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(54) **ENCODING RECORDING DATA ON OPTICAL DISKS**

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Related U.S. Patent Documents

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369/47.28, 59.33, 59.34, 47.27, 47.23, 47.24

See application file for complete search history.

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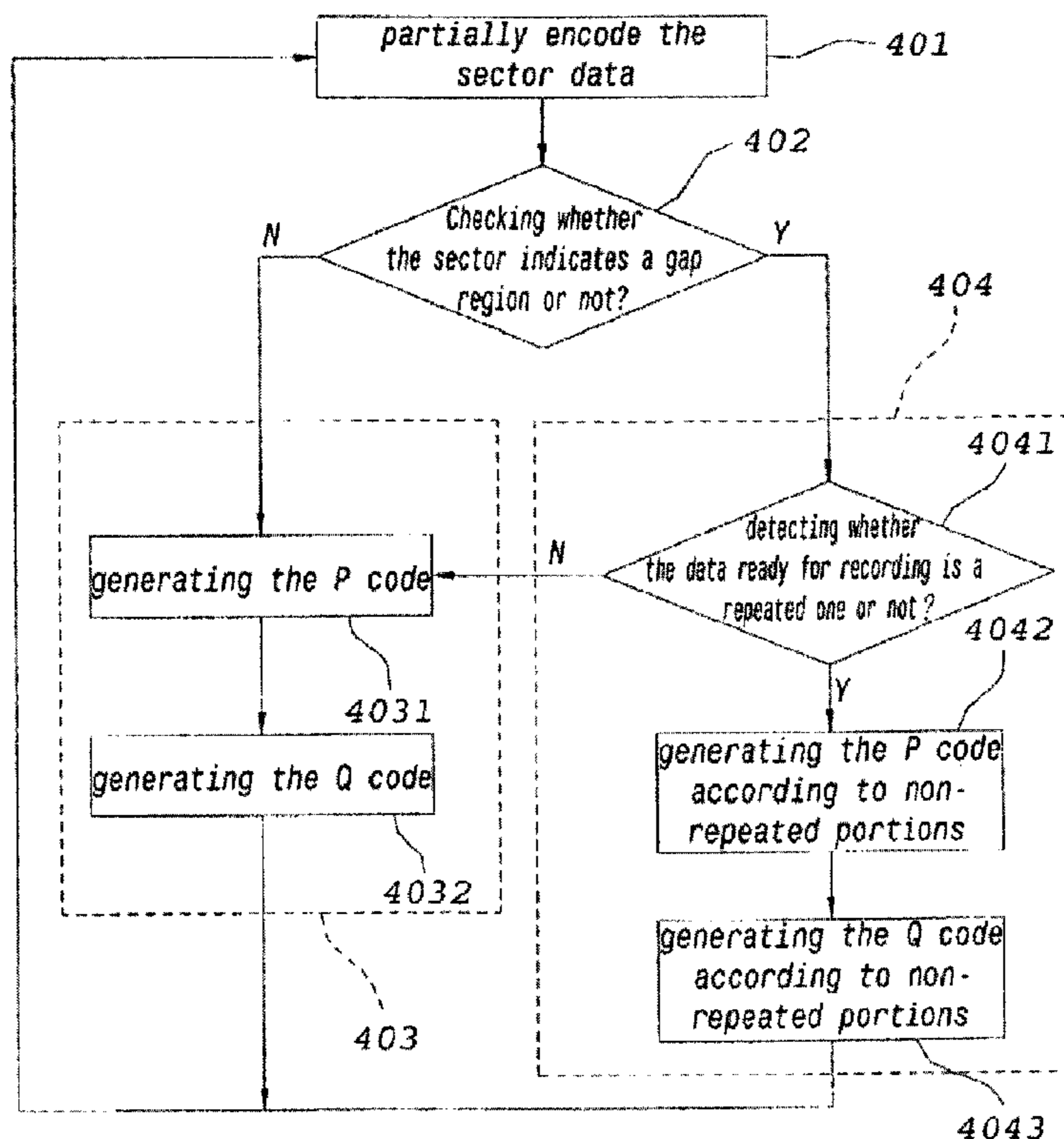
Primary Examiner — Nabil Z Hindi

(74) *Attorney, Agent, or Firm* — Perkins Coie LLP

(57) **ABSTRACT**

An encoding method for recording gap regions or sectors having repeated data is disclosed. At least one sector is entirely encoded and stored in a memory buffer of the optical recording system. If the currently encoded are gap regions or sector having repeated data embedded in the fields of user data, only those portions affected by the modified header will be encoded to derive associated P code and Q code. The error detection code is firstly generated in the mode 1 standard when a gap region is encoded. P code is then encoded for those regions affected by the sequentially modified header and error detection code, while associated Q code is then derived according the modified header, error detection code, and P code. In the mode 2 form 1 and mode form 2 standards, only those regions affected by the sequentially modified header should be re-encoded again. Since the remaining portions employ the same data as the last encoded one in the memory buffer so that the encoding performance would be significantly upgraded whatever encoding standards are employed.

31 Claims, 4 Drawing Sheets



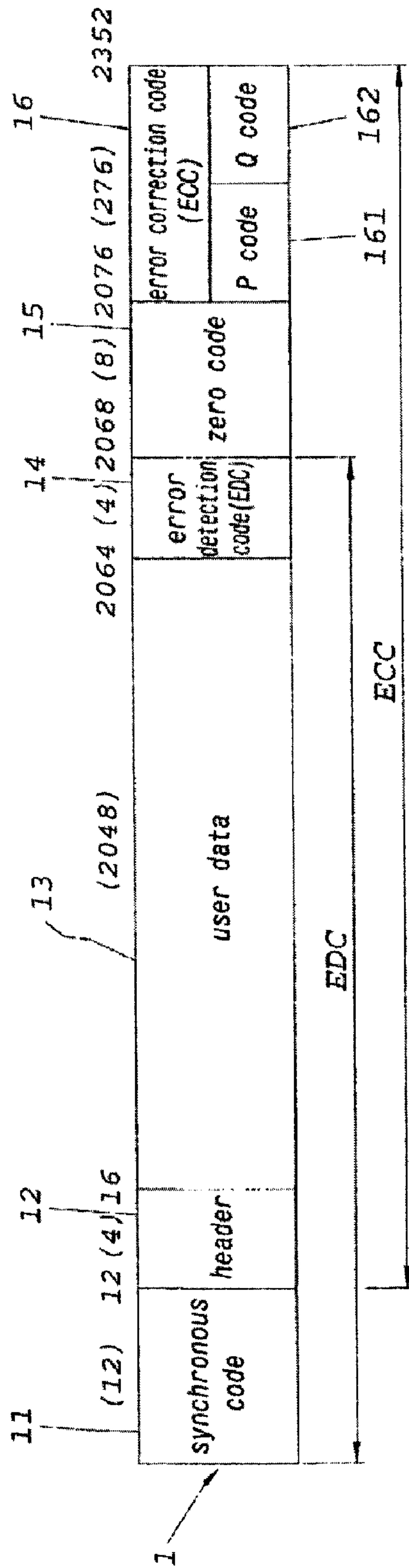


FIG 1
PRIOR ART

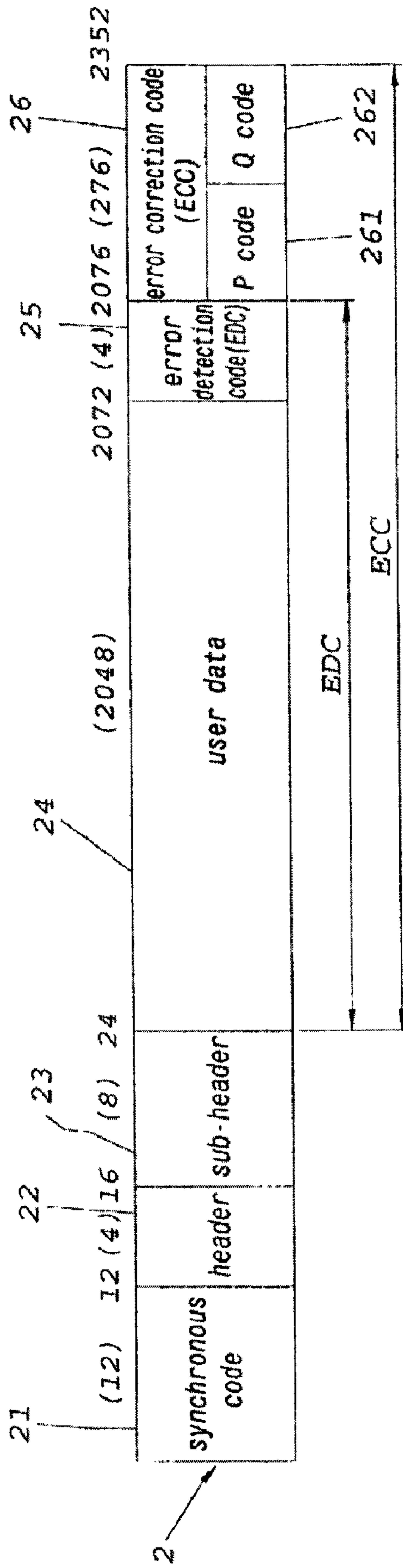


FIG 2
PRIOR ART

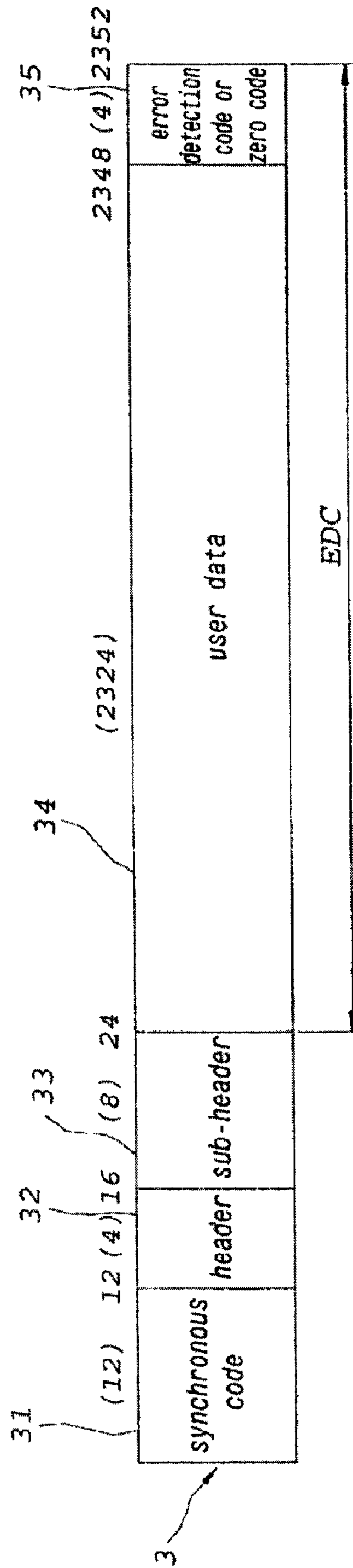


FIG 3
PRIOR ART

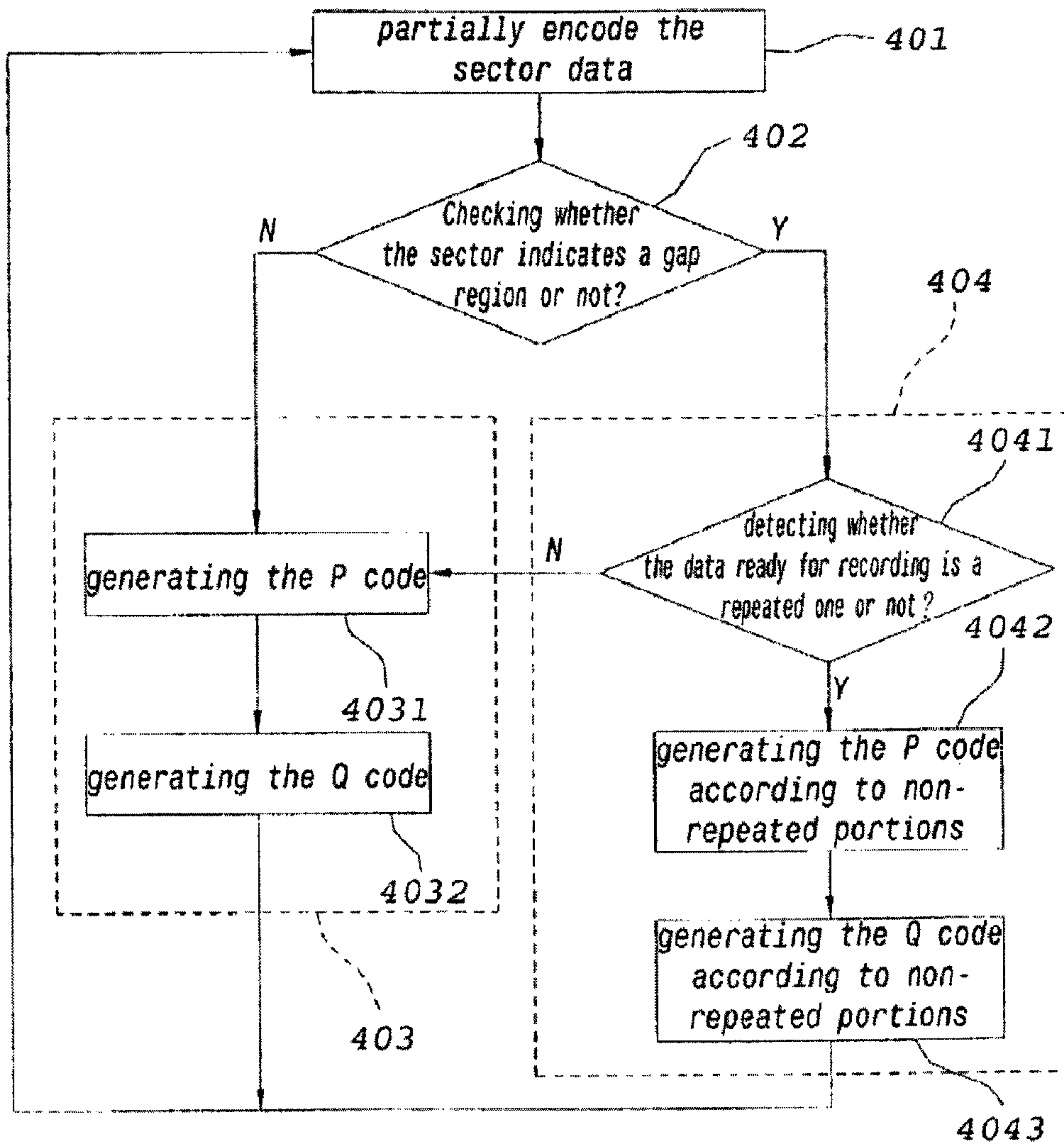


FIG 4

ENCODING RECORDING DATA ON OPTICAL DISKS

Matter enclosed in heavy brackets [] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

CROSS-REFERENCE TO RELATED APPLICATION

This patent application is a reissue application for commonly assigned U.S. Pat. No. 7,023,784, issued Apr. 4, 2006 from U.S. patent application Ser. No. 10/400,574, filed on Mar. 28, 2003.

BACKGROUND

1. Field of the Invention

The present invention is related to an encoding method for recording data on a compact disk (CD), and more particularly, to an encoding method that can efficiently upgrade the data encoding performance when an optical recording system records gap regions or sectors including repeated data onto a compact disk.

2. Background of the Invention

[Recently, optical] *Optical* disks have become an important and popular storage media for holding a huge volume of data. Generally, the data that is ready to be recorded onto a compact disk is divided and encoded into a plurality of sectors by following standard formats such as the sector structures shown in FIGS. 1 to 3. In these figures, the unit of data is byte, and there are 2352 bytes included in a sector. FIG. 1 is a schematic diagram of the first encoding form (e.g., mode 1 standard), which is adapted to encode data for application software. FIGS. 2 and 3 respectively show the second encoding form (e.g., mode 2 form 1 standard) and the third encoding form (e.g., mode 2 form 2 standard) that both of them are adapted for encoding video/audio data.

The conventional encoding method is described by making reference with FIG. 1. A host such as a personal computer (PC) firstly transfers a user data 13 having 2048 bytes to an optical recording system, e.g. a compact disk-recordable (CD-R) drive or a compact disk-rewritable (CD-RW) drive. The optical recording system then generates a synchronous code 11 and a header 12 for the user data 13, while an error detection code 14 (EDC) is generated according to the synchronous code 11, header 12, and the user data 13. Sequentially, after a zero code 15 is attached (with 4-byte length), an error correction code 16 (ECC) is next generated according to the header 12, user data 13, EDC 14, and the zero code 15. The first encoding form (or the C3 encoding procedure) is completed when the above encoding procedure terminates, wherein the ECC 16 includes a P code 161 (P-parity check code) and a Q code 162 (Q-parity check code). Sequential encoding procedures, including C2 and C1 encoding procedures, are then performed to the complete encoded data under the mode 1 standard.

Sometimes the optical recording system will record so-called gap regions on the compact disk within the data recording procedures. For example, when an audio or music CD is recording, the optical recording system may record a lot of gap regions (e.g., 2 seconds, about 150 gap regions) adjacent to a just recorded song before recording another one. Besides, if the so-called buffer-under-run occurs during data recording operations, the optical recording system will also record gap

regions on the current compact disk and wait for the data stored in buffers reaches to a predetermined threshold again. In comparison with a normal sector, these gap regions usually contain repeated information (e.g., all bit 0's) stored therein, and contents of the gap regions will be repeated except the header 12, 22 and 32, the EDC 14, 25 and 35, and the ECC 16 and 22.

As shown in FIG. 1, when a sector is being encoded, the ECC 16 will be generated according the header 12, user data 13, EDC 14 and zero code 15, while the ECC 26 will be derived according to the user data 24 and EDC 25 as shown in FIG. 2. However, since the [the] user data 13, 24 and 34 occupy most of the entire sector portions and they usually store repeated data as mentioned above, the conventional approach is [obvious] an inefficient way for encoding information due to a time-cost as well as resource-cost [approach is employed for the optical recording system].

Accordingly, the aforementioned conventional encoding scheme obviously includes many disadvantages waiting for further improvements. The present invention therefore discloses a solution for overcoming these disadvantages of the prior art scheme.

SUMMARY OF THE INVENTION

The principal object of the present invention is to provide an encoding method for recording data on a compact disk so that the encoding efficiency can be significantly upgraded [than before].

In the preferred embodiment, the disclosed method provides an encoding method adapted for recording gap regions or sectors having repeated data that these repeated data are not always entirely encoded so as to upgrade encoding efficiency.

In accordance with the present invention, the optical recording system will encode at least one gap region or sector having repeated data firstly. The non-repeated portions such as the headers of the following gap regions or sectors in memory buffer of the optical recording system are then modified. Encoding procedures are then actuated for those portions affected by the modified header, while those unaffected portions are not encoded again since the unaffected ones in the memory buffer are not changed during the encoding procedures. The current encoded sector or gap region is then delivered to actuate following encoding procedures before being recorded onto a compact disc.

In the embodiment, when a header is modified in the memory buffer under the mode 1 standard when gap regions are encoded, the error detection code will be changed according to the modified [heard] header simultaneously. The optical recording system then only encodes those portions affected by the modified header and error detection code. In another embodiment, since only the header changes as different gap regions in the mode 2 form 1 standard and the mode 2 form 2 standard, only those portions affected by the modified headers will be encoded by the optical recording system. Total time-cost regarding the encoding procedures will be significantly reduced since the bus bandwidths for accessing data is significantly reduced.

Numerous additional features, benefits and details of the method of the present invention are described in the detailed description which follows.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagram of the first encoding form;
FIG. 2 is a diagram of the second encoding form;
FIG. 3 is a diagram of the third encoding form; and

FIG. 4 is a flow chart of the preferred embodiment according to the present invention.

Table 1 is a coding table of the first encoding form 1.

Table 2 is a coding table of the Q code of the first encoding form 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Please refer to FIG. 1 and by making reference to Tables 1 and 2. Table 1 is the coding table of the mode 1 standard (the sync code 11 of the first encoding form is not included in Table 1), while Table 2 is the coding table of the Q code 162 of the mode 1 standard. The word addresses (a word is composed of two bytes) are respectively marked as 0~1169 in Table 1, and the contents of the first encoding form is mapped into Table 1 orderly. For example, the header 12 is stored in words 0~1, the user data 13 employs 1024 words 2~1025 for storing purpose, the error detection code 14 is stored in words 1026~1027, while the fields of words 1028~1031 is used to store zero code 15. Furthermore, the P code 161 and the Q code of the error correction code 16 are respectively stored in words 1032~1117 and 1118~1169.

Since all information of the gap regions is stored into a memory buffer of the optical recording system for encoding [purpose] purposes, the operating flows of the embodiment are described based on the memory buffer in the following paragraphs. The first embodiment demonstrates the operating flows when the optical recording system encodes data under the mode 1 standard. During the operation of recording data onto a compact disk, the optical recording system will encode whole portions of the first sector (or, at least one sector stored in the memory buffer currently). Thereafter, the optical recording system will generate a synchronous code 11 and a header 12 for the user data 13, while an error detection code 14 (EDC) is then derived according to the synchronous code 11, header 12, and the user data 13 when the mode 1 standard is followed. If gap regions are currently encoded, only the header 12 of the first sector (which indicates the first gap region now) will be changed (in fact, the content of header 12 will plus an integer one to indicate the header of the next gap region), which will also affect the error detection code under the mode 1 standard. Accordingly, the optical recording system will partially encode the next gap region to those non-repeated [portions] portions (or affected portions), e.g. those portions affected by the modified header 12 (such column and rows including information regarding the modified header 12, EDC 14 and P code 161 under the mode 1 standard). All gap regions are encoded by following the aforementioned steps so that encoding efficiency will be significantly upgraded since most of the entire sectors do not need to be repeatedly encoded except the first gap region. On the other hand, if the currently encoded sector [are] is not a gap region, error correction code (ECC) 16 including P code and Q code are then derived by the optical recording system based on header 12, user data 13, EDC 14, and zero code 15. Please note that the optical recording system may employ the disclosed method of the embodiments for encoding sectors having repeated data embedded in their user data 13 in order to decrease required time-cost regarding encoding procedures. Any ordinary person having skills in the art may modify the embodiment [as applications] but all similar rearrangements and modifications within the [spirits] spirit of the embodiment should included in the appended claims.

The first encoding operation when encoding sectors having non-repeated data (i.e., non-repeated data in their fields of user data 13) is described as follows. Please refer to Table 1

firstly. The optical recording system will generate P code 161 according to the data stored in rows R0~23, while the derived P code is then stored into rows R24~25. Taking column C0 as an example (the other columns will be manipulated in the same way), the optical recording system will encode the data in addresses 0, 43, 86 . . . 989 to derive corresponding parity check codes before storing in addresses 1032 and 1075.

Please now refer to Table 2. The optical recording system will generate Q code 162 according to the data in column C'0~C'42 after P code 161 is derived, while the derived Q code 162 is then stored into column C'43~44. Taking column R'0 as an example (the other rows will be encoded as the same manner), the optical recording system will encode the data in addresses 0, 44, 88 . . . 730 to generate corresponding parity check codes, while the derived parity check codes are then stored in addresses 1118 and 1144.

On the other hand, the second encoding operation when encoding gap regions or sectors having repeated data is described as follows. The optical recording system will firstly detect whether the gap region or sector encompasses repeated information or not. Please note that the gap regions basically including repeated data stored therein, this detection will be a step for guarantee purpose. If the detected sector or gap region is not a repeated one, the first encoding operation will be performed, otherwise the optical recording system will perform the second encoding operation to generate the error correction code 16 for those portions unaffected by the modified header 12.

Taking the first encoding form as an example. Since the header 12 in addresses 0~1, the error detection code 14 in addresses 1026~1027 and their corresponding parity check codes in addresses 1032, 1033, 1069, 1070, 1075, 1076, 1112 and 1113 are changed in the memory buffer when recording gap regions under mode 1 standard, the optical recording system only have to encode those portions affected by the above addresses during the second encoding operation.

For the sake of clarity, the encoding procedures of those portions affected by the modified header 12 are described further in the following.

(a) Firstly, the optical recording system generates the P code 161, according to the header 12 and the error detection code 14. Referring to Table 1, since there are columns C0, C1, C37 and C38 include the information regarding modified header 12 and EDC 14, the optical recording system generates the parity check codes for the data in columns C0, C1, C37 and C38 and then stores the derived parity check codes in addresses 1032, 1033, 1069, 1070, 1075, 1076, 1112 and 1113. Taking column C0 for example, the optical recording system will generate parity check codes according to the data in addresses 0, 43, 86 . . . 989, while these parity check codes are then stored into the addresses 1032 and 1075.

(b) The optical recording system generates the Q code 162 according to the header 12, the error detection code 14 and the P code 161 since modifications to P code 161 will cause modifications to Q code 162 simultaneously. Referring to Table 2, the optical recording system generates the Q code 162 according to the data in eight rows R'0, R'11, R'12, R'13, R'14, R'23, R'24 and R'25 and then stores the generated parity check codes in addresses 1118, 1129, 1130, 1131, 1132, 1141, 1142, 1143, 1144, 1155, 1156, 1157, 1158, 1167, 1168 and 1169, respectively. Taking row R'0 for example, the optical recording system generates parity check codes for the data in addresses 0, 44, 88 . . . 730 and then stores these parity check codes into the addresses 1118 and 1144. As known by an ordinary person having skills in the art, the modified header 12 will directly affect two rows by itself, and simultaneously affect two rows regarding the EDC 14 under the

mode 1 standard. Since the P code 161 and Q code 162 will be affected to vary their currently stored values by the modified header 12 and EDC 14, eight additional rows are changed and need to be encoded in the embodiment. Finally, only aforementioned eight rows require to be encoded since some overlapped rows must be eliminated.

Please now refer to FIGS. 1 and 4 and by making reference to Tables 1 and 2, wherein FIG. 4 is a flow chart of the encoding method in accordance with the present invention. The encoding method of the present invention includes those steps as follows. Please note that the method described below is an embodiment of the present invention according to the mode 1 standard as shown in FIG. 1. However, in practice, this method also can apply to mode 2 form 1 and the mode 2 form 2 standards respectively shown in FIGS. 2 and 3, which may bring more encoding efficiency than that of the mode 1 standard. Detailed descriptions regarding the use of mode 2 form 1 and mode 2 form 2 standards are given later.

Step 401: During data recording operations, the optical recording system will encode the ready-for-encoding sector in the memory buffer to derive EDC 14 firstly. Of course, at least one sector (whether a gap region or a normal sector) should be encoded by using whole sector data. For example, there may create memory buffer having enough spaces to store three sectors in practical implementations, and the optical recording system will perform encoding procedures to all these three sectors before the operating flow of FIG. 4 starts. Please note that only the headers 12 of the three gap regions are different since they are given by sequential numerals, e.g. 00000001h, 00000002h, 00000003h are given for these three gap regions. The optical recording system will modify the header 00000001h of the first gap region to be 00000004h for the purpose of indicating the fourth gap region after the first gap region has been delivered to arisen the following C2 and C1 encoding procedures. Similarly, the fifth and sixth gap regions may be encoded by respectively modifying the header 00000002h and 00000003h to be 00000005h, 00000006h after the second and third gap regions being delivered. An artisan having ordinary skills in the art may modify the embodiment as requirements and applications *dictate*.

Step 402: The optical recording system then [check] checks whether the next sector ready for recording indicates a gap region (or a sector having repeated data) or not. This step will be one for achieving the guarantee purpose as above-mentioned when encoding gap regions. Based on decision result, the optical recording system performs the following Step 403 if the next sector data does not indicate a gap region, otherwise the following Step 404 will be performed if a gap region is going to be encoded.

Step 403: A first encoding operation is performed, which also includes Steps 4031 and 4032 as follows.

Step 4031: Referring to Table 1, the optical recording system will perform an encoding operation to derive the P code 161 according to related portions of the encoding format in Table 1. In other words, the data in columns C0~C42 are sequentially encoded along the direction indicated by rows R0~R23, while the generated parity check codes are then stored in rows R24~25. Taking column C0 as an example (of course the other columns will be encoded as the same manner), the optical recording system will encode the data in addresses 0, 43, 86 . . . 989 and generate corresponding parity check codes that are stored in addresses 1032 and 1075 as mentioned above.

Step 4032: Referring to Table 2, the optical recording system would generate the Q code 162. Taking column R'0 as an example, the optical recording system will encode the data mapped to addresses 0, 44, 88 . . . 730 and generate a corre-

sponding parity check code stored in addresses 1118 and 1144. The encoding procedure of the embodiment is complete after this step terminates, while the optical recording system returns to Step 401 for encoding the successive sectors or gap regions.

Step 404: The optical recording system will execute the second encoding operation, which can be divided into separate Steps 4041, 4042 and 4043 described as follows.

Step 4041: By comparing with the former encoded data, the optical recording system will firstly detect whether the ready-for-encoding sector or gap region encompasses repeated data or not. This step may be eliminated or remained for confirmation purpose as applications since the optical recording system understands whether the currently encoding sector is a gap region (or a sector having repeated data stored in the filed of user data 13) or not. The optical recording system will switch to Step 4031 to perform the first encoding operations if the current encoding sector or gap region does not include repeated data. Otherwise the optical recording system will go on the following Step 4042.

Step 4042: The optical recording system generates the parity check code, i.e., the P code 161, according to those non-repeated portions (or "affected" portions) that are affected by the modified header 12 and EDC 14. Please now refer to Table 1, the optical recording system generates the parity check code according to the data mapped to columns C0, C1, C37 and C 38 and stores the generated parity check code in addresses 1032, 1033, 1069, 1070, 1075, 1076, 1112 and 1113. Taking column C0 for example, the optical recording system will generate a parity check code mapped to addresses 1032 and 1075 according to the data mapped to addresses 0, 43, 86 . . . 989. Moreover, the optical recording system will generate the parity check code of the P code 161 corresponding to the repeated portions by copying that of the former encoding data.

Step 4043: The optical recording system generates the Q code 162 according to the non-repeated portions affected by the modified header 12 and EDC 14. Please note that only the header 12 mapped to addresses 0~1, the EDC 14 mapped to addresses 1026~1027 and their corresponding parity check code (P code) mapped to addresses 1032, 1033, 1069, 1070, 1075, 1076, 1112 and 1113 are non-repeated portions here. Please refer to Table 2 now, the optical recording system will generate the Q code 162 according to the data mapped to rows R'0, R'11, R'12, R'13, R'14, R'23, R'24 and R'25 and then stores the generated parity check code in Addresses 1118, 1129, 1130, 1131, 1132, 1141, 1142, 1143, 1144, 1155, 1156, 1157, 1158, 1167, 1168 and 1169. Taking row R'0 for example, the optical recording system will generate a parity check code mapped to addresses 1118 and 1144 according to the data in addresses 0, 44, 88 . . . 730. Moreover, the optical recording system does not need to generate Q code 162 for those repeated portions since the Q code 162 regarding the repeated portions has been calculated and stored in the memory buffer already when encoding the first gap region. The second encoding operation is complete when this step terminates and the current encoded gap region can be delivered for recording onto a compact disc. Finally the optical recording system returns to Step 401 for encoding the sequential gap regions.

Since the encoding method of the present invention only encodes the non-repeated portions of the gap region, time-cost for encoding the gap region will be effectively reduced so that the data encoding efficiency can be significantly upgraded due to the system resource being efficiently used. In another embodiment, there is no additional portion in the memory buffer affected by the modified headers 22 and 32

under the mode 2 form 1 and mode 2 form 2 standards, respectively. In other words, the EDC **25** and ECC **26** in the mode 2 form 1 standard, and the EDC **35** in the mode 2 form 2 standard will remain the same as the former encoded results when only the header is modified. Therefore, only those portions related to the headers require to be encoded by the optical recording system, that is, only those rows and columns that include the modified header need to be encoded in these two embodiments. Totally encoding time will be significantly reduced since the bus bandwidths for accessing

data will be significantly reduced whatever mode 1, mode 2 form 1, or mode 2 form 2 standards are employed.

Although the present invention has been described with reference to the preferred embodiment thereof, it will be understood that the invention is not limited to the details thereof. Various substitutions and modifications have been suggested in the foregoing description, and other will occur to those of ordinary skill in the art. Therefore, all such substitutions and modifications are embraced within the scope of the invention as defined in the appended claims.

TABLE I

PRIOR ART															
	C0	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14
R0	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
R1	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57
R2	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
R3	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143
R4	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186
R5	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229
R6	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272
R7	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315
R8	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358
R9	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401
R10	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444
R11	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487
R12	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530
R13	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573
R14	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616
R15	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659
R16	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702
R17	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745
R18	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788
R19	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831
R20	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874
R21	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917
R22	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960
R23	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003
R24	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046
R25	1075	1076	1077	1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	1089
R26	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132
R27	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158
	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28	C29
R0	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
R1	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
R2	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115
R3	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158
R4	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201
R5	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244
R6	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287
R7	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330
R8	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373
R9	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416
R10	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459
R11	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502
R12	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545
R13	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588
R14	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631
R15	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674
R16	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717
R17	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760
R18	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803
R19	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846
R20	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889
R21	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932
R22	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975
R23	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018
R24	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061
R25	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104
R26	1133	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143				
R27	1159	1160	1161	1162	1163	1164	1165	1166	1167	1168	1169				

TABLE 1-continued

PRIOR ART													
	C30	C31	C32	C33	C34	C35	C36	C37	C38	C39	C40	C41	C42
R0	30	31	32	33	34	35	36	37	38	39	40	41	42
R1	73	74	75	76	77	78	79	80	81	82	83	84	85
R2	116	117	118	119	120	121	122	123	124	125	126	127	128
R3	159	160	161	162	163	164	165	166	167	168	169	170	171
R4	202	203	204	205	206	207	208	209	210	211	212	213	214
R5	245	246	247	248	249	250	251	252	253	254	255	256	257
R6	288	289	290	291	292	293	294	295	296	297	298	299	300
R7	331	332	333	334	335	336	337	338	339	340	341	342	343
R8	374	375	376	377	378	379	380	381	382	383	384	385	386
R9	417	418	419	420	421	422	423	424	425	426	427	428	429
R10	460	461	462	463	464	465	466	467	468	469	470	471	472
R11	503	504	505	506	507	508	509	510	511	512	513	514	515
R12	546	547	548	549	550	551	552	553	554	555	556	557	558
R13	589	590	591	592	593	594	595	596	597	598	599	600	601
R14	632	633	634	635	636	637	638	639	640	641	642	643	644
R15	675	676	677	678	679	680	681	682	683	684	685	686	687
R16	718	719	720	721	722	723	724	725	726	727	728	729	730
R17	761	762	763	764	765	766	767	768	769	770	771	772	773
R18	804	805	806	807	808	809	810	811	812	813	814	815	816
R19	847	848	849	850	851	852	853	854	855	856	857	858	859
R20	890	891	892	893	894	895	896	897	898	899	900	901	902
R21	933	934	935	936	937	938	939	940	941	942	943	944	945
R22	976	977	978	979	980	981	982	983	984	985	986	987	988
R23	1019	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031
R24	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074
R25	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117
R26													
R27													

TABLE 2

PRIOR ART															
	C'0	C'1	C'2	C'3	C'4	C'5	C'6	C'7	C'8	C'9	C'10	C'11	C'12	C'13	C'14
R'0	0	44	88	132	176	220	264	308	352	396	440	484	528	572	616
R'1	43	87	131	175	219	263	307	351	395	439	483	527	571	615	659
R'2	86	130	174	218	262	306	350	394	438	482	526	570	614	658	702
R'3	129	173	217	261	305	349	393	437	481	525	569	613	657	701	745
R'4	172	216	260	304	348	392	436	480	524	568	612	656	700	744	788
R'5	215	259	303	347	391	435	479	523	567	611	655	699	743	787	831
R'6	258	302	346	390	434	478	522	566	610	654	698	742	786	830	874
R'7	301	345	389	433	477	521	565	609	653	697	741	784	829	873	917
R'8	344	388	432	476	520	564	608	652	696	740	784	828	872	916	960
R'9	387	431	475	519	563	607	651	695	739	783	827	871	915	959	1003
R'10	430	474	518	562	606	650	694	738	782	826	870	914	958	1002	1046
R'11	473	517	561	605	649	693	737	781	825	869	913	957	1001	1045	1089
R'12	516	560	604	648	692	736	780	824	868	912	956	1000	1044	1088	14
R'13	559	603	647	691	735	779	823	867	911	955	999	1043	1087	13	57
R'14	602	646	690	734	778	822	866	910	954	998	1042	1086	12	56	100
R'15	645	689	733	777	821	865	909	953	997	1041	1085	11	55	99	143
R'16	688	732	776	820	864	908	952	996	1040	1084	10	54	98	142	186
R'17	731	774	819	863	907	951	995	1039	1083	9	53	97	141	185	229
R'18	774	818	862	906	950	994	1038	1082	8	52	96	140	184	228	272
R'19	817	861	905	949	993	1037	1081	7	51	95	139	183	227	271	315
R'20	860	904	948	992	1036	1080	6	50	94	138	182	226	270	314	358
R'21	903	947	991	1035	1079	5	49	93	137	181	225	269	313	357	401
R'22	946	990	1034	1078	4	48	92	136	180	224	268	312	356	400	444
R'23	989	1033	1077	3	47	91	135	179	223	267	311	355	399	443	487
R'24	1032	1076	2	46	90	134	178	222	266	310	354	398	442	486	530
R'25	1075	1	45	89	133	177	221	265	309	353	397	441	485	529	573
	C'15	C'16	C'17	C'18	C'19	C'20	C'21	C'22	C'23	C'24	C'25	C'26	C'27	C'28	C'29
R'0	660	704	748	792	836	880	924	968	1012	1056	1100	26	70	114	158
R'1	703	747	791	835	879	923	967	1011	1055	1099	25	69	113	157	201
R'2	746	790	834	878	922	966	1010	1054	1098	24	68	112	156	200	244
R'3	789	833	877	921	965	1009	1053	1097	23	67	111	155	199	243	287
R'4	832	876	920	964	1008	1052	1096	22	66	110	154	198	242	286	330
R'5	875	919	963	1007	1051	1095	21	65	109	153	197	241	285	329	373
R'6	918	962	1006	1050	1094	20	64	108	152	196	240	284	328	372	416
R'7	961	1005	1049	1093	19	63	107	151	195	239	283	327	371	415	459
R'8	1004	1048	1092	18	62	106	150	194	238	282	326	370	414	458	502

TABLE 2-continued

PRIOR ART															
R'9	1047	1091	17	61	105	149	193	237	281	325	369	413	457	501	545
R'10	1090	16	60	104	148	192	236	280	324	368	412	456	500	544	588
R'11	15	59	103	147	191	235	279	323	367	411	455	499	543	587	631
R'12	58	102	146	190	234	278	322	366	410	454	498	542	586	630	674
R'13	101	145	189	233	277	321	365	409	453	497	541	585	629	673	717
R'14	144	188	232	276	320	364	408	452	496	540	584	628	672	716	760
R'15	187	231	275	319	363	407	451	495	539	583	627	671	715	759	803
R'16	230	274	318	362	406	450	494	538	582	626	670	714	758	802	846
R'17	273	317	361	405	449	493	537	581	625	669	713	757	801	845	889
R'18	316	360	404	448	492	536	580	624	668	712	756	800	844	888	932
R'19	359	403	447	491	535	579	623	667	711	755	799	843	887	931	975
R'20	402	446	490	534	578	622	666	710	754	798	842	886	930	974	1018
R'21	445	489	533	577	621	665	709	753	797	841	885	929	973	1017	1061
R'22	488	532	576	620	664	708	752	796	840	884	928	972	1016	1060	1104
R'23	531	575	619	663	707	751	795	839	883	927	971	1015	1059	1103	29
R'24	574	618	662	706	750	794	838	882	926	970	1014	1058	1102	28	72
R'25	617	661	705	749	793	837	881	925	969	1013	1057	1101	27	71	115
C'30	C'31	C'32	C'33	C'34	C'35	C'36	C'37	C'38	C'39	C'40	C'41	C'42	C'43	C'44	
R'0	202	246	290	334	378	422	466	510	554	598	642	686	730	1118	1144
R'1	245	289	333	377	421	465	509	553	597	641	685	729	773	1119	1145
R'2	288	332	376	420	464	508	552	596	640	684	728	772	816	1120	1146
R'3	331	375	419	463	507	551	595	639	683	727	771	815	859	1121	1147
R'4	374	418	462	506	550	594	638	682	726	770	814	858	902	1122	1148
R'5	417	461	505	549	593	637	681	725	769	813	857	901	945	1123	1149
R'6	460	504	548	592	636	680	724	768	812	856	900	944	988	1124	1150
R'7	503	547	591	635	679	723	767	811	855	899	943	987	1031	1125	1151
R'8	546	590	634	678	722	766	810	854	898	942	986	1030	1074	1126	1152
R'9	589	633	677	721	765	809	853	897	941	985	1029	1073	1117	1127	1153
R'10	632	676	720	764	808	852	896	940	984	1028	1072	1116	42	1128	1154
R'11	675	719	763	807	851	895	939	983	1027	1071	1115	41	85	1129	1155
R'12	718	762	806	850	894	938	982	1026	1070	1114	40	84	128	1130	1156
R'13	761	805	849	893	937	981	1025	1069	1113	39	83	127	171	1131	1157
R'14	804	848	892	936	980	1024	1068	1112	38	82	126	170	214	1132	1158
R'15	847	891	935	979	1023	1067	1111	37	81	125	169	213	257	1133	1159
R'16	890	934	978	1022	1066	1110	36	80	124	168	212	256	300	1134	1160
R'17	933	977	1021	1065	1109	35	79	123	167	211	255	299	343	1135	1161
R'18	976	1020	1064	1108	34	78	122	166	210	254	298	342	386	1136	1162
R'19	1019	1063	1107	33	77	121	165	209	253	297	341	385	429	1137	1163
R'20	1062	1106	32	76	120	164	208	252	296	340	384	428	472	1138	1164
R'21	1105	31	75	119	163	207	251	295	339	383	427	471	515	1139	1165
R'22	30	74	118	162	206	250	294	338	382	426	470	514	558	1140	1166
R'23	73	117	161	205	249	293	337	381	425	469	513	557	601	1141	1167
R'24	116	160	204	248	292	336	380	424	468	512	556	600	644	1142	1168
R'25	159	203	247	291	335	379	423	467	511	555	599	643	687	1143	1169

What is claimed is:

1. A method for encoding data ready-for-recording on a compact disk, wherein said ready-for-recording data comprises a plurality of data sectors and each of said data [sector] sectors having a header and a user data, said method comprising:

encoding first sector of said plurality of data sectors;
modifying said header of a second data sector of said plurality of data sectors, said second data sector being succeeding to said first data sector;

partially encoding said second data sector by encoding an affected portion of said second data sector according to said modified header when said second sector having said user data identical to that of said first sector, wherein a portion of said second data sector that is not affected by said modified header is not varied when said affected portion is encoded; and

encoding said second sector by using entire data of said second sector when said second sector has user data non-identical to that of said first sector.

2. The encoding method as claimed in claim 1 wherein said affected portion is varied with said modified header.

3. The encoding method as claimed in claim 2 wherein an encoding form for recording said optical disk is the mode 1 standard.

4. The encoding method as claimed in claim 1 wherein said modified header modified according to a relationship between said first sector and said second sector.

5. The encoding method as claimed in claim 4 wherein said affected portion comprises a row including information being modified by said modified header and a column including information being modified by said modified header.

6. The encoding method as claimed in claim 4 wherein said affected portion comprises an error detection code being modified according to said modified header.

7. The encoding method as claimed in claim 4 wherein said affected portion comprises an error correction code being modified according to said modified header.

8. The encoding method as claimed in claim 1 wherein said ready-for-recording data indicates a gap region when all of said user data in said plurality of data sectors are identical.

9. The encoding method as claimed in claim 1 wherein portion of said second data sector that is not affected by said modified header remains the same in a memory buffer of an optical recording system when encoding said second data sector.

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10. A method of encoding a plurality of data sectors having identical user data before an optical recording system records said sector onto a compact disk comprising:

encoding a first sector of said plurality of data sectors, wherein each one of said plurality of data sectors having a header;

modifying said header of a second data sector of said plurality of data sectors, said second data sector being succeeding to said first data sector; and

partially encoding said second data sector by encoding an affected portion of said second data sector according to said modified header, wherein a portion of said second data sector that is not affected by said modified header is not varied when said affected portion is encoded.

11. The encoding method as claimed in claim 10 wherein said affected portion is varied with said modified header.

12. The encoding method as claimed in claim 10 wherein an encoding form for recording said optical disk is the mode 1 standard.

13. The encoding method as claimed in claim 12 wherein said affected portion comprises a row including information being modified by said modified header and a column including information being modified by said modified header.

14. The encoding method as claimed in claim 12 wherein said affected portion comprises an error detection code being modified according to said modified header.

15. The encoding method as claimed in claim 14 wherein said affected portion comprises an error correction code being modified according to said modified header.

16. The encoding method as claimed in claim 15 wherein said currently encoded sector follows a standard adapted to encode application software.

17. The encoding method as claimed in claim 10 wherein said ready-for-recording data indicates a gap region when all of said user data in said plurality of data sectors are identical.

18. The encoding method as claimed in claim 10 wherein said portion of said second data sector that is not affected by said modified header remains the same in a memory buffer of an optical recording system when encoding said second data sector.

19. A method for encoding a gap region ready-for-recording onto a compact disk, wherein said gap region comprises a plurality of data sectors and each of said data sectors having a repeated user data identical to said other data sectors and a header that is non-identical to said other data sectors, said method comprising:

encoding a first sector of said plurality of data sectors according to said repeated user data and said non-repeated portion;

modifying said header of a second data sector of said plurality of data sector according to a relationship between said first sector and said second data sector, said second data sector being succeeding to said first data sector;

encoding an affected portion of said second data sector according to said modified header, wherein said affected portion is varied with said modified header; and

encoding said second data sector according to an encoding form said compact disk being employed.

20. The encoding method as claimed in claim 19 wherein said step of encoding said affected portion of said second data sector comprises a step of encoding an error detection code of said second data sector according to a synchronous code of said second data sector, said modified header, and said identical user data when said encoding form is the mode 1 standard.

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21. The encoding method as claimed in claim 19 wherein a non-affected portion of said encoded result of said first sector remains the same when encoding said gap region.

22. The encoding method as claimed in claim 19 wherein said step of encoding said affected portion of said second data sector skipped when said encoding form is the mode 2 standard.

23. A method for encoding data ready-for-recording on a compact disk, wherein the ready-for-recording data comprises multiple data sectors and the individual data sectors have a header and a user data, the method comprising:

modifying the header of a second data sector of the multiple data sectors, the second data sector following a first data sector; and

at least partially encoding the second data sector by encoding an affected portion of the second data sector according to the modified header if the second sector has identical user data to that of the first data sector, wherein a portion of the second data sector that is not affected by the modified header is not varied if the affected portion is encoded.

24. The method of claim 23 further comprising encoding the first data sector before the modifying.

25. The method of claim 23 further comprising encoding the second data sector by using substantially all data of the second data sector if the second data sector has user data that is not identical to that of the first data sector.

26. The method of claim 23 further comprising:

encoding the first data sector before the modifying; and

encoding the second data sector by using substantially all data of the second data sector if the second data sector has user data that is not identical to that of the first data sector.

27. A computer-readable storage device storing computer-executable instructions that, when executed, perform a method for encoding data ready-for-recording on a compact disk, wherein the ready-for-recording data comprises multiple data sectors and individual data sectors have a header and a user data, the method comprising:

modifying the header of a second data sector of the multiple data sectors, the second data sector following a first data sector; and

at least partially encoding the second data sector by encoding an affected portion of the second data sector according to the modified header if the second sector has identical user data to that of the first data sector, wherein a portion of the second data sector that is not affected by the modified header is not varied if the affected portion is encoded.

28. The computer-readable storage device of claim 27 wherein the method further comprises:

encoding the first data sector before the modifying; and

encoding the second data sector by using substantially all data of the second data sector if the second data sector has user data that is not identical to that of the first data sector.

29. A system for encoding data ready-for-recording on a compact disk, wherein the ready-for-recording data comprises multiple data sectors and individual data sectors have a header and a user data, comprising:

a component configured to modify the header of a second data sector of the multiple data sectors, the second data sector following a first data sector; and

a component configured to encode the second data sector by encoding an affected portion of the second data sector according to the modified header if the second sector has identical user data to that of the first data sector, wherein

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a portion of the second data sector that is not affected by the modified header is not varied if the affected portion is encoded.

30. *A system for encoding data ready-for-recording on a compact disk, wherein the ready-for-recording data comprises multiple data sectors and individual data sectors have a header and a user data, comprising:*

means for modifying the header of a second data sector of the multiple data sectors, the second data sector following a first data sector; and

means for at least partially encoding the second data sector by encoding an affected portion of the second data sector according to the modified header if the second

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sector has identical user data to that of the first data sector, wherein a portion of the second data sector that is not affected by the modified header is not varied if the affected portion is encoded.

31. *The system of claim 30 further comprising: means for encoding the first data sector before the modifying; and*

means for encoding the second data sector by using substantially all data of the second data sector if the second data sector has user data that is not identical to that of the first data sector.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : RE43,019 E
APPLICATION NO. : 12/098361
DATED : December 13, 2011
INVENTOR(S) : Chang et al.

Page 1 of 6

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

The title page showing the illustrative figure should be deleted to be replaced with the attached title page.

On the Cover Page, item (57), under “ABSTRACT”, in Column 2, Line 12, delete “according” and insert -- according to --, therefor.

On the Cover Page, item (57), under “ABSTRACT”, in Column 2, Line 13, delete “mode form 2” and insert -- mode 2 form 2 --, therefor.

In the drawing sheets, consisting of Figs. 1-4, should be deleted to be replaced with the drawing sheets, consisting of Figs. 1-4, as shown on the attached pages.

In Column 2, Line 9, delete “according” and insert -- according to --, therefor.

In Column 2, Line 45, delete “disc” and insert -- disc. --, therefor.

In Column 5, Line 58, delete “R24~25” and insert -- R24~25. --, therefor.

In Column 6, Line 16, delete “filed” and insert -- field --, therefor.

In Column 12, Line 45, in Claim 4, delete “header” and insert -- header is --, therefor.

In Column 12, Line 63, in Claim 9, delete “wherein” and insert -- wherein said --, therefor.

Signed and Sealed this
Fourth Day of December, 2012



David J. Kappos
Director of the United States Patent and Trademark Office

(19) **United States**
 (12) **Reissued Patent**
Chang et al.

(10) **Patent Number:** **US RE43,019 E**
 (45) **Date of Reissued Patent:** **Dec. 13, 2011**

(54) **ENCODING RECORDING DATA ON OPTICAL DISKS**

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 Kun-Long Lhu, Taipei Hsien (TW)**
 (73) Assignee: **Tian Holdings, L.L.C., Wilmington, DE (US)**

(21) Appl. No.: **12/098,361**
 (22) Filed: **Apr. 4, 2008**

Related U.S. Patent Documents

Reissue of:
 (64) Patent No.: **7,023,784**
 Issued: **Apr. 4, 2006**
 Appl. No.: **10/400,574**
 Filed: **Mar. 28, 2003**

(30) **Foreign Application Priority Data**
 Mar. 29, 2002 (TW) 91106426 A

(51) Int. Cl. **G11B 7/00 (2006.01)**
 (52) U.S. Cl. **369/59.25**
 (58) **Field of Classification Search** **369/59.25, 369/59.11, 59.12, 53.33, 53.34, 53.35, 47.1, 369/47.28, 59.33, 59.34, 47.27, 47.23, 47.24**
 See application file for complete search history.

(56) **References Cited**

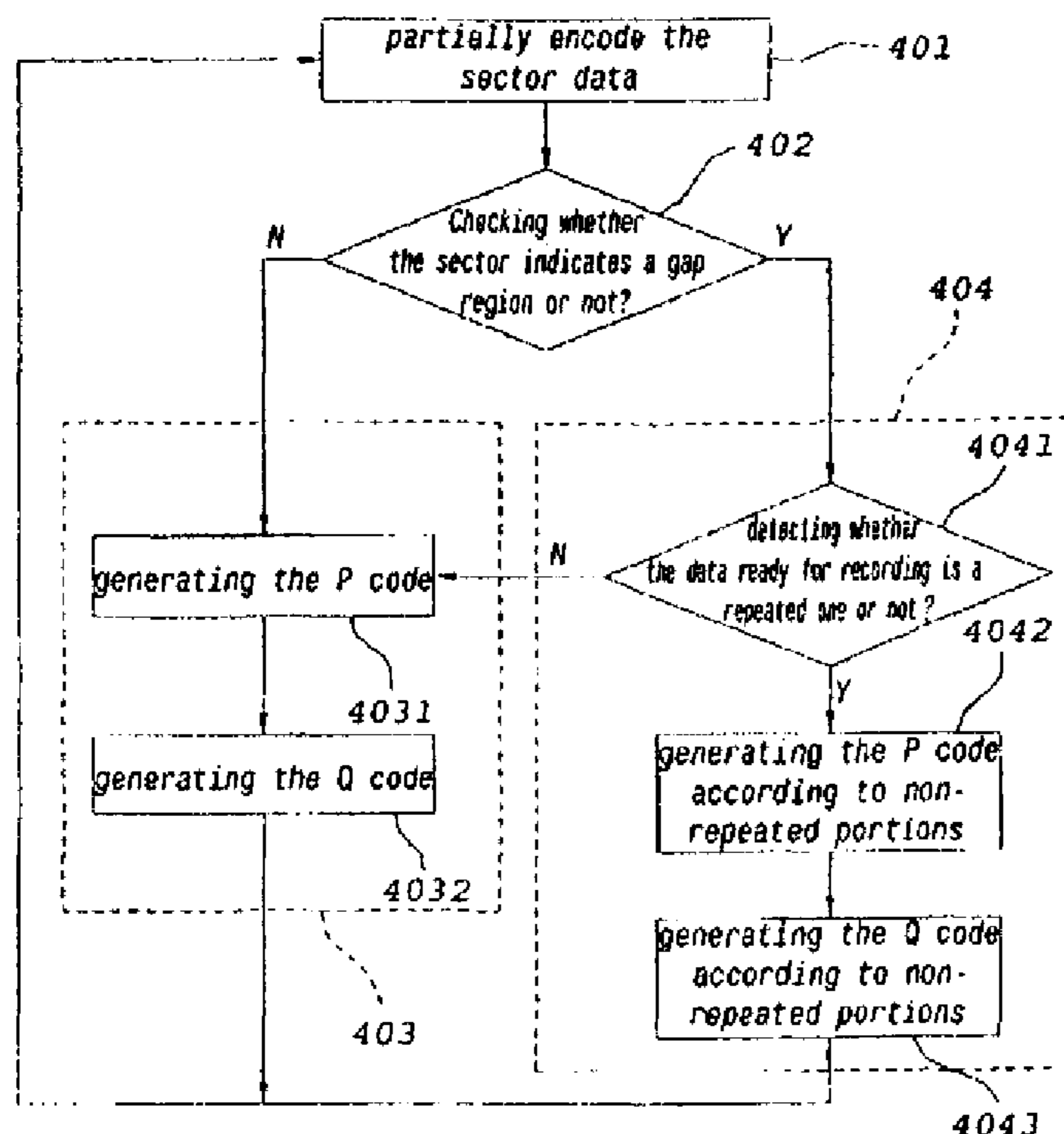
U.S. PATENT DOCUMENTS
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 TW 244066 11/2005
 * cited by examiner

Primary Examiner - Nabil Z Hindi
 (74) *Attorney, Agent, or Firm* — Perkins Coie LLP

(57) **ABSTRACT**

An encoding method for recording gap regions or sectors having repeated data is disclosed. At least one sector is entirely encoded and stored in a memory buffer of the optical recording system. If the currently encoded are gap regions or sector having repeated data embedded in the fields of user data, only those portions affected by the modified header will be encoded to derive associated P code and Q code. The error detection code is firstly generated in the mode 1 standard when a gap region is encoded. P code is then encoded for those regions affected by the sequentially modified header and error detection code, while associated Q code is then derived according the modified header, error detection code, and P code. In the mode 2 form 1 and mode form 2 standards, only those regions affected by the sequentially modified header should be re-encoded again. Since the remaining portions employ the same data as the last encoded one in the memory buffer so that the encoding performance would be significantly upgraded whatever encoding standards are employed.

31 Claims, 4 Drawing Sheets



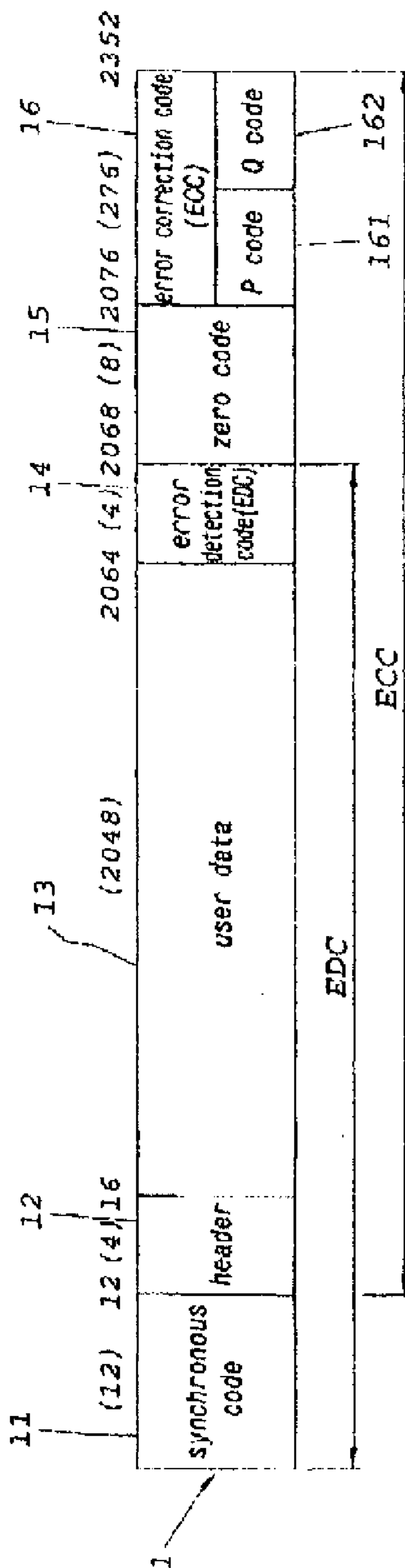


FIG. 1
PRIOR ART

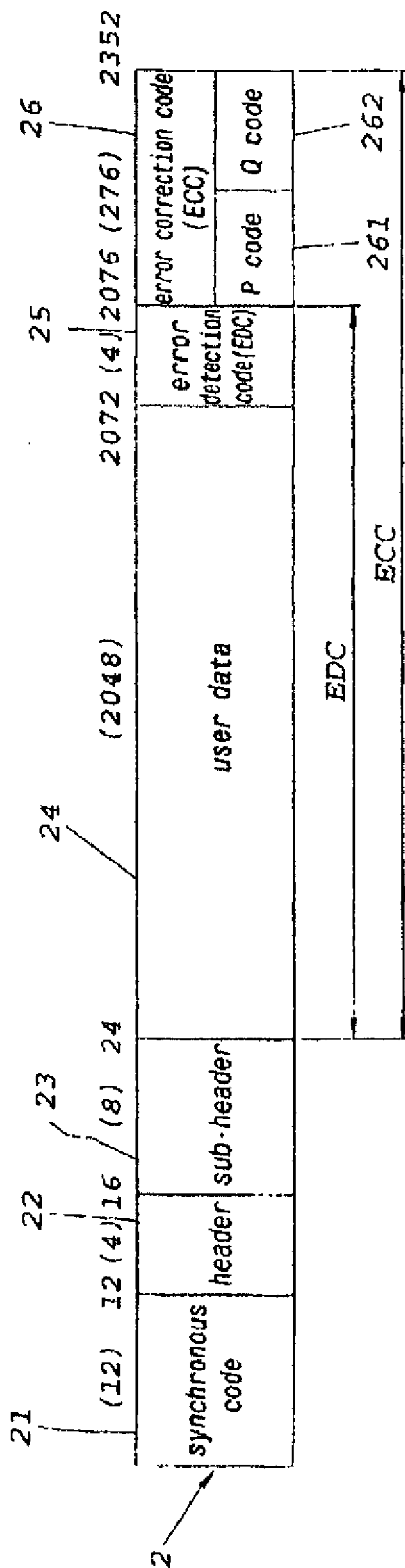


FIG. 2
PRIOR ART

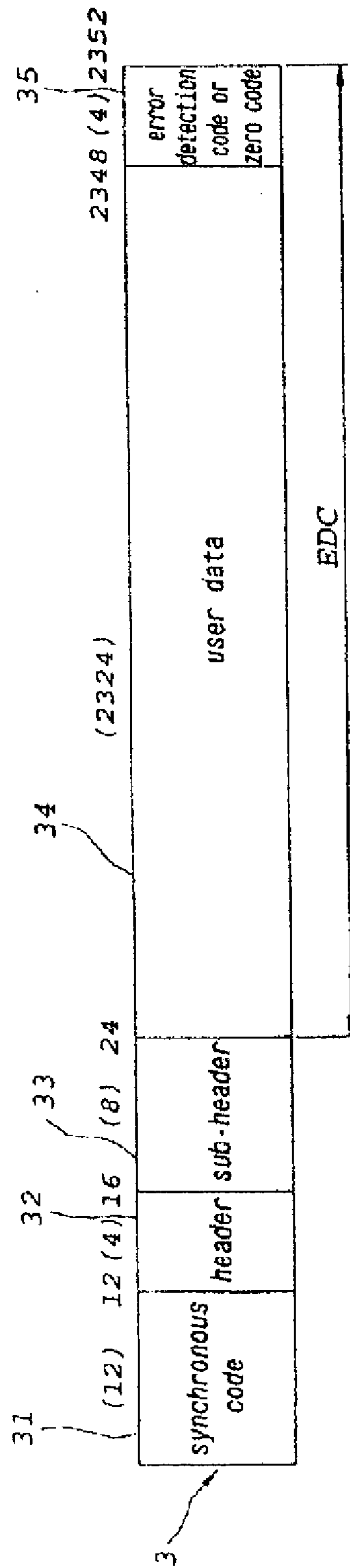


FIG. 3
PRIOR ART

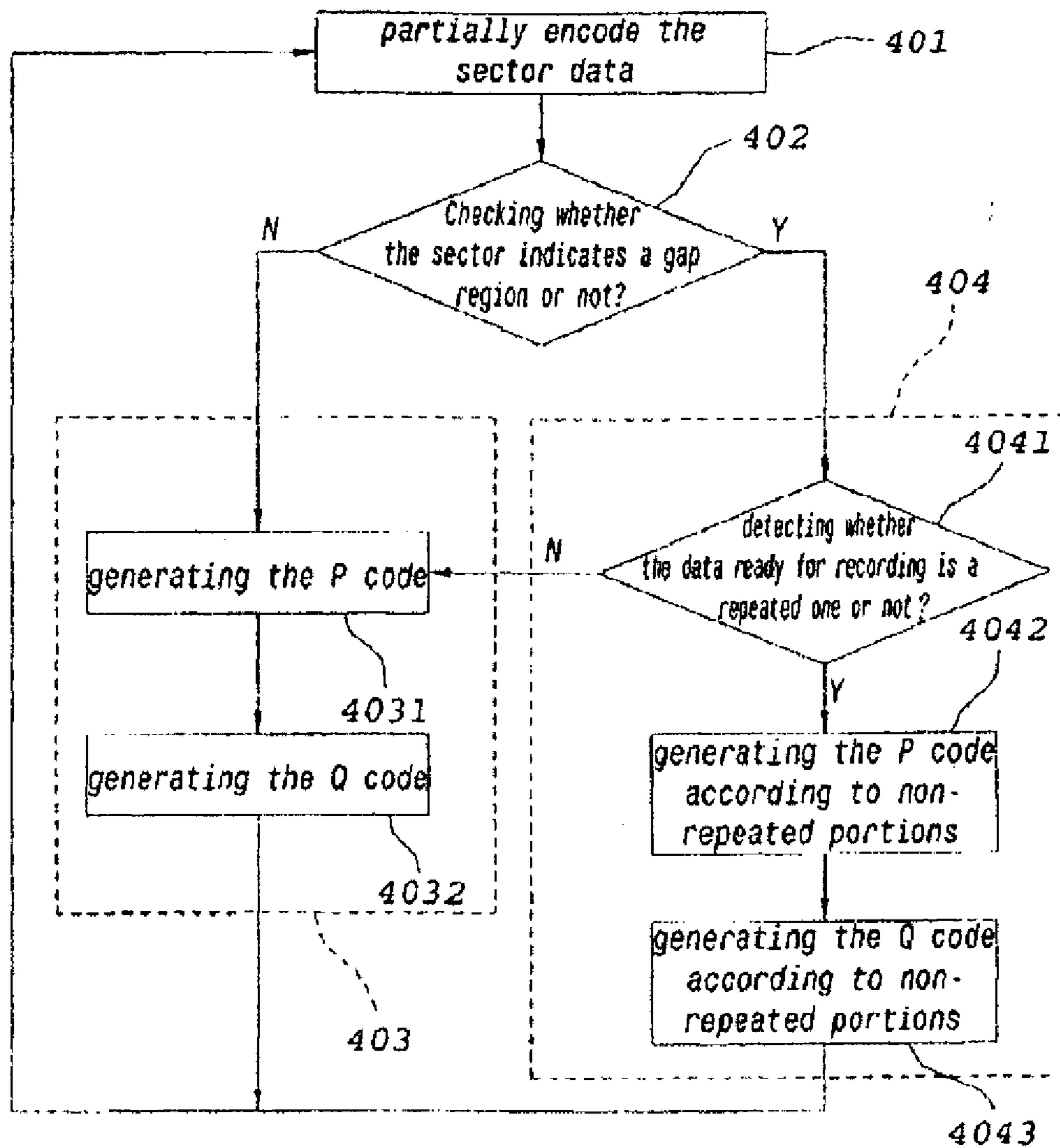


FIG.4