protection method for use in a copyright protection system including a recording device for recording encrypted content on a recording medium and a reproduction device for decrypting the encrypted content recorded on the recording medium, the recording medium having an unrewritable area in which a media number unique to the recording medium is recorded, comprising:

acquiring, by the recording device, the media number from the recording medium; generating license information by performing a specific operation using the media number and decryption key so that the license information reflects both the media number and the decryption key, the decryption key being necessary to decrypt the encrypted content;

recording, by the recording device; the license information, a decryption information generated by using the decryption key, and the encrypted content on the recording medium;

reading, by the reproduction device, the media number, the decryption information, and the license information from the recording medium;

judging, by the reproduction device, whether the read license information can be obtained if the specific operation is performed using the read media number and the decryption key;

reading, by the reproduction device, the encrypted content from the recording medium;

decrypting, by the reproduction device, the encrypted content using the decryption information;

reproducing the decrypted content; and

suppressing the processing by the reproduction device not to reproduce the content, if the judgment in the judging is in the negative.

12. A recording method for recording encrypted content on a recording medium, the recording medium having an unrewritable area in which a media number unique to the recording medium is recorded, comprising:

acquiring the media number from the recording medium;

generating license information by performing a specific operation using the media number and decryption key so that the license information reflects both the media number and the decryption key, the decryption key being necessary to decrypt the encrypted content; and

recording the license information, a decryption information generated by using the decryption key, and the encrypted content on the recording medium.

13. A reproduction method for decrypting encrypted content recorded on a recording medium, wherein the encrypted content, decryption information necessary to decrypt the encrypted content, and license information used for judging whether the encrypted content is permitted to be decrypted are recorded on the recording medium, and the recording medium has an unrewritable area in which a media number unique to the recording medium is recorded, comprising:

reading the media number, the decryption information, and the license information from the recording medium;

judging whether the read license information can be obtained if a specific operation is performed using the read media number and the decryption key which can be obtained from the read decryption information; and

reading the encrypted content from the recording medium;

decrypting the encrypted content using the decryption key obtained from the decryption information;

reproducing the decrypted content; and

suppressing the processing of the reproduction method not to reproduce the content, if the judgment in the judging is in the negative.

14. A recording program for use in a recording device for recording encrypted content on a recording medium, the recording medium having an unrewritable area in which a media number unique to the recording medium is recorded, the recording program having the recording device execute:

acquiring the media number from the recording medium;

generating license information by performing a specific operation using the media number and decryption key so that the license information reflects both the media number and the decryption key, the decryption key being necessary to decrypt the encrypted content; and

recording the license information, a decryption information generated by using the decryption key, and the encrypted content on the recording medium.

15. A reproduction program for use in a reproduction device for decrypting encrypted content recorded on a recording medium, wherein the encrypted content, decryption information necessary to decrypt the encrypted content, and license information used for judging whether the encrypted content is permitted to be decrypted are recorded on the recording medium, and the recording medium has an unrewritable area in which a media number unique to the recording medium is recorded, the decryption program having the reproduction device execute:

reading the media number, the decryption information, and the license information from the recording medium;

judging whether the read license information can be obtained if a specific operation is performed using the read media number and the decryption key which can be obtained from the read decryption information;

reading the encrypted content from the recording medium;

decrypting the encrypted content using the decryption key obtained from the decryption information;

reproducing the decrypted content; and

suppressing the processing of the reproduction program not to reproduce the content, if the judgment by the judging is in the negative.

16. A computer-readable storage medium storing a recording program for use in a recording device for recording encrypted content on a recording medium, the recording medium having an unrewritable area in which a media number unique to the recording medium is recorded, the recording program having the recording device execute:

acquiring the media number from the recording medium;

generating license information by performing a specific operation using the media number and decryption key so that the license information reflects both the media number and the decryption key, the decryption key being necessary to decrypt the encrypted content; and

recording the license information, a decryption information generated by using the decryption key, and the encrypted content on the recording medium.

17. A computer-readable storage medium storing a reproduction program for use in a reproduction device for decrypting encrypted content recorded on a recording medium, wherein the encrypted content, decryption information necessary to decrypt the encrypted content, and license information used for judging whether the encrypted content is permitted to be decrypted are recorded on the recording medium, and the recording medium has an unrewritable area in which a media number unique to the recording medium is recorded, the decryption program having the reproduction device execute:

reading the media number, the decryption information, and the license information from the recording medium;

judging whether the read license information can be obtained if a specific operation is performed using the read media number and the decryption key which can be obtained from the read decryption information;

reading the encrypted content from the recording medium;

decrypting the encrypted content using the decryption key obtained from the decryption information;

reproducing the decrypted content; and

suppressing the processing of the reproduction program not to reproduce the content, if the judgment by the judging is in the negative.

18. A recording medium comprising:

an unrewritable area in which a media number unique to the recording medium is recorded; and

a rewritable area in which (a) encrypted content, (b) decryption information necessary to decrypt the encrypted content, and (c) license information that is obtained by a specific operation using the media number and the decryption key and that reflects both the media number and the decryption key are recorded.

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