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(71) Applicant(s)
Sony Corporation

(72) Inventor(s)
Ikuro Tsukagoshi

(74) Agent/Attorney
SPRUSON and FERGUSON,GPO Box 3898,SYDNEY NSW 2001

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(71) Applicant(s)
SONY CORPORATION

(72) Inventor(s)
IKUO TSUKAGOSHI

(74) Attorney or Agent
SPRUSON & FERGUSON, GPO Box 3898, SYDNEY NSW 2001

(57)

Encoding and decoding of subtitle data is performed in real time. A buffer (68) regulates a flow rate of the subtitle data to ensure that the appropriate subtitles are superimposed with the correct video picture (NTSC/PAL). In encoding (Fig. 7), subtitles are generated in correspondence to a video picture. The subtitles are separately encoded (68) and multiplexed (58) with the video picture for transmission (91). Upon decoding (7), the subtitles are selected at a time which corresponds to the display of the corresponding video picture (NTSC/PAL). Since the subtitles are processed separately from the video data, the subtitles may be manipulated with great control; thus providing more flexibility in encoding and decoding.

Claim

1. A subtitle data encoding apparatus for generating subtitles to be multiplexed with video pictures by a multiplexer, said apparatus comprising:

subtitle generating means for separately generating said subtitles for superimposition with a respective video picture selected from among said video pictures;

encoding means for encoding said subtitles into encoded subtitle data; and

buffer means for regulating a flow rate of said encoded subtitle data to transfer said encoded subtitle data contemporaneously with said respective video picture to the multiplexer.

11. A subtitle data decoding apparatus for decoding encoded subtitles demultiplexed from video pictures by a demultiplexer and for superimposing said subtitles on said video pictures, said apparatus comprising:

buffer means for regulating a flow rate of said encoded subtitles to read out said encoded subtitles contemporaneously with a display of a respective video picture selected from among said video pictures;

decoding means for decoding said encoded subtitles into decoded subtitles; and

mixing means for mixing said decoded subtitles with said respective video picture such that the decoded subtitles are superimposed on a display of said respective video picture.

Subtitle Encoding/Decoding Method and Apparatus

Abstract

Encoding and decoding of subtitle data is performed in real time. A buffer (68) regulates a flow rate of the subtitle data to ensure that the appropriate subtitles are superimposed with the correct video picture (NTSC/PAL). In encoding (Fig. 7), subtitles are generated in correspondence to a video picture. The subtitles are separately encoded (68) and multiplexed (58) with the video picture for transmission (91). Upon decoding (7), the subtitles are selected at a time which corresponds to the display of the corresponding video picture (NTSC/PAL). Since the subtitles are processed separately from the video data, the subtitles may be manipulated with great control; thus providing more flexibility in encoding and decoding.



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Name and Address
of Applicant: Sony Corporation
7-35, Kitashinagawa 6-chome
Shinagawa-ku
Tokyo
JAPAN

Actual Inventor(s): Ikuro Tsukagoshi

Address for Service: Spruson & Ferguson, Patent Attorneys
Level 33 St Martins Tower, 31 Market Street
Sydney, New South Wales, 2000, Australia

Invention Title: Subtitle Encoding/Decoding Method and Apparatus

The following statement is a full description of this invention, including the best method of performing it known to me/us:-

1 viewer desires to video record the broadcast without the
2 subtitles. For example, the viewer may be recording a televised
3 movie and, suddenly, news subtitles are superimposed on the
4 broadcast thereby ruining the recording.

5 Previously superimposed subtitles are also undesirable
6 because a plurality of languages cannot be selected. Where a
7 viewer does not comprehend the subtitle language the subtitles
8 are annoying surplusage. On the other hand, Where the viewer
9 further does not comprehend the spoken language, the broadcast is
10 incomprehensible to the viewer.

11 Compact Disc Graphics (CD-G) provide more flexibility
12 in displaying subtitles because this technique records graphics
13 on a compact disc (CD) by using subcodes. However, CD-G has a
14 serious disadvantage because this technique is limited to CD
15 applications. The CD-G technique does not lend itself to other
16 recording formats and, thus, to the vast majority of audio/video
17 broadcasts which employ such other recording formats, such as
18 video tape.

19 Figs. 13a-c and 14 demonstrate that the CD-G technique
20 is not suitable for use with broadcasting subtitles during real-
21 time broadcasts. In particular, an analysis of the data format
22 employed by CD-G reveals that this technique requires a
23 transmission lead-time of several seconds (10.24s) which
24 generally is unacceptable for most real-time broadcasts.

1 Fig. 13a depicts the CD-G data format in which one
2 frame includes 1 byte of a subcode and 32 bytes of audio channel
3 data. Of the 32 bytes, 24 bytes are allocated for L and R audio
4 channel data (each channel having 6 samples with 2 bytes per
5 sample) and 8 bytes are allocated to an error correction code.

6 The frames are grouped as a block of 98 frames (Frame 0, Frame 1,
7 ..., Frame 96 and Frame 97) as shown in Fig. 13b. Eight blocks
8 P, Q, R, S, T, U, V and W are transmitted as shown in Fig. 13c. The
9 subcodes for Frames 0 and 1 in each block are defined as sync
10 patterns S0, S1, whereas the remaining 96 frames store various
11 subcode data. Among a group of 8 blocks, the first 2 blocks P, Q
12 are allocated to search data employed for searching through
13 record tracks; and graphic data can be allocated to the subcodes
14 in the remaining 6 blocks R, S, T, U, V and W.

15 Since each block of 98 frames is transmitted at a
16 repeating frequency of 75 Hz, the data transmission rate for 1
17 block is (75 x 98 bytes) 7.35 kHz, or 7.35 K bytes/s. The
18 transmission format for transmitting the information present in
19 blocks R, S, T, U, V and W is shown in Fig. 14. Each of the 96
20 frames (2, 3, ... 97) of the 6 blocks (R, S, T, U, V and W) 96 is
21 arranged as a packet including 6 channels (R to W) of 96 symbols
22 per channel. The packet is further subdivided into 4 packs of 24
23 symbols each (symbol 0 to symbol 23), with each symbol
24 representing a frame.

1. A CD-G character is made up of 6 x 12 pixels. Since
 2 each pack is 6 x 24, a 6 x 12 character is easily accommodated in
 3 each pack. The CD-G format allocates the six channels of
 4 (R,S,T,U,V and W) and the 12 symbols 8 to 19 to a character. The
 5 remainder of the symbols in each of the packs store information
 6 about the character.

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Mode information is stored in the first 3 channels (R, S, T) of symbol 0 in each pack, and item information is stored in the last 3 channels (U, V, W) of symbol 0. A combination of the mode information and the item information defines the mode for the characters stored in the corresponding pack as follows:

12 Table 1

13	Mode	Item
14	000	000 mode
15	001	000 graphics mode
16	001	001 TV-graphics mode
17	111	000 user's mode

18 An instruction is stored in all of the channels of
 19 symbol 1. Corresponding mode, item, parity or additional
 20 information for the instruction is stored in all of the channels
 21 of symbols 2 to 7. Parity for all of the data in the channels of
 22 symbols 0 to 19 is stored in all of the channels of the last 4
 23 symbols (symbols 20 to 23) of each pack.

1. As discussed, the data is transmitted at a repeating
2 frequency of 75 Hz. Therefore, a packet which contains 4 packs
3 is transmitted at a rate of 300 packs per second (75 Hz x 4
4 packs). That is, with 1 character allocated to the range of 6 x
5 12 pixels, 300 characters can be transmitted in 1 second.

6. However, a CD-G screen requires more than 300
7 characters. A CD-G screen is defined as 288 horizontal picture
8 elements x 192 vertical picture elements and requires more than
9 twice the 300 characters transmitted in 1 second. The total
10 transmission time for a 288 x 192 screen is, therefore, 2.56
11 seconds as shown by the following equation:

12
$$(288/6) \times (192/12) \div 300 = 2.56 \text{ seconds}$$

13 This is extremely long to regenerate each screen when
14 it is considered that screens are usually refreshed every 0.6
15 seconds. This problem is compounded when hexadecimal codes are
16 used for the characters because each hexadecimal expression
17 requires 4 bits to represent 1 pixel. As a result, 4 times the
18 data described above is transmitted increasing the transmission
19 rate to 10.24 seconds (4 x 2.56 seconds). Since each screen
20 requires a sluggish 10.24 seconds for transmission, a continual
21 transmission of screens means that a lag time of 10.24 seconds is
22 experienced when transmitting screens using the CD-G technique.
23 Thus, the CD-G technique is not performed in real time and is
24 unacceptably slow for use in a real time broadcast.

1 The CD-G system also suffers from defects in
2 reproducing the subtitles. The CD-G system displays subtitles
3 only upon normal reproduction and not during special reproduction
4 such as a fast forward or fast reverse reproduction. CD-G
5 pictures are also subject to sing phenomena (in which oblique
6 portions of a character are ragged) or flickering because this
7 system allocates only one bit of data for each picture element.
8 The lag time of the CD-G picture also prevents switching the
9 subtitle display on or off at a high speed.

10 In one type of system (known as the CAPTAIN system),
11 dot patterns, as well as character codes, represent the
12 subtitles. This system, however, does not appear to be any
13 better than the CD-G system and suffers from some of the same
14 disadvantages. In both systems, for example, the subtitles lack
15 refinement because these systems do not provide sufficient
16 resolution power in displaying the subtitles. The CAPTAIN
17 system, for example, is developed for a 248 (horizontal picture
18 elements) by 192 (vertical picture elements) display and not for
19 high resolution video pictures of 720 x 480.

20 21 OBJECTS OF THE INVENTION

22 An object of the invention, therefore, is to provide an
23 encoding/decoding method and apparatus for encoding and decoding
24 subtitles with a greater degree of flexibility.

1. A further object of the invention is to encode the
2 subtitles separately from the video data so that the subtitles
3 may be independently manipulated.

4 A further object of the invention is to decode the
5 subtitles in real time so that the subtitles may be
6... contemporaneously superimposed with a video picture.

7... An even further object of the invention is to provide a
8... processor for controlling the encoding/decoding of the subtitles
9... for controlling a flow rate of subtitle data read out from a
10... buffer such that the subtitle data is contemporaneously combined
11... with corresponding video data.

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13... SUMMARY OF THE INVENTION

14 The encoding apparatus of the present invention
15... provides a subtitle generator for generating the subtitles for
16 display with a respective video picture. The subtitles are
17 encoded into encoded subtitle data and the flow rate of the data
18 is regulated by a buffer to be contemporaneous with the
19 respective video picture encoded by a video encoder.

20 In the decoding apparatus of the present invention a
21 buffer regulates the flow rate, i.e. the rate at which bits are
22 read from the buffer, of the encoded subtitle data to
23 contemporaneously combine the encoded subtitle data with a
24 respective video picture decoded by a video decoder. The encoded

1. subtitle data is decoded into decoded subtitle data and a mixer
2 superimposes the decoded subtitle data and the respective video
3 picture.

4 The invention also provides a processor for controlling
5 the encoding/decoding. A respective one of several bit streams
6 of subtitle data is selectively buffered; and a time display
7 stamp indicates the time when the respective bit stream is to be
8 decoded. Decoding of the respective bit stream is initiated
9 during the time indicated by the time display stamp. A mixer
10 mixes the respective decoded bit stream with video picture data.

11
12 BRIEF DESCRIPTION OF THE DRAWINGS

13 A more complete appreciation of the present invention
14 and many of its attendant advantages will be readily obtained by
15 reference to the following detailed description considered in
16 connection with the accompanying drawings, in which:

17 Fig. 1 is a block diagram of a data decoding apparatus
18 of the present invention;

19 Fig. 2 is a block diagram of the subtitle decoder
20 depicted in Fig. 1;

21 Fig. 3 is a table of communications between the system
22 controller of Fig. 1 and the controller of Fig. 2;

23 Fig. 4 is a table of parameters for the communications
24 between components of Fig. 1 and Fig. 2;

1. Figs. 5a to 5c are signal diagrams demonstrating data
2 encoding of the present invention;
3 Fig. 6 is a color look up table referred to when
4 encoding subtitle data;
5 Figs. 7a and 7b constitute a block diagram of the
6 encoding apparatus of the present invention;
7 Fig. 8 is a graph for the explanation of a code buffer
8 operation;
9 Fig. 9 is a block diagram describing the internal
10 operation of the code buffer in Fig. 2;
11 Fig. 10 is an explanatory depiction of streams of
12 subtitle data;
13 Fig. 11a-d depict the relationship between video and
14 subtitle data relative to an aspect ratio of a monitor;
15 Fig. 12 is a color look up table referred to when
16 conducting a color wipe operation;
17 Figs. 13a to 13c depict the arrangement of data
18 according to a CD-G format; and
19 Fig. 14 depicts a transmission format of the data in
20 the CD-G format.
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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

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Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout, the present invention will be described.

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Decoding Apparatus

The data decoding apparatus which incorporates the present invention is shown in Fig. 1 and decodes a reproduction signal to generate a video picture superimposed with subtitles. The system controller 14 of the data decoding apparatus causes the reproduction signal to be processed and sent to a subtitle decoder 7. The system controller communicates with the controller 35 (Fig. 2) of the subtitle decoder to decode the subtitles and combine the decoded subtitles with decoded video data. The combined subtitle and video data are, then, prepared for display on a television screen.

A data decoder and demultiplexer 1 receives a digital reproduction signal from, for example, a VCR. The data decoder and demultiplexer 1 error decodes the reproduction signal preferably employing an Error Correcting Code (ECC) technique and demultiplexes the error decoded reproduction signal into video, subtitle and audio data. A memory 2 may be used, for example, as

1 a buffer memory and a work area for the purpose of error decoding
2 and demultiplexing the reproduction signal.

3 A video decoder 3 decodes the demultiplexed video data
4 from a video data stream. A memory 4 may be employed for the
5 operation of decoding the video data similar to the operation of
6 the memory 2 employed with data decoder and demultiplexer 1.

7 A letter box circuit 5 converts a video picture with a
8 4:3 aspect ratio (a squeeze mode) to a 16:9 letter box ratio.
9 The conversion is performed using a 4 to 3 decimation process,
10 whereby every four horizontal lines are decimated to three
11 horizontal lines, thus squeezing the video picture into a $\frac{3}{4}$
12 picture. According to the letter box format, a vertical
13 resolution component is derived from the remaining $\frac{1}{4}$ of the video
14 picture which is employed to enhance the vertical resolution of
15 the decimated video picture. A timing control memory 6 ensures
16 that the $\frac{1}{4}$ of the letter box picture is not transmitted. When
17 the decoded video data generated by the video decoder 3 is
18 already in a 16:9 letter box format, the letter box circuit
19 bypasses the decimation operation and sends the decoded video
20 data directly to the subtitle decoder 7.

21 Meanwhile, the decoded subtitle data demultiplexed by
22 the data decoder and demultiplexer 1 is directly sent to the
23 subtitle decoder 7. The subtitle decoder 7 decodes the subtitle

1 data according to instructions from the system controller 14 and
2 mixes the decoded subtitle data with the decoded video data.

3 A composite encoder 8 encodes the mixed subtitle data
4 and video data into a suitable video picture format, such as
5 NTSC/PAL. A mode display 9 interfaces with a user and indicates,
6 for example, the mode of television monitor connected thereto. A
7 D/A converter 10 converts the encoded signal received from the
8 composite encoder 8 into an analog signal suitable for display in
9 the indicated mode, such as NTSC or PAL.

10 The audio portion of the audio/video signal decoded by
11 the data decoder and demultiplexer 1 is decoded by an audio
12 decoder 11 which decodes the demultiplexed audio data using a
13 memory 12, for example. The decoded audio data output from the
14 audio decoder is converted into an analog audio signal
15 appropriate for broadcast through a television monitor by a D/A
16 converter 13.

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18 Subtitle Decoder

19 The subtitle decoder 7 of Fig. 1 communicates with the
20 system controller 14 through a controller 35 as shown in Fig. 2.
21 This communication controls the subtitle decoding performed by
22 the subtitle decoder. Definitions of the communication signals
23 between the system controller 14 and the controller 35 will be
24 discussed with reference to Fig. 3.

1 The system controller 14 sends a **reset** command to the
2 controller 35 to reset the subtitle decoder 7 and sends command
3 signals indicating an operation mode of the subtitle decoder to
4 initialize it. A **special** command is sent to the controller 35,
5 for example, when a user indicates through the mode display 9
6 (Fig. 1) that special reproduction, such as a fast-forward or
7 fast-reverse reproduction, is to be commenced. The user may also
8 turn the subtitles on or off through the mode display, causing
9 the system controller to issue a **display ON/OFF** command to the
10 subtitle decoder. The user may also control the subtitle display
11 position in the vertical direction relative to the video picture
12 on the television monitor, causing the system controller to issue
13 an **U_position** value to the subtitle decoder. With these initial
14 parameters defined for the subtitle decoder, a decoding operation
15 now will be described.

16 The subtitle data is grouped into streams of data
17 comprising bits. Each bit stream corresponds to a portion of a
18 page making up the entire subtitle picture for one picture frame.
19 As shown in Fig. 2, the bit streams are applied to a word
20 detector 20. Since the word detector selects which bits to
21 forward to the code buffer 22, different types of bit streams may
22 be applied to the word detector contemporaneously. In the
23 preferred invention, for example, bit streams of both a normal

1 playback mode and a fast-forward, or a fast-reverse, mode
2 (special reproduction) are applied to the word detector.

3 Indeed, several broadcasts of video pictures can be
4 applied to the word detector simultaneously. To that end,
5 different channels are provided for different video pictures.

6 The word detector 20 selects the channel indicated by a
7 channel_select signal sent from the system controller 14 and
8 receives the appropriate bit streams.

9 The system controller 14 also issues a stream_select
10 signal to instruct the word detector 20 to select either the
11 normal playback mode bit streams or the special reproduction mode
12 bit streams. Thus, a viewer can switch between a normal playback
13 mode and a special reproduction mode without delay.

14 The word detector 20 is also responsible for detecting
15 both header and header_error information received in the selected
16 bit streams. The header and header_error information are sent as
17 information signals, S. header and header error, to the system
18 controller 14 (via the controller 35) for further processing.
19 Similarly, error data representing a detected error is sent as a
20 data error signal to the system controller 14 when the word
21 detector detects errors in the bit stream subtitle data. If the
22 data cannot be restored, a buffer clear signal is sent from the
23 system controller to the controller and the erroneous subtitle
24 data is dumped.

1 A scheduler 21 is provided to ensure that the data
2 received from the demultiplexer 1 (Fig. 1) does not overflow the
3 code buffer 22. The scheduler controls read/write access to the
4 code buffer by determining a bandwidth for an I/O port (not
5 shown) which receives the bit streams selected by the word
6... detector. The bandwidth refers to the number of parallel bits
7... supplied to the I/O port at one time and is calculated by
8... dividing the rate at which the demultiplexer demultiplexes data
9... by the rate at which data is read from the code buffer. For
10... example, a data rate from the demultiplexer of 20 Mbps divided by
11... a 2.5 Mbps rate of data read from the code buffer is equal to 8
12... bits. Therefore, the scheduler will set the I/O port to receive
13... 8 bits in parallel in order to maintain a consistent flow rate of
14... data into and out of the code buffer.

15... A read operation is commenced in real time and is
16... triggered when the code buffer receives a decode start command
17... from the system controller 14. The timing for the reading is
18... determined from horizontal and vertical sync signals stored in
19... the headers of the subtitle data detected by the word detector
20... 20. For real time display, the reading rate should correspond to
21... a picture element sampling rate, preferably 13.5 MHz. As
22... discussed, the subtitle data preferably is written into the code
23... buffer at a rate of 2.5 MHz or more. Thus, the 13.5 MHz sampling
24... clock is divided into four clock cycles of 3.375 MHz each. One

1 of these 3.375 MHz clock cycles is allocated to writing (because
2 writing requires at least 2.5 MHz) and the remaining three clock
3 cycles are allocated to reading data from the code buffer thus
4 satisfying the requirement for real time display.

5 The read/write operation described is performed in real
6... time and provides high resolution. Eight bit of the subtitle
7... data are read from the code buffer 22 for each of three clock
8... cycles, or twenty-four bits per sampling clock. When display of
9... the picture is conducted by the television monitor every fourth
10 clock cycle, one-fourth of the twenty-four bits, $(24/4 =) 6$ bits
11... are displayed at every clock cycle. That is, each subtitle
12 picture element may comprise six bits, which is more than
13... sufficient to achieve a high quality of resolution for the
14 subtitles.

15... A duration signal and a PTS signal are retrieved by the
16 controller 35 when it is deemed that data will be read from the
17 code buffer. The duration signal indicates the duration that the
18 subtitle data lasts and the PTS signal indicates the proper time
19 that the subtitle data is to be superimposed with the video data.
20 The controller times the display of the subtitles using an
21 internal system clock reference (SCR). When the subtitles are to
22 be displayed, the system controller 14 sends the display ON
23 command to the controller 35. The system controller sends the

1 display OFF signal as a subtitle decode termination signal to the
2 controller 35 upon termination of the subtitle display.

3 The system controller may also initiate a special
4 reproduction operation in the subtitle decoder by sending a
5 special command to the controller 35. The controller sends back
6 an acknowledge signal (**special_ack**), acknowledging that special
7 reproduction is to be initiated. To perform a special
8 reproduction operation, the word detector must select bit streams
9 at a special reproduction rate. Moreover, the code buffer will
10 read out bit streams at a special reproduction rate. To
11 uniformly speed up (or slow down) the operations of the subtitle
12 decoder according to the special reproduction rate, the system
13 clock reference (SCR) can be altered by adding or subtracting
14 clock pulses. Subtraction pulses are created at an n times rate
15 corresponding to the rate of fast-feeding or fast-reverse
16 feeding. At the actual time when special reproduction is
17 commenced, real time subtraction is performed on the bit stream
18 of subtitle data read out from the code buffer at the n times
19 rate. The special reproduction operation may also correspond to
20 a pause operation, wherein no subtraction pulses are created; and
21 instead, an identical frame is continuously read from the code
22 buffer repeatedly.

23 Decoding of the subtitles also ends when the subtitle
24 decoder 7 determines that an end of page (EOP) of the video

1 picture is reached. In the preferred embodiment, the system
2 controller 14 sends a **repeat time** signal to the controller 35
3 which indicates the length of a page. A run-length circuit 24
4 includes a counter and sends a **display end** signal to the
5 controller 35 when the count value of the counter reaches the
6 value indicated by the **repeat time** signal. The controller 35
7 thus determines that the repeat time is reached and stops reading
8 from the code buffer. For purposes of this invention, the code
9 buffer preferably stores two pages of subtitle data because one
10 page will be read as another page is written into the code
11 buffer.

12 The controller 35 issues a **buffer overflow** signal to
13 the system controller 14 when an overflow of the code buffer
14 occurs. An overflow can be determined when the controller
15 receives the **display end** signal from the run-length circuit 24
16 before the word detector 20 receives an **end of page (EOP)** signal
17 on the following page. At that time, the system controller 14
18 withholds transfer of subtitle data from the data decoder and
19 demultiplexer 1 (Fig. 1) to the word detector to prevent an
20 overflow of the code buffer. The **stream_select** signal from the
21 system controller 14 designates the streams of subtitle data and
22 the display start position is updated on every frame. Thus,
23 after an overflow condition has passed, the next stream will be

1. written into the code buffer and displayed at the correct display
2. start position.

3. Fig. 8 graphically demonstrates the data flow into and
4. out of the code buffer 22. The t-axis (abscissa) represents
5. time, while the D-axis (ordinate) represents a data size for each
6. page of data. Thus, the gradient (rise/run) represents the data
7. flow rate of the subtitles into the code buffer. Graph (C)
8. represents the data flow of the subtitle data. The vertical
9. portions of graph (C) indicate a transfer of subtitle data from
10. the code buffer when the display time stamp (PTS) is aligned with
11. the synchronizing clock (SCR) generated internally by the
12. subtitle decoder 7. The horizontal portions of the graph (C)
13. indicate the transfer of subtitle data into the code buffer. For
14. example, at a time that the display time stamp (PTS) for page
15. (S0) is received by the code buffer, the previous page of
16. subtitle data is transferred from the code buffer and page (S0)
17. is written into the code buffer. When another display time stamp
18. (PTS) is received by the code buffer, the subtitle data of page
19. (S0) is transferred out of the code buffer and page (S1) is
20. written in. Similarly, the remaining pages (S2), (S3) are
21. written into and read out of the code buffer as indicated.

22. An underflow condition exists when the code buffer has
23. completed reading the subtitle data for an entire page and no
24. further data exists in the code buffer. A code buffer with a

1. capacity of two pages is depicted by the "code buffer size" line
2 in the Fig. 8. Graphically, an underflow would appear in Fig. 8
3 as one of the vertical portions of line (C) which extends below
4 the lower limit of the code buffer. By contrast, an overflow
5 condition is graphically depicted in Fig. 8 when the subtitle
6 data read into the code buffer is too large, i.e., the horizontal
7... portion of line (C) extends beyond line (B). The code buffer
8... must also perform delay compensation, especially where an
9... external memory is employed, for decoding the video data. The
10... delay compensation is achieved by controlling the timing of the
11... decode start command from the system controller 14. When the
12... controller 35 of the subtitle decoder 7 sends the display time
13... stamp (PTS) to the system controller upon writing the subtitle
14... data to the code buffer 22, the system controller, in response,
15... sends the decode start instruction to the controller 35. The
16... system controller 14 delays the decode start command by a time
17... equal to the processing of a letter box picture (approximately
18... one field) and a delay caused by video decoding at the instant
19... the synchronizing clock of the controller (SCR) is aligned with
20... the display time stamp (PTS). Delay compensation is particularly
21... useful, since the video, audio and subtitle data are multiplexed
22... on the premise that the decode delay in each of the video, audio
23... and subtitle data signals is zero in the data encoding apparatus.

1 Once the subtitle data is read from the code buffer 22,
2 an inverse VLC (Variable Length Coding) circuit 23 (Fig. 2)
3 subjects the subtitle data to variable length decoding. The
4 variable length decoded subtitle data is composed of level data
5 and run data as paired data. In the case where variable length
6 decoding is not employed, the inverse VLC circuit may be bypassed
7 and the subtitle data read from the code buffer will be directly
8 output to the inverse run-length circuit 24.

9 The inverse run-length circuit 24 conducts run-length
10 decoding by generating the level of data from the number of run
11 data elements. Thus, the VLC circuit 23 and the run-length
12 circuit 24 decompress the subtitle data which had been stored as
13 compressed data in the code buffer 22.

14 The decompressed subtitle data is then sent to a 3:4
15 filter 25. The 3:4 filter receives an **xsqueeze** signal from the
16 system controller 14 indicating the aspect ratio of the
17 corresponding television monitor. Where the signal indicates
18 that the monitor has a 4:3 aspect ratio, the 3:4 filter applies
19 3:4 filtration processing to the subtitle data to match the size
20 of the subtitles to the size of a (16:9) video picture as shown
21 in Figs. 11c, d. In the preferred embodiment, the controller 35
22 reads 90 pixels worth of subtitle data from the code buffer 22
23 before the H sync pulse is generated. In the case where the
24 television monitor already has a 16:9 aspect ratio, or the

1 decompressed subtitle data represents fonts, the 3:4 filter is
2 bypassed as shown in Figs. 11a, b.

3 A color look-up table 26 (CLUT) (which stores luminance
4 data Y, color difference data (Cr Cb), background video data, and
5 key data K representing a data mixing ratio for the Y, Cr and Cb
6 color components), receives the subtitle data from the 3:4 filter

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25. Fig. 6 shows an example of a color look-up table where the
components Y, Cr, Cb and K are arranged according to the
addresses 0...F (hexadecimal). The color look-up table is
employed to generate the correct color for each pixel of the
subtitle characters. That is, the luminance value Y and the
color difference values Cr, Cb for a particular pixel are mixed
according to the ratio specified by the key data K. A mixer 34
(Fig. 2) mixes the pixel from color look-up table 26 with video
data from the video decoder 3 (Fig. 1). The resulting mixed data
represents a video picture with superimposed subtitles and is
ready to be output to a television monitor.

18 Background video data is incorporated in the
19 arrangement of the color look-up table. For example, address 0
20 of the look-up table includes key data K having the value of 00
21 H; which means that the subtitle data will not be seen and the
22 background video data will manifest, as shown by regions T1 and
23 T5 in Fig. 5c. Addresses 1 to 6 of the look-up table include
24 values of the key data K which increase linearly (20, 40 ... C0

1 hexadecimal); which means that the subtitle pixels according to
2 these addresses are mixed with the background data as shown by
3 the regions T2 and T4 in Fig. 5c. Finally, addresses 8 to F of
4 the look-up table include values of key data K of E0; which means
5 that the components Y, Cr and Cb are mixed without any background
6 video data as shown by region T3 in Fig. 5c. The color look-up
7 table data is generated from the system controller and is
8 previously downloaded to the CLUT circuit before decoding. With
9 the color look-up table, the filtered subtitle data is
10 transformed into the appropriate color pixel for display on the
11 television monitor.

12 Another example of a color look-up table is shown in
13 Fig. 12. The arrangement of the data and the values according to
14 the components in this table may be used to provide color wiping.
15 Color wiping is a display technique which "overlaps" previously
16 displayed elements, such as subtitles, with another color usually
17 by performing the overlay from left to right progression.

18 With the present invention, a viewer has control over
19 the display of the subtitle through the mode display 9. The
20 system controller 14, upon command from the user, sends a control
21 signal to the mixer 34 (Fig. 2), turning the subtitles on or off.
22 Since the present invention generates subtitles in real time, the
23 user does not experience any unpleasant delay when turning the
24 subtitles on or off. In addition, the subtitles can be

1 controlled, by the user or otherwise, to fade-in/fade out at a
2 variable rate. This is achieved by multiplying a fade
3 coefficient to the pattern data representing the subtitles at a
4 designated speed. This function also allows an editor of the
5 subtitles to present viewers with different sensations according
6 to the broadcast audio/video picture. For example, news
7 information may be "flashed" rapidly to draw attention to the
8 viewer, whereas subtitles in a movie might "softly" appear in
9 order not to detract from the enjoyment of the movie.

10 The mixer 34 is also operable for positioning the
11 subtitles within the video picture. This is achieved by a
12 u_position signal sent from the system controller 14 to the mixer
13 via controller 35 which designates the vertical direction for
14 display on the screen. It will be noticed that the u_position
15 value may be varied, either by a user or otherwise. This
16 provides additional control over the position of the subtitles
17 and a user is free to place the subtitles anywhere along a
18 vertical axis.

19 The decoding apparatus of the present invention may be
20 practiced with the parameters for the different signals shown in
21 Fig. 4. However, the present invention is not limited to the
22 parameters set forth in that figure and may be employed in
23 different video systems.

1 In overview, the subtitle decoder 7 may be thought of
2 as the subtitle decoder buffer model in Fig. 9. The code buffer
3 22-1 accumulates streams of subtitle data until at least one page
4 of subtitle data is accumulated in the code buffer. The subtitle
5 data for one page is transferred from the code buffer 22-1 to the
6 display memory 22-2 (which acts as a buffer for the subtitle
7 decoder) when the display time stamp (PTS) is aligned with the
8 synchronizing clock (SCR). It will be noted that placing the
9 code buffer and display memory in a single unit is preferred
10 since the code buffer need only increment a pointer pointing to
11 the current address in the display memory 22-2 which stores the
12 next set of subtitle data. Thus, no delay is caused due to a
13 transfer, resulting in a high speed transfer of the subtitle
14 data.

15 Once the subtitle data for one page is transferred to
16 the display memory 22-2, the subtitles are transferred to the
17 IVLC or run-length decoding section 23, 24 for decoding. The
18 headers of the bit streams are separated therefrom by a parser
19 22-3 and forwarded to the inverse variable-length code or run-
20 length decoder 23,24 during a vertical blanking period (V).
21 After decoding, the decoded subtitle data is filtered by filter
22 25 and color adjusted according to the color look-up table
23 circuit 26. The streams applied to the code buffer 22-1 include
24 subtitles for both **normal** and **special** reproduction, such as a

1 fast-forward or fast-reverse mode. The code buffer selectively
2 writes the streams therein according to the `stream_select`
3 information supplied from the system controller 14 to select
4 either the normal or special reproduction streams as will now be
5 described.

6 Fig. 10 demonstrates the order of the streams for both
7 normal and special reproduction. The t-axis represents the time
8 in which a frame of subtitle streams are written into the code
9 buffer 22. A frame includes streams which make up a page during
10 normal play and streams that make up a page for special (or
11 trick) play. Streams (1) through (7), for example, make up one
12 page of subtitle data for normal play. These normal-play streams
13 are written into the code buffer at a time along the t-axis
14 corresponding to an "entry point". When all of the streams (1)
15 through (7) are transferred to the code buffer, the entire page
16 constituted by these streams is output to the display memory.
17 The streams for special play (referred in Figure 10 as "trick
18 play") are staggered in-between the streams for normal play as
19 shown in the figure. The code buffer selects between the streams
20 of normal and special play depending upon the `stream_select`
21 signal sent from the system controller 14.

22 This arrangement is advantageous because both pages for
23 normal and special reproduction are applied to the code buffer at
24 the same time. That is, the mode of the subtitle decoder 7 can

1 be instantly changed from normal to special reproduction without
2 lapse and the viewer experiences no lapse when subtitles are
3 displayed in a normal mode, then, in a special mode, such as a
4 fast-forward reproduction.

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Encoding Technique

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The encoding technique employed in the present invention will be described in more particular detail with reference to Figs. 5a, 5b and 5c and Fig. 6. As an example, the technique for encoding the letter "A" of Fig. 5a will be explained. The letter "A" is scanned along successive horizontal lines and the fill data of Fig. 5b is generated for the letter "A" along each horizontal line. It will be noted that the level "E0" demarks the highest level for recreating a color pixel from the color look-up table shown in Fig. 6, whereas level "0" represents a lack of subtitle data.

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The key data (K) determines the degree to which the fill data is mixed with background video. Regions T1 and T5 of the key data correspond to areas in the video picture that are not superimposed with the fill data; therefore, these areas are designated as level 0 as indicated by address 0 in Fig. 6. Regions T2 and T4 are mixed areas where the subtitles are gradually mixed with the background video picture so that the subtitles blend into the background video picture and do not

1 sharply contrast therewith. Any of the fill data in this area is
2 stored in addresses 1 through 6. The main portion of the letter
3 "A" is displayed within the T3 region where the background
4 information is muted. The subtitle information in region T3 is
5 stored as addresses 7 to F hexadecimal. The color look-up table
6 of Fig. 6 is arranged in varying degrees of the luminance
7... component Y. When a pixel in the region T3 is to be stored, for
8... example, and the level of the luminance component Y for that
9... particular pixel is 20 (hexadecimal), address 9 is stored for
10... that pixel. In this manner, the remaining pixels for the
11 subtitle characters are encoded for transmission.

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Encoding Apparatus

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15 The encoding apparatus of the present invention is
16... depicted in Figs. 7A, B. Audio and video information is received
17... by a microphone 53 and video camera 51, respectively and
18... forwarded to a multiplexer 58. The subtitle data are entered
19... through either a character generator 55 or a flying spot scanner
20... 56 and encoded by a subtitle encoding circuit 57. The encoded
21... subtitle information is sent to the multiplexer 58 and combined
22... with the audio/video information onto a record disc 91 or channel
23... for transmission, display, recording or the like.

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The video camera 51 generates the video signal and supplies the same to a video encoding unit 52 which converts the

1. video signal from analog to digital form. The digitized video
2. signal is then compressed for video transmission and forwarded to
3. a rate controller 52a, which controls the rate that the
4. compressed video data is transferred to the multiplexer in
5. synchronism with the rate that the subtitles are sent to the
6. multiplexer. In this manner, the compressed video data is
7. combined with the subtitle data at the correct time. Similarly,
8. audio information is obtained by the microphone 53 and encoded by
9. an audio encoding unit 54 before being sent to the multiplexer.
10. The audio encoding unit does not necessarily include a rate
11. controller because the audio data is ultimately recorded on a
12. different track or transmitted over a different channel from the
13. video data.

14. The subtitles are generated by either character
15. generator 55 or flying spot scanner 56. The character generator
16. includes a monitor and a keyboard which allows an operator to
17. manually insert subtitles into a video picture. The operator
18. edits the subtitles by typing the subtitles through the keyboard.
19. The flying spot scanner 56 is provided in the situation where
20. subtitles are already provided in an external video picture. The
21. flying spot scanner scans the video picture and determines where
22. the subtitles are positioned and extracts them from the video
23. picture. The subtitles from the flying spot scanner are pre-
24. processed by the processing circuit 63 to conform with subtitles

1. generated by the character generator and forwarded to the
2 subtitle encoding circuit.

3 The subtitle data from either the character generator
4 55 or the processing circuit 63 are then selected for
5 compression. The character generator outputs blanking data,
6 subtitle data and key data. The subtitle data and key data are
7... forwarded to a switch 61 which is switched according to a
8... predetermined timing to select either the subtitle or key data.
9... The selected data from switch 61 is filtered by a filter 72 and
10... supplied to another switch 62. Switch 62 switches between the
11 blanking data, the filtered data from the character generator and
12... the processed data from the flying spot scanner. When it is
13 determined that no subtitles are present, the blanking data is
14... chosen by the switch 62. Where subtitles are present, the switch
15 62 chooses between the character generator data or the flying
16... spot scanner data accordingly. The selected data is then
17... quantized by a quantization circuit 64, using a quantization
18 based on data fed back from a subtitle buffer verifier 68. The
19 quantized data, which may be compressed data, are supplied to a
20 switch 69 and, during normal operation, forwarded to a
21 differential pulse code modulation (DPCM) circuit 65 for pulse
22 code modulation. The modulated data is run-length encoded by a
23 run-length coding circuit 66 and variable-length encoded by a
24 variable-length encoding circuit 67 and forwarded to the subtitle

1. buffer verifier 68 for final processing before being sent to the
2. multiplexer 58.

3 The subtitle buffer verifier 68 assembles a load block
4 which includes the encoded subtitle data. The frame of the load
5 block is generated by a loading block creator 70 and is
6 referenced by the subtitle buffer verifier in assembling the data
7... into the load block. The subtitle buffer verifier references the
8... load block by causing switch 69 to switch from the output of the
9... quantization circuit 64 to the output of the loading block
10... creator 70. The loading block creator creates the load block in
11 part with reference to the color look-up table in a color look-up
12... table 71. For purposes of decoding, the color look-up table is
13 forwarded directly to the subtitle buffer verifier and
14... transferred to the multiplexer as part of the load block.

15 The subtitle buffer verifier 68 also prepares a header
16... for the subtitle data which contains information indicating
17... whether the data is to be decoded upon normal or special
18 reproduction. Specifically, the subtitle display time (displayed
19 duration) is determined from those signals at 90 kHz accuracy as
20 PTS, those signals using an upper several bits and 90 kHz or
21 those signals synchronized with the video vertical sync pulse.
22 The header also indicates the subtitle display time as determined
23 from the display start/termination time for the particular
24 subtitle. The amount of information, display position, fade in

1 information and fade out information are also stored in the
2 header for transmission with the load block. The subtitle buffer
3 verifier 68 also loads control information such as: normal/trick
4 play information; position information; subtitle encoding
5 information; time code information; and EOP information; and, an
6 upper limit value.

7... The subtitle buffer verifier 68 verifies that the
8... buffer is sufficiently filled with data without overflowing.
9... This is done by feeding back a control signal (referred to in
10... Fig. 7A as a filter signal) to the quantization circuit 64. The
11 control signal changes the quantization level of the quantization
12... circuit, thereby changing the amount of data encoded for a
13 particular subtitle. By increasing the quantization level, the
14... amount of data required for the subtitle data is reduced and the
15 bit rate of data flowing to the subtitle buffer verifier is
16... consequently reduced. When the subtitle buffer verifier
17... determines that there is an underflow of data, the control signal
18 decreases the quantization level and the amount of data output
19 from the quantization circuit increases, thereby filling the
20 subtitle buffer verifier.

21 The subtitles may also be controlled by color wiping.
22 For this purpose, a wipe lever 81 is provided for an operator who
23 operates the lever to control the color wiping of the subtitles.
24 An adapter 82 adapts the analog signals of the wipe lever to

1 R,G,B color data. The color data is forwarded to the loading
2 block creator 70 to employ the color wiping look-up table in Fig.
3 12 instead of the normal color look-up table in Fig. 6. The
4 operator is also provided with a monitor 84 which displays the
5 subtitles supplied thereto by a switcher 83 as they are color
6 wiped.

7... The subtitle buffer verifier 68 may be considered to be
8... symmetrical (meaning that the encoding and decoding circuits
9... employ the same components, but in a reverse order) with the code
10... buffer 22 (Fig. 8). That is, the subtitle buffer verifier
11... accumulates streams of subtitle data for at least one page of
12... subtitles and transfers each page to display buffer 22-2 when the
13... system clock reference (SCR) is aligned with the subtitle display
14... time stamp (PTS). In this manner, pages of subtitle data are
15... forwarded to the multiplexer 58 for multiplexing with the
16... audio/video data. The multiplexed data is then recorded on an
17... optical disc 91, or transmitted to a television receiver or
18... recorded on other suitable media.

19 The present invention, thus, provides a flexible
20 encoding/decoding method and apparatus that encodes and decodes
21 subtitles to be superimposed on video pictures in real time. The
22 subtitles are also manipulated during encoding, providing a
23 different appearance for the subtitles with different video
24 pictures. In addition, the invention may also be employed to

1. generate subtitle codes instead of actual text, allowing a
2. receiving decoder to change between different languages. It will
3. be appreciated that the present invention is applicable to other
4. applications, such as interactive video where users can be
5. singled out for special messages. It is, therefore, to be
6. understood that, within the scope of the appended claims, the
:7... invention may be practiced otherwise than as specifically
:8... described herein.

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~~WE CLAIM:~~ The claims defining the invention are as follows:

1. A subtitle data encoding apparatus for generating subtitles to be multiplexed with video pictures by a multiplexer, said apparatus comprising:

subtitle generating means for separately generating said subtitles for superimposition with a respective video picture selected from among said video pictures;

encoding means for encoding said subtitles into encoded subtitle data; and

buffer means for regulating a flow rate of said encoded subtitle data to transfer said encoded subtitle data contemporaneously with said respective video picture to the multiplexer.

2. The subtitle data encoding apparatus of claim 1, wherein the encoding means comprises:

quantization means for quantizing said subtitles to produce quantized subtitle data; and

coding means for compressing said subtitle data quantized by said quantization means.

3. The subtitle data encoding apparatus of claim 2, wherein the coding means comprises:

pulse code modulation means for performing pulse code modulation on the subtitle data quantized by the quantization means;

run-length coding means for performing run-length coding on the subtitle data modulated by the pulse code modulation means; and

variable length coding means for variable length coding said run-length coded subtitle data.

4. The subtitle data encoding apparatus of claim 1

wherein for encoding means includes a quantizer having a quantization level and the buffer means comprises subtitle buffer verifier means for controlling said flow rate of said encoded subtitle data by controlling the quantization level of said encoding means.

5. The subtitle data encoding apparatus of claim 4

further comprising loading block creator means for creating a load block referenced by said subtitle buffer verifier means, wherein said subtitle buffer verifier means assembles headers of information into said load block and transfers the same to the multiplexer for multiplexing with said data of the respective video picture.

6. The subtitle data encoding apparatus of claim 5

further comprising a color look-up table circuit for storing a color look-up table of color components, and wherein said loading block creator means references said color look-up table in creating said load block, and said subtitle buffer verifier means

stores said color look-up table in said load block for transfer to said multiplexer.

7. The subtitle data encoding apparatus of claim 1, wherein the subtitle generating means comprises a character generator including a visual display and a keyboard for keying in said subtitles.

8. The subtitle data encoding apparatus of claim 7, wherein said subtitle generating means further comprises a flying spot scanner for automatically extracting said subtitles from an external video source.

9. The subtitle data encoding apparatus of claim 6, further comprising color wiping means for performing color wiping of said subtitles.

10. The subtitle data encoding apparatus of claim 9, wherein said color wiping means performs color wiping by replacing said color look-up table with a color look-up table having a color wiping format.

11. A subtitle data decoding apparatus for decoding encoded subtitles demultiplexed from video pictures by a demultiplexer and for superimposing said subtitles on said video pictures, said apparatus comprising:

buffer means for regulating a flow rate of said encoded subtitles to read out said encoded subtitles contemporaneously



with a display of a respective video picture selected from among said video pictures;

decoding means for decoding said encoded subtitles into decoded subtitles; and

mixing means for mixing said decoded subtitles with said respective video picture such that the decoded subtitles are superimposed on a display of said respective video picture.

12. The subtitle data decoding apparatus of claim 11 further comprising detector means for detecting said encoded subtitles supplied in bit streams and selectively forwarding said bit streams to said buffer means according to a reproduction mode of said subtitle data decoding apparatus.

13. The subtitle data decoding apparatus of claim 11, further comprising scheduling means for controlling read/write access to said buffer means by setting a band width of an I/O port of said buffer means, said band width determined by dividing a rate of data demultiplexed by said demultiplexer by said flow rate of said buffer means.

14. The subtitle data decoding apparatus of claim 11, wherein said decoding means comprises:

inverse variable length coding means for decoding said encoded subtitles forwarded from said buffer means by employing inverse variable length coding; and

inverse run-length coding means for decoding said subtitles from said inverse variable length coding means by performing inverse run-length coding.

15. The subtitle data decoding apparatus of claim 14 further comprising a 3:4 filter for transforming subtitles decoded by said inverse run-length coding means into a 4:3 video picture format.

16. The subtitle data decoding apparatus of claim 11 wherein said subtitles are comprised of pixels, and further comprising color look-up table means for generating color components from a color look up table in response to said decoded subtitles, and for determining a mixing ratio for the color components of each pixel in the subtitles, wherein said mixing means mixes said color components according to said mixing ratio with said decoded subtitles.

17. A subtitle data encoding method for generating subtitles to be multiplexed with video pictures by a multiplexer, said method comprising the steps of:

generating said subtitles separately for superimposition with a respective video picture selected from among said video pictures;

encoding said subtitles into encoded subtitle data; and

regulating a flow rate of said encoded subtitle data to transfer said encoded subtitle data contemporaneously with said respective video picture to the multiplexer.

18. The subtitle data encoding method of claim 17, wherein the encoding step further comprises the steps of:

quantizing said subtitles to produce quantized subtitle data; and

compressing said quantized subtitle data.

19. The subtitle data encoding method of claim 18, wherein said compressing comprises:

pulse code modulating the quantized subtitle data;

run-length coding the pulse code modulated subtitle data; and

variable length coding said run-length coded subtitle data.

20. The subtitle data encoding method of claim 18 wherein said encoding step comprises controlling said flow rate of said encoded subtitle data by controlling a quantization level at which said subtitle data is quantized.

21. The subtitle data encoding method of claim 20 further comprising:

creating a load block referenced when said flow rate is controlled; and



assembling headers of information into said load block and transferring the same to the multiplexer for multiplexing with said respective video picture.

22. The subtitle data encoding method of claim 21 further comprising:

storing a color look-up table of color components, referencing said color look-up table when creating said load block; and

storing said color look-up table in said load block for transfer to said multiplexer.

23. The subtitle data encoding method of claim 22, further comprising color wiping said subtitles.

24. The subtitle data encoding method of claim 23, wherein said color wiping comprises replacing said color look-up table with a color look-up table having a color wiping format.

25. The subtitle data encoding method of claim 17, wherein said subtitles are generated by keying in said subtitles from a keyboard and visually displaying said keyed-in subtitles.

26. The subtitle data encoding method of claim 17, wherein said subtitles are generated by automatically extracting said subtitles from an external video source using a flying spot scanner.

27. A subtitle data decoding method for decoding encoded subtitles demultiplexed from video pictures by a

demultiplexer and for superimposing said subtitles on said video pictures, said method comprising the steps of:

regulating a flow rate of said encoded subtitles to read out said encoded subtitles from a buffer contemporaneously with a display of a respective video picture selected from among said video pictures;

decoding said encoded subtitles into decoded subtitles;

and

mixing said decoded subtitles with said respective video picture such that the decoded subtitles are superimposed on a display of said respective video picture.

28. The subtitle data decoding method of claim 27 further comprising selectively buffering bit streams supplied to said buffer which correspond to a designated reproduction mode.

29. The subtitle data decoding method of claim 28, further comprising scheduling read/write access to said buffer by setting a band width of an I/O port of said buffer means, said band width being determined by dividing a rate of data demultiplexed by said demultiplexer by said flow rate of said bit streams.

30. The subtitle data decoding method of claim 27, wherein said decoding comprises:

inverse variable length coding said subtitles read out from said buffer; and

inverse run-length coding said inverse variable length coded subtitles.

31. The subtitle data decoding method of claim 30 further comprising 3:4 filtering said inverse run-length coded subtitles into a 4:3 video picture format.

32. The subtitle data decoding method of claim 27 wherein said subtitles are comprised of pixels, and further comprising:

generating color components from a color look up table in response to said decoded subtitles;

determining a mixing ratio for the color components of each pixel in the subtitles; and

mixing said color components according to said mixing ratio with said decoded subtitles.

33. A subtitle processor for processing subtitle data comprising:

bit stream select means for selecting a respective bit stream of subtitle data from among a plurality of supplied subtitle data bit streams;

time display stamp means for indicating a time when said selected bit stream is to be decoded;

decode start means for initiating decoding of said selected bit stream at said time indicated by said time display stamp means; and

mixing means for mixing said selected bit stream
decoded by said decode start means with video picture data.

34. The subtitle processor for processing subtitle data according to claim 33 further comprising system reset means for resetting said subtitle processor.

35. The subtitle processor for processing subtitle data according to claim 33 further comprising channel select means for selecting a channel carrying different sets of said bit streams, each said set representing a different video broadcast.

36. The subtitle processor for processing subtitle data according to claim 33 further comprising buffer clear means for dumping said respective bit stream upon detection of corrupt data.

37. The subtitle processor for processing subtitle data according to claim 33 further comprising special reproduction means for setting the subtitle processor in a special reproduction mode by causing said bit stream select means to select special reproduction bit streams from among said bit streams.

38. The subtitle processor for processing subtitle data according to claim 33 further comprising squeeze means for initiating a 4:3 conversion of a subtitle picture composed of said bit streams selected by said selected bit stream.

39. The subtitle processor for processing subtitle data according to claim 33 further comprising vertical position means for designating a vertical display position of a subtitle composed of said selected bit stream to said mixing means.

40. The subtitle processor for processing subtitle data according to claim 33 further comprising on/off means for causing said mixing means to selectively display said bit streams as a subtitle picture.

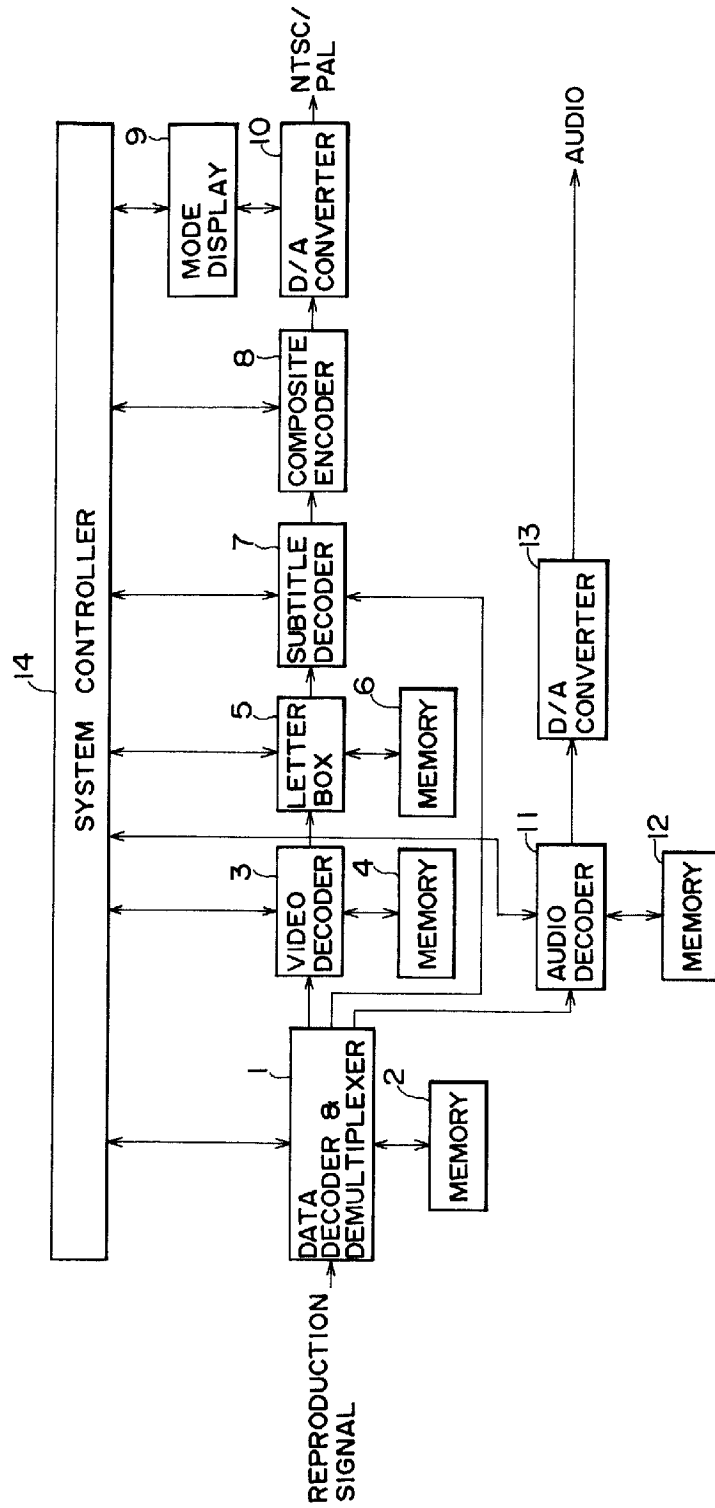
41. The subtitle processor for processing subtitle data according to claim 33 further comprising color look up table means for providing a color look up table, wherein said mixing means generates color components from said subtitle data making up a subtitle picture by referencing said color look up table.

DATED this FIFTEENTH day of MARCH 1996
Sony Corporation

Patent Attorneys for the Applicant
SPRUSON & FERGUSON

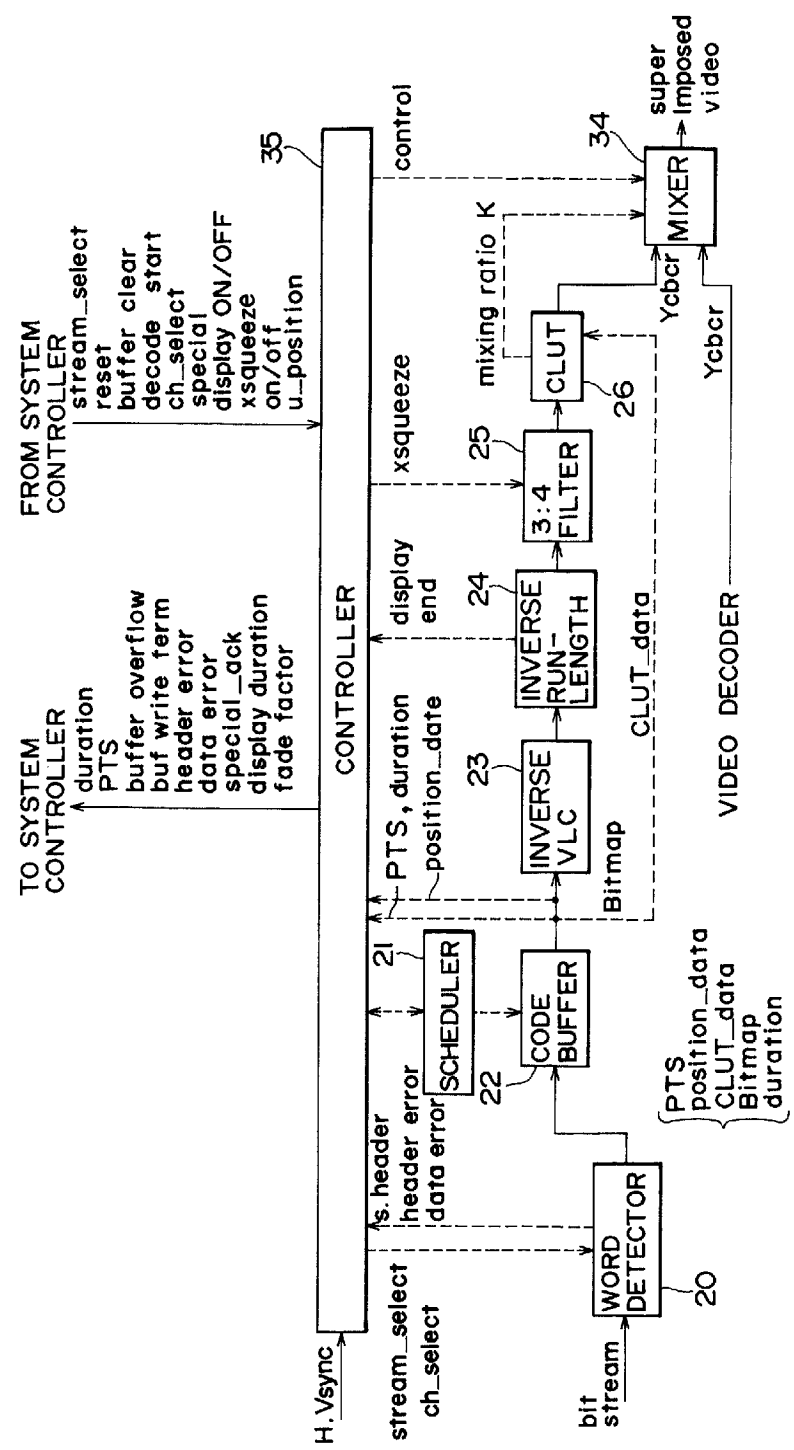
19 00 36 40157

FIG. 1



19 03 96

FIG. 2



SUBTITLE DECODER 7

48167/96

FIG. 4

 (1) (2) : 8bit bus+4bit select+1bit I/O
 others: real signal bits

(3) from generator bits

H sync	1
V sync	1
13.5Mhz clock	1

(4) from demux

data stream	8
strobe	1
error	1

(5) to code buffer

address	15
data	8
xce	1
xwe	1
xoe	1

(6) from video decoder

video data (4:2:2)	16
--------------------	----

(7) to DAC

video data (4:2:2)	16
--------------------	----

19 03 95 4:08:07

FIG. 5a

HORIZONTAL LINE

A

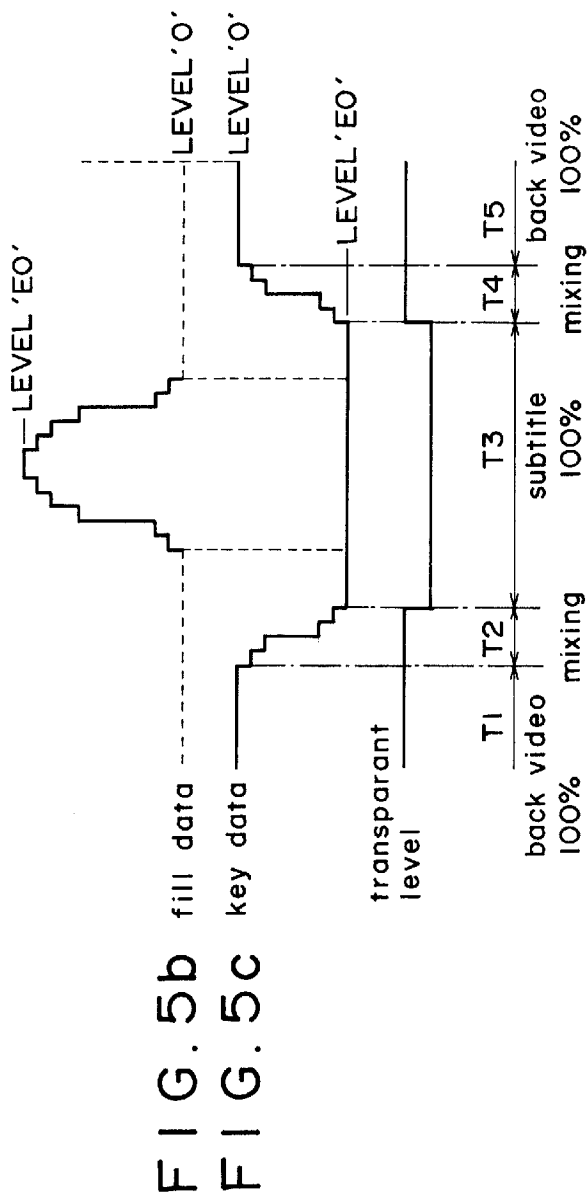


FIG. 6

Addr	Y	Cr	Cb	K
0	00	7F	7F	00
1	00	7F	7F	20
2	00	7F	7F	40
:				
6	00	7F	7F	C0
7	00	7F	7F	E0*
8	00	7F	7F	E0
9	20	7F	7F	E0
:				
E	C0	7F	7F	E0
F	E0	7F	7F	E0

* E0 : SUBTITLE DATA 100 %
: VIDEO DATA 0 %

FIG. 7A

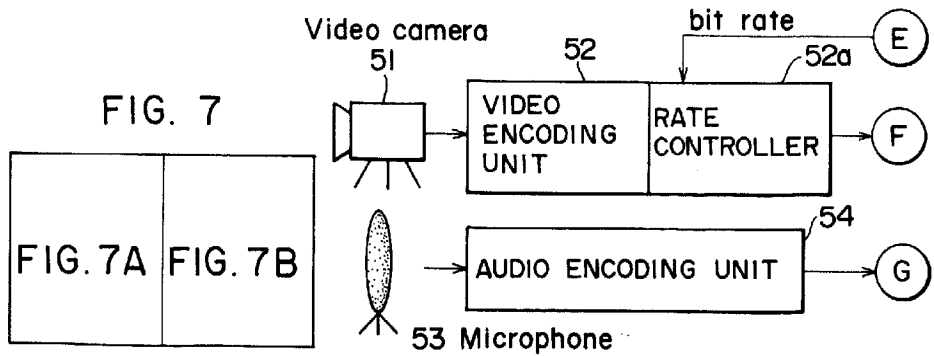
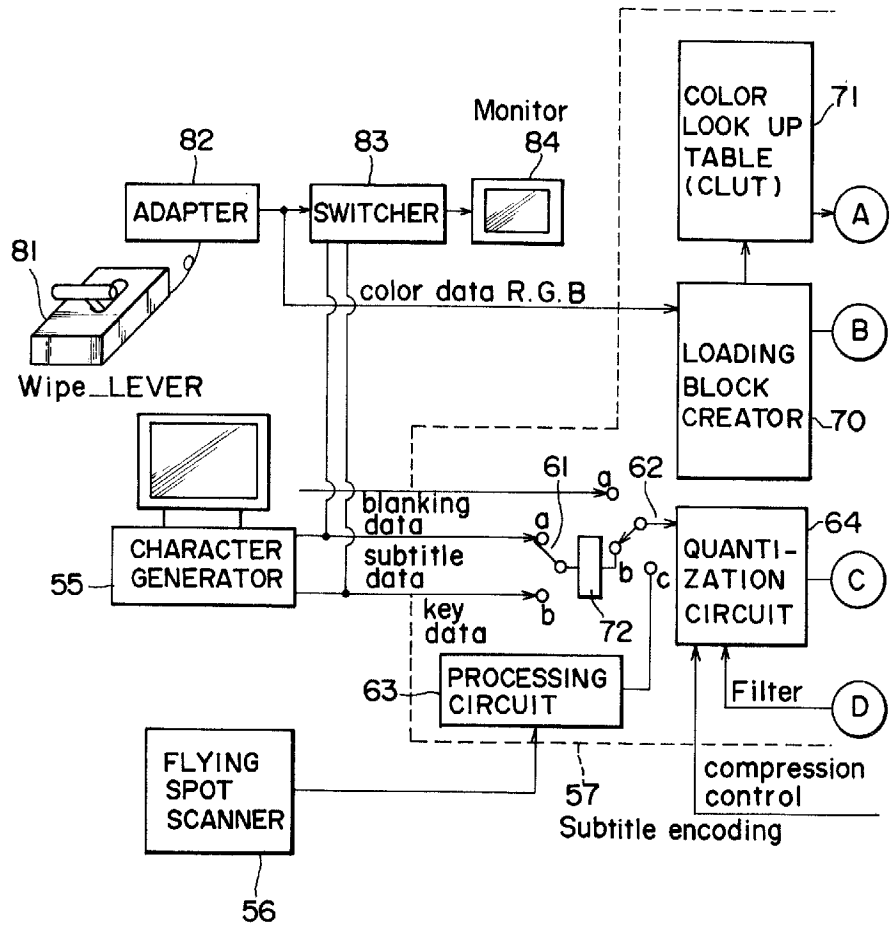
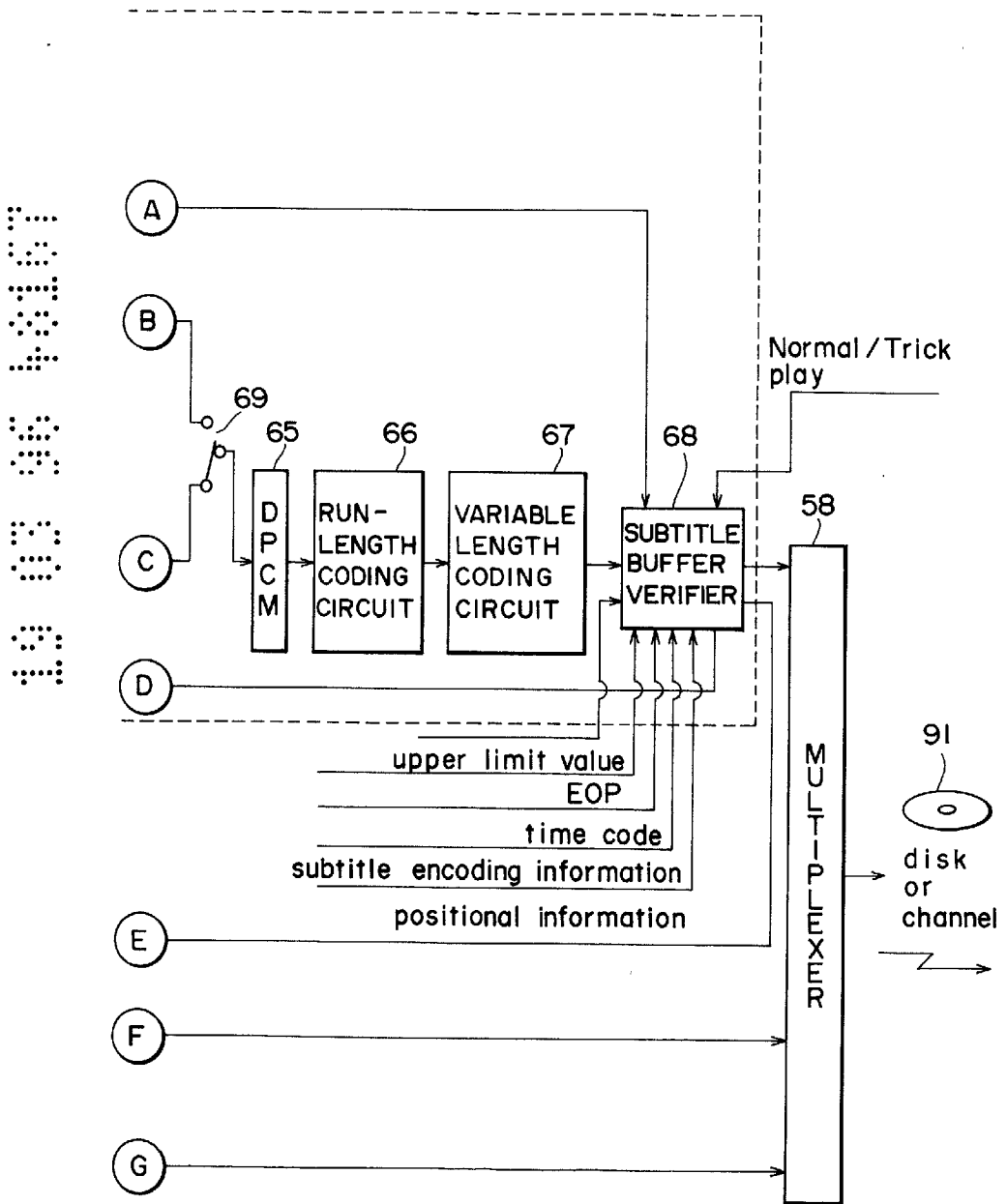
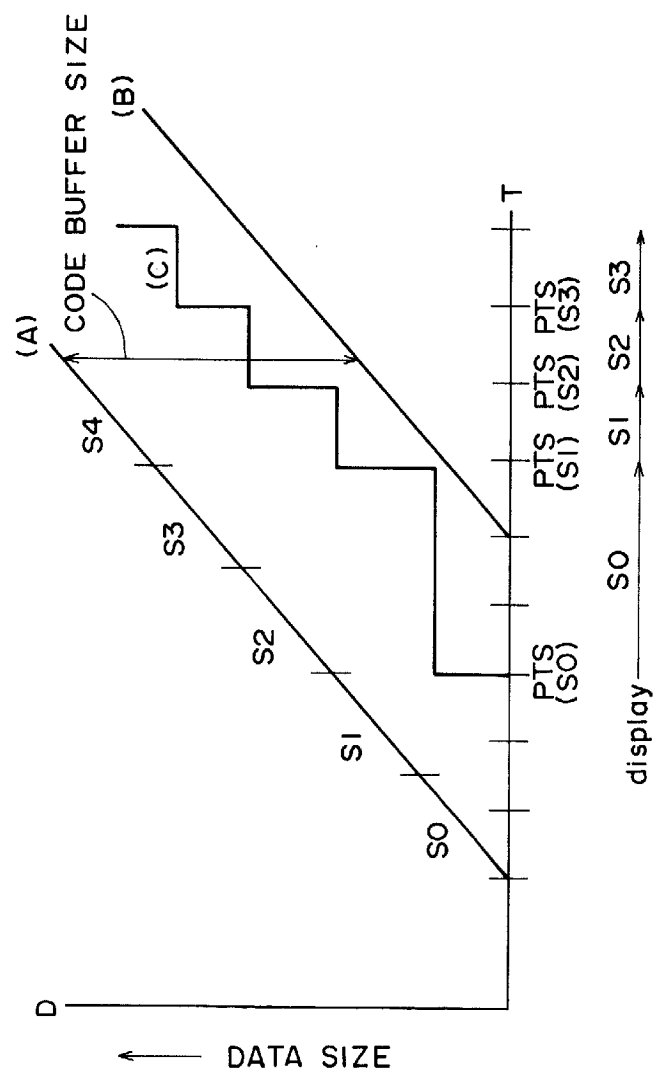


FIG. 7B



10 03 98 4:10:07

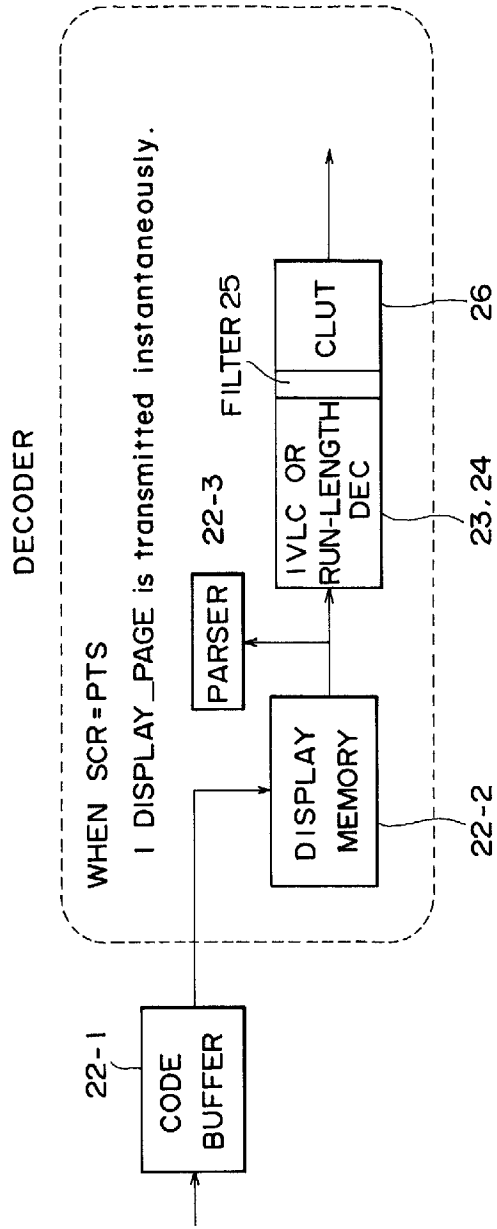
FIG. 8



19 03 85 40107

FIG. 9

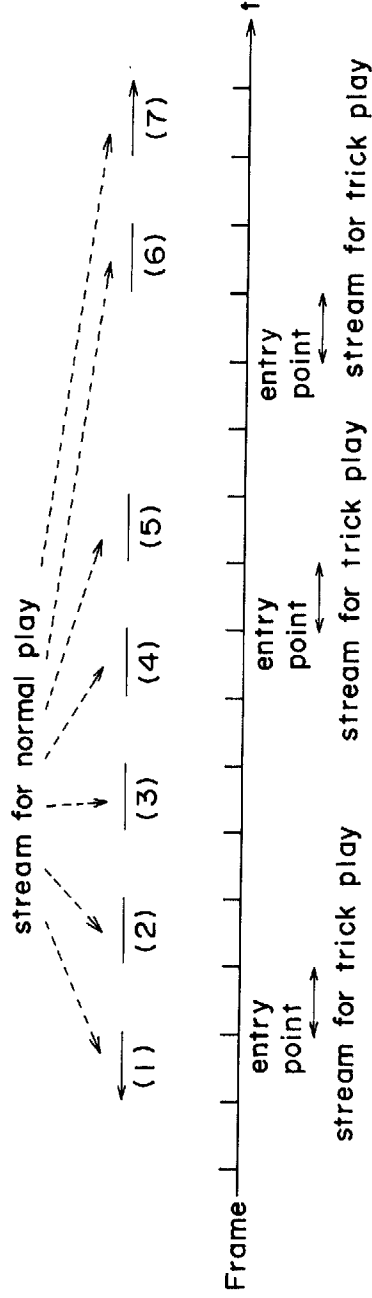
Subtitle decoder buffer model



19 03 85 40167

FIG. 10

Subtitle streams



→ (1), (2), (3), (4), (5), (6) and (7) form a page.

→ One page.

19 03 86 10:57

FIG. 11

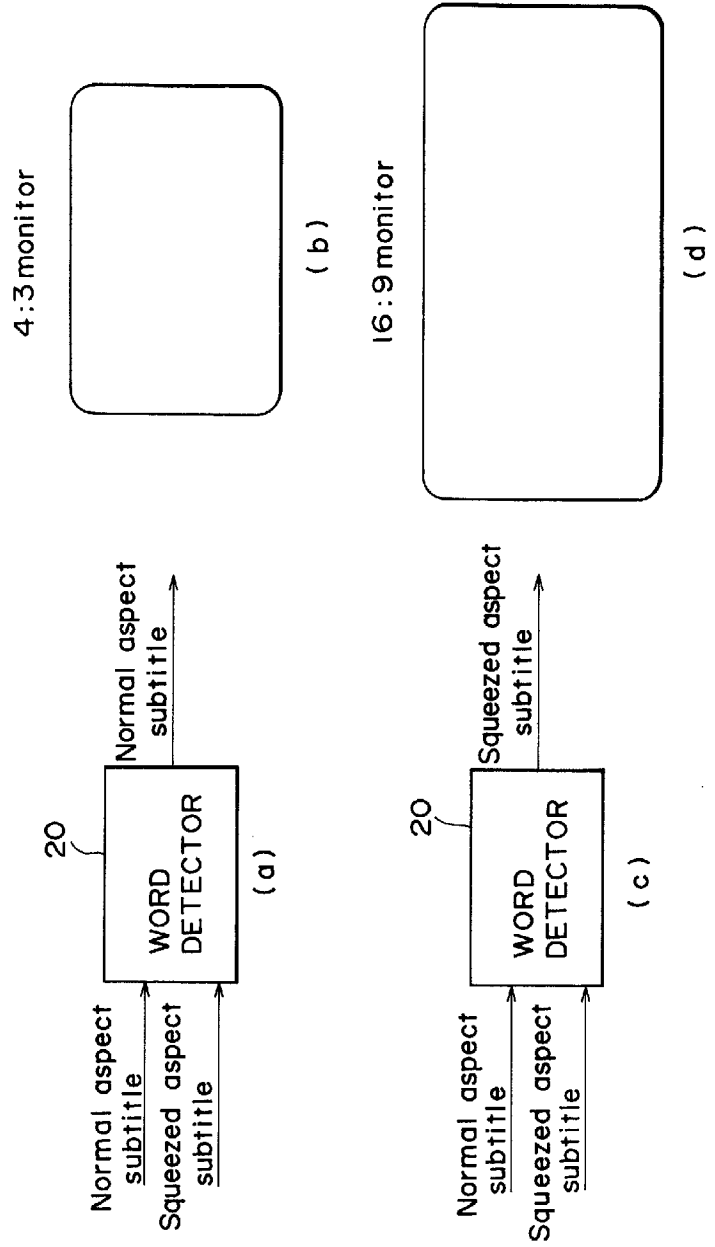


FIG. 12

Color Lookup table

Addr	Y	Cr	Cb	K
0	00	7F	7F	00
1	20	7F	7F	40
2	40	7F	7F	80
3	60	7F	7F	C0
4	80	7F	7F	F0
5	A0	7F	7F	F0
6	C0	7F	7F	F0
7	E0	7F	7F	F0
8	00	FF	FF	00
9	20	FF	FF	40
A	40	FF	FF	80
B	60	FF	FF	C0
C	80	FF	FF	F0
D	A0	FF	FF	F0
E	C0	FF	FF	F0
F	E0	FF	FF	F0



FIG.13a

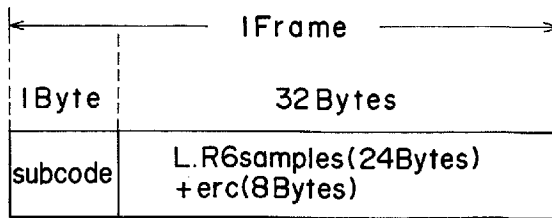


FIG.13b

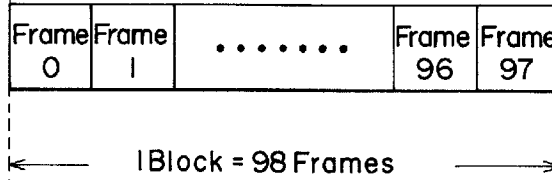
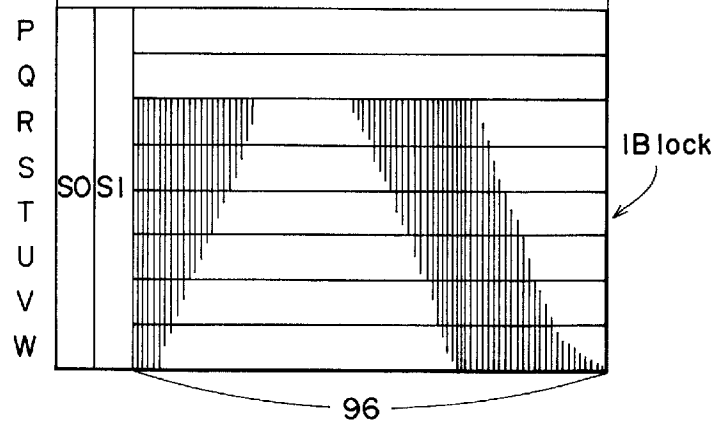


FIG.13c

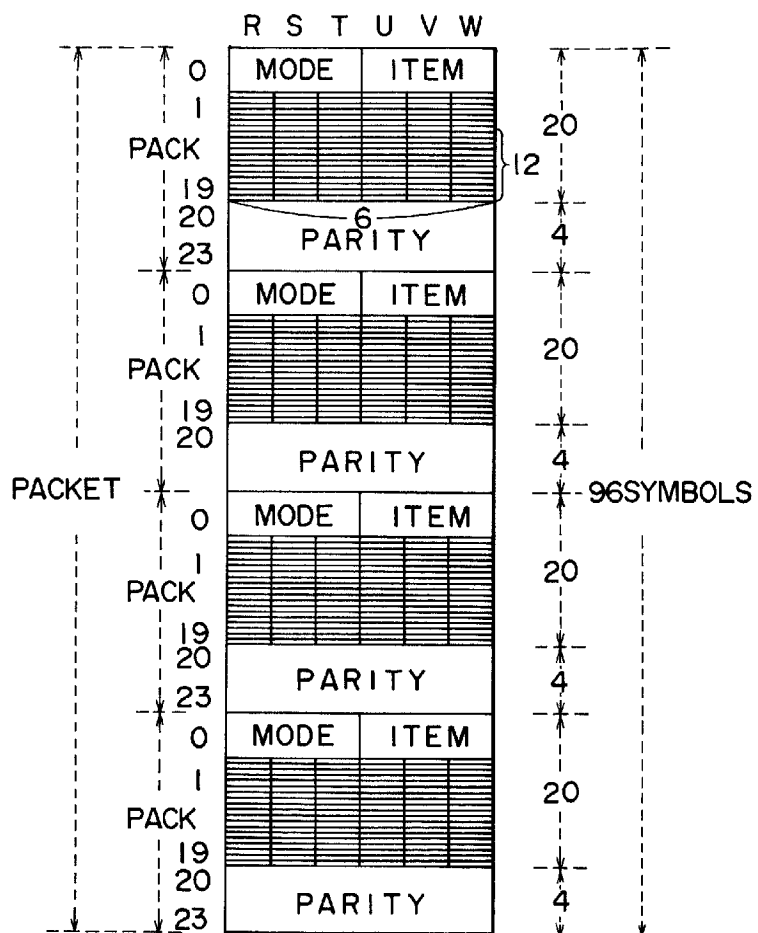


IBlock → 75Hz

IFrame → 75 x 98Hz

subcode bit rate = 7.35kBytes/s

FIG. 14



TRANSMISSION FORMAT