

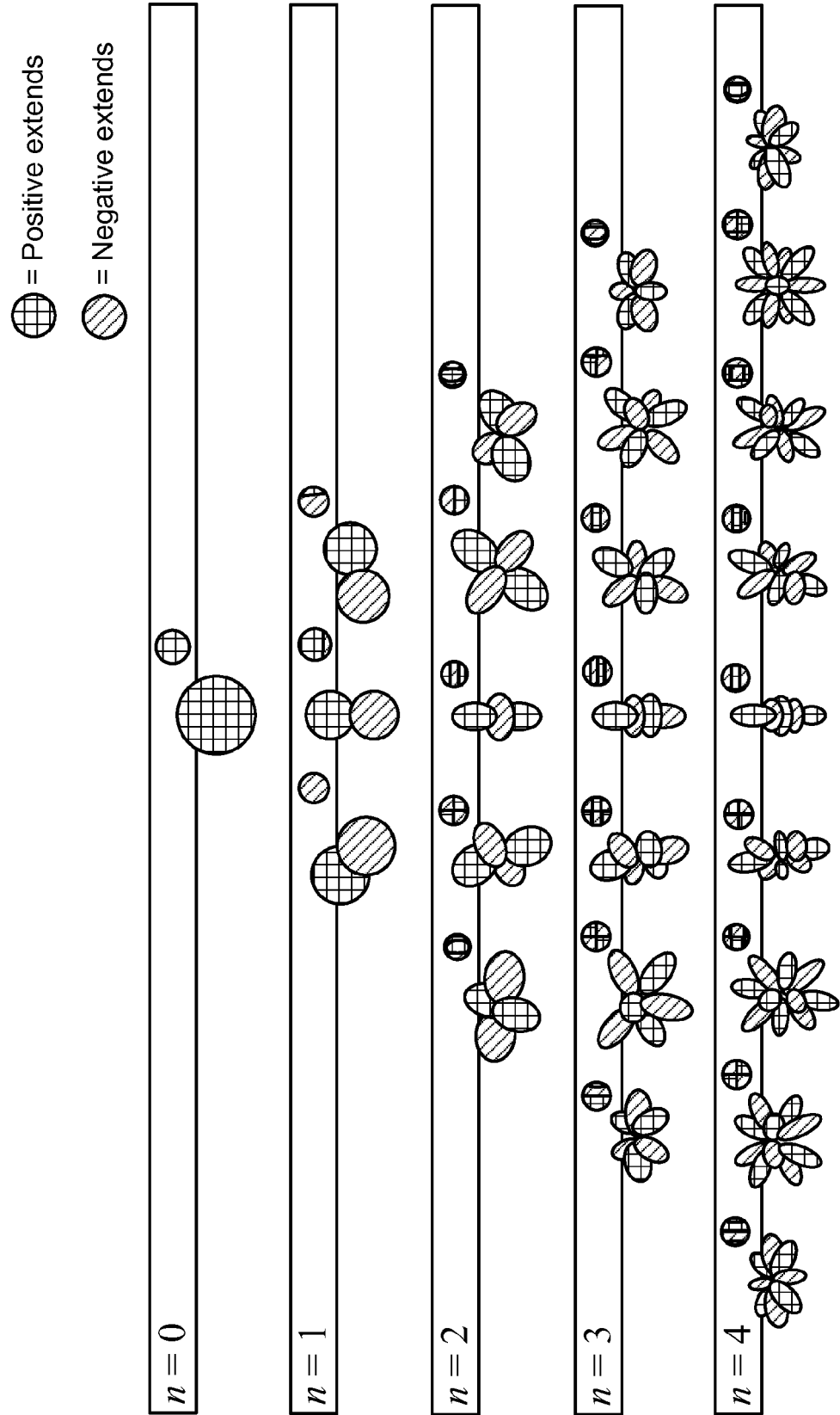


FIG. 1

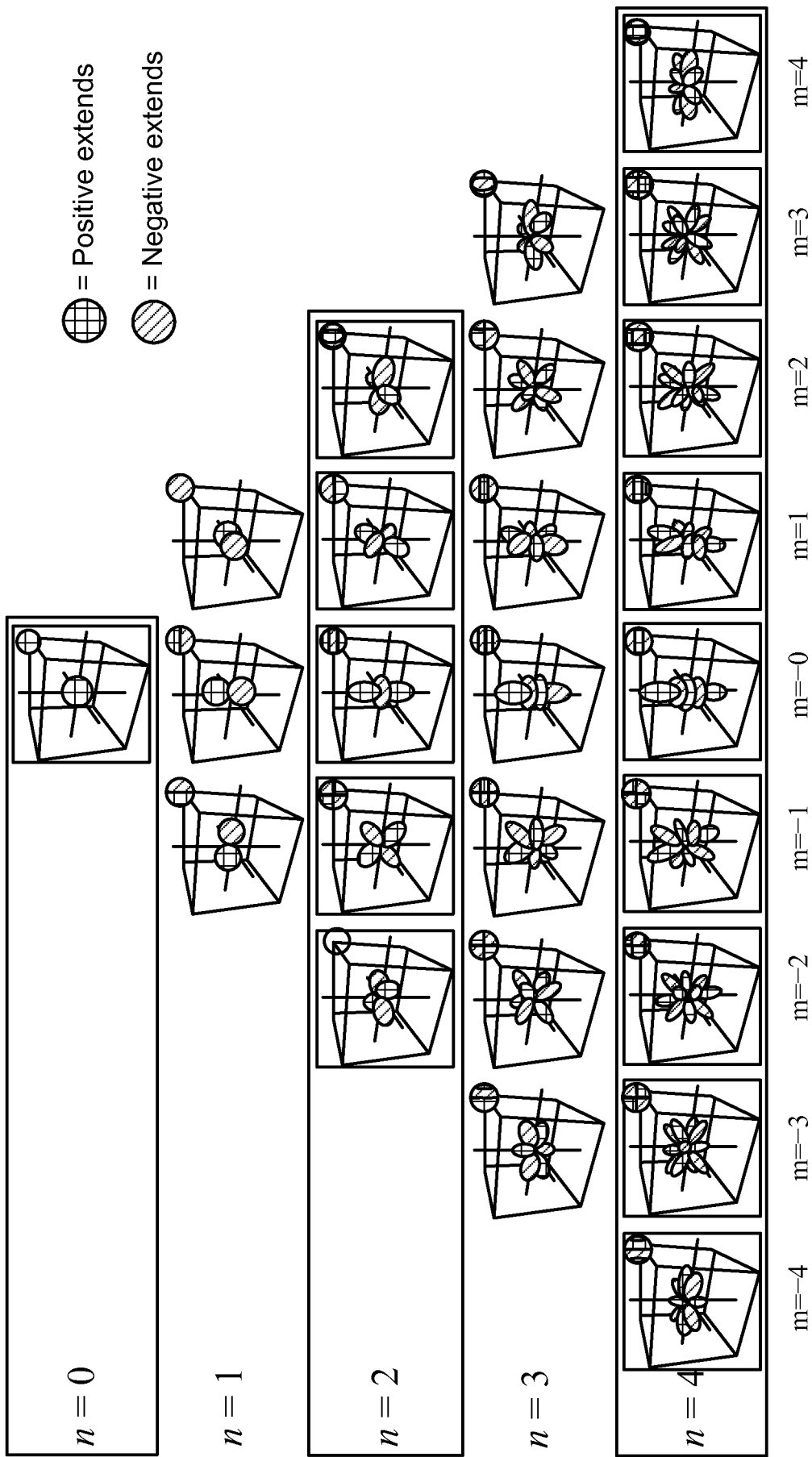


FIG. 2

10

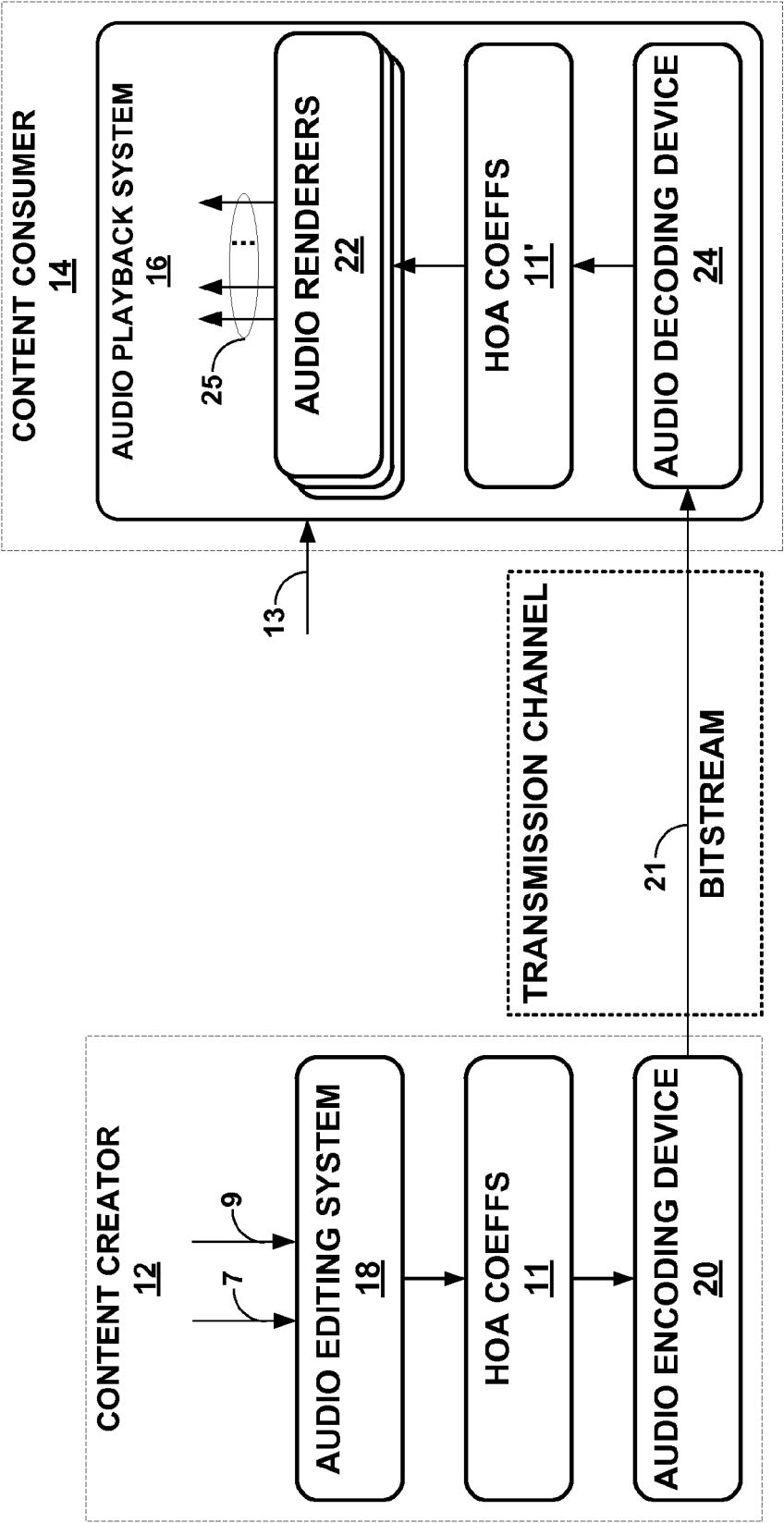
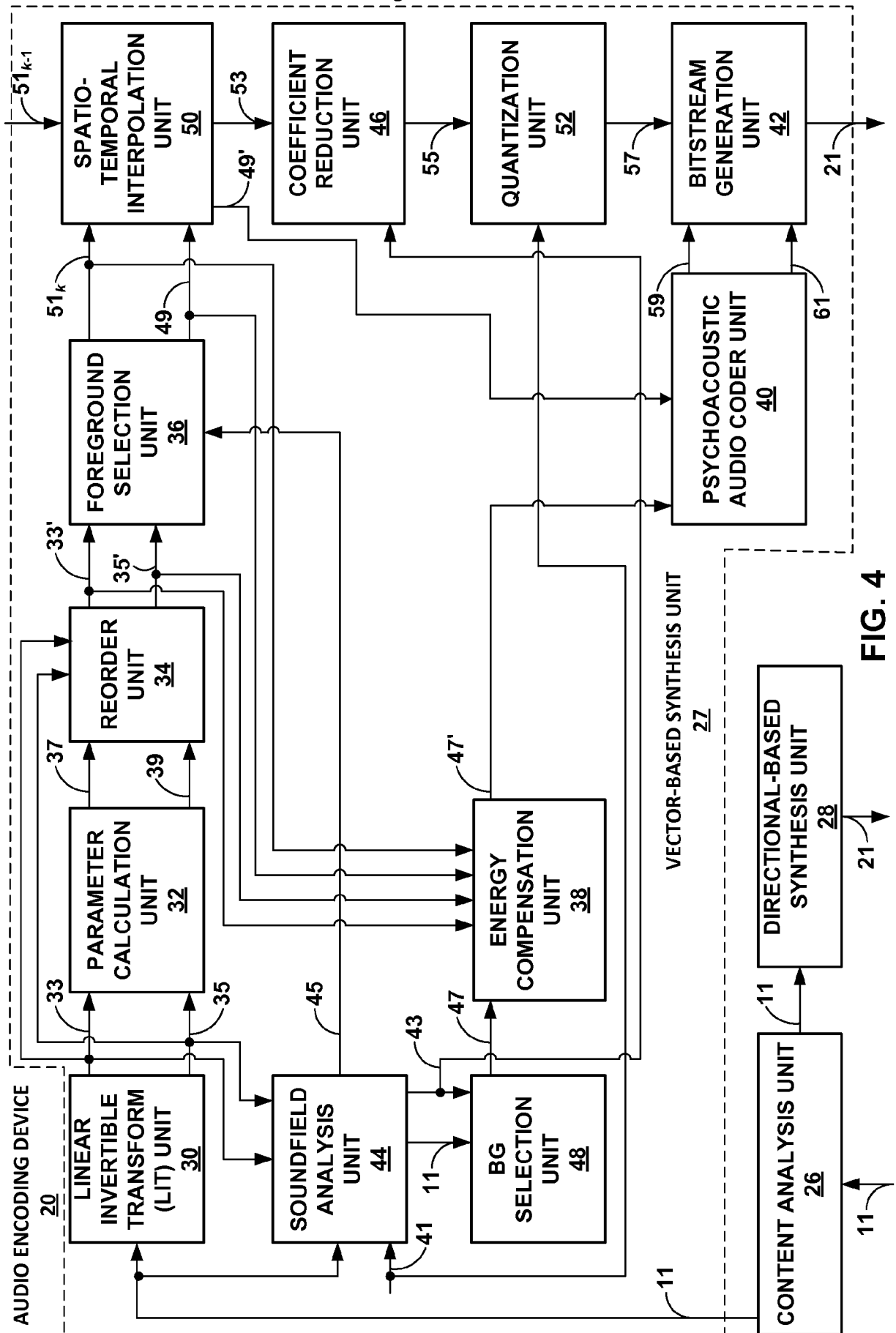


FIG. 3



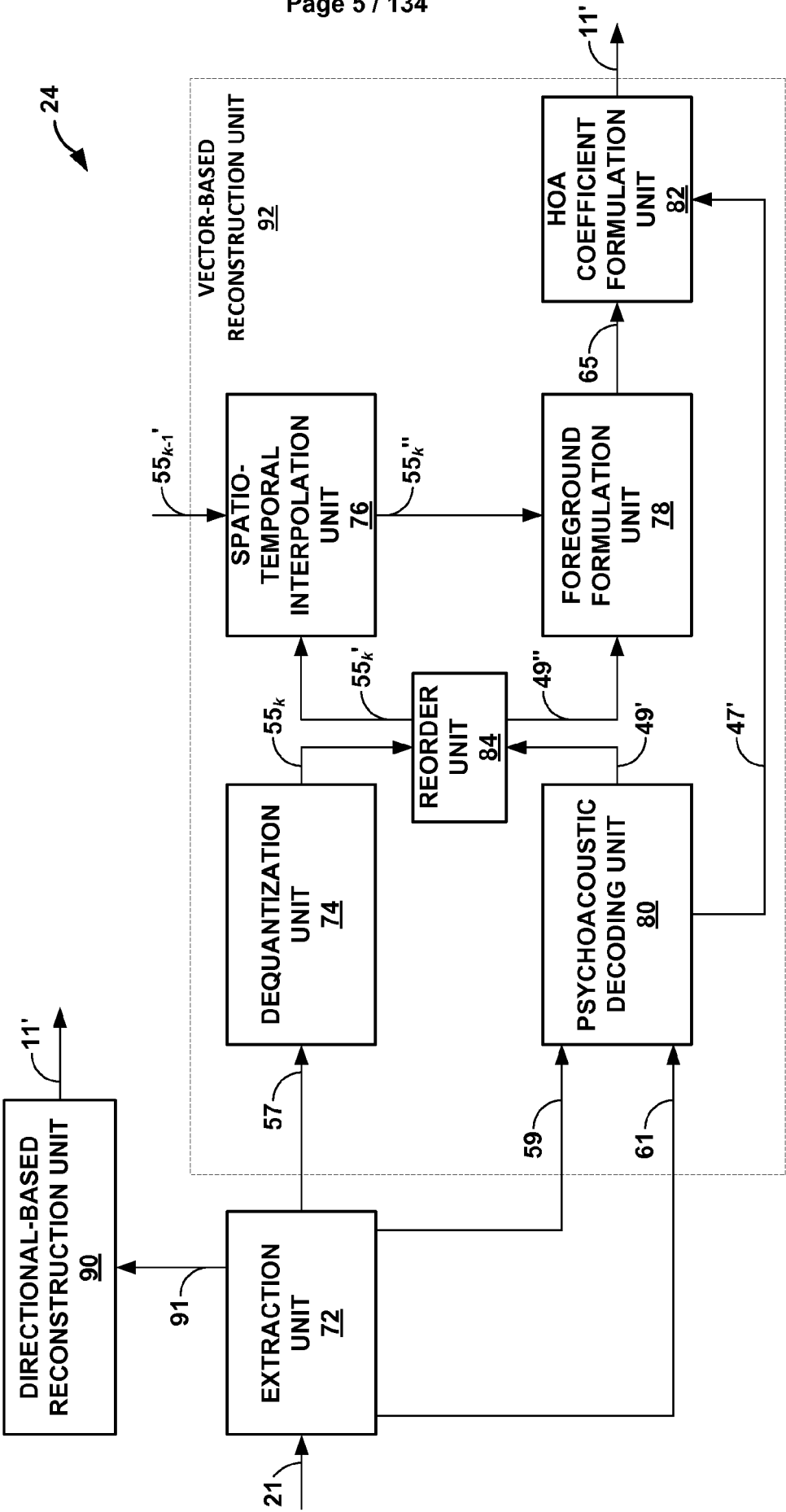


FIG. 5

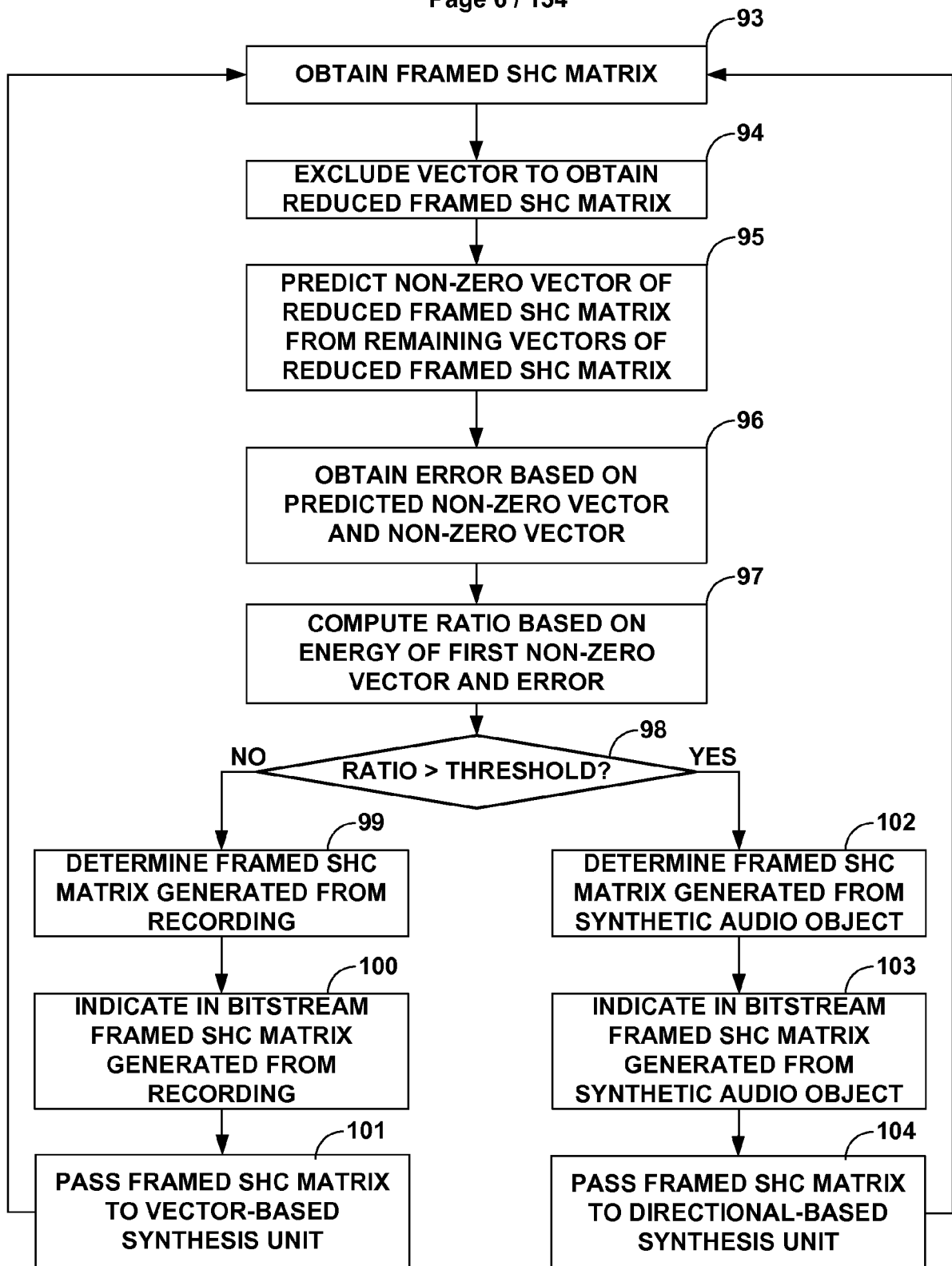


FIG. 6

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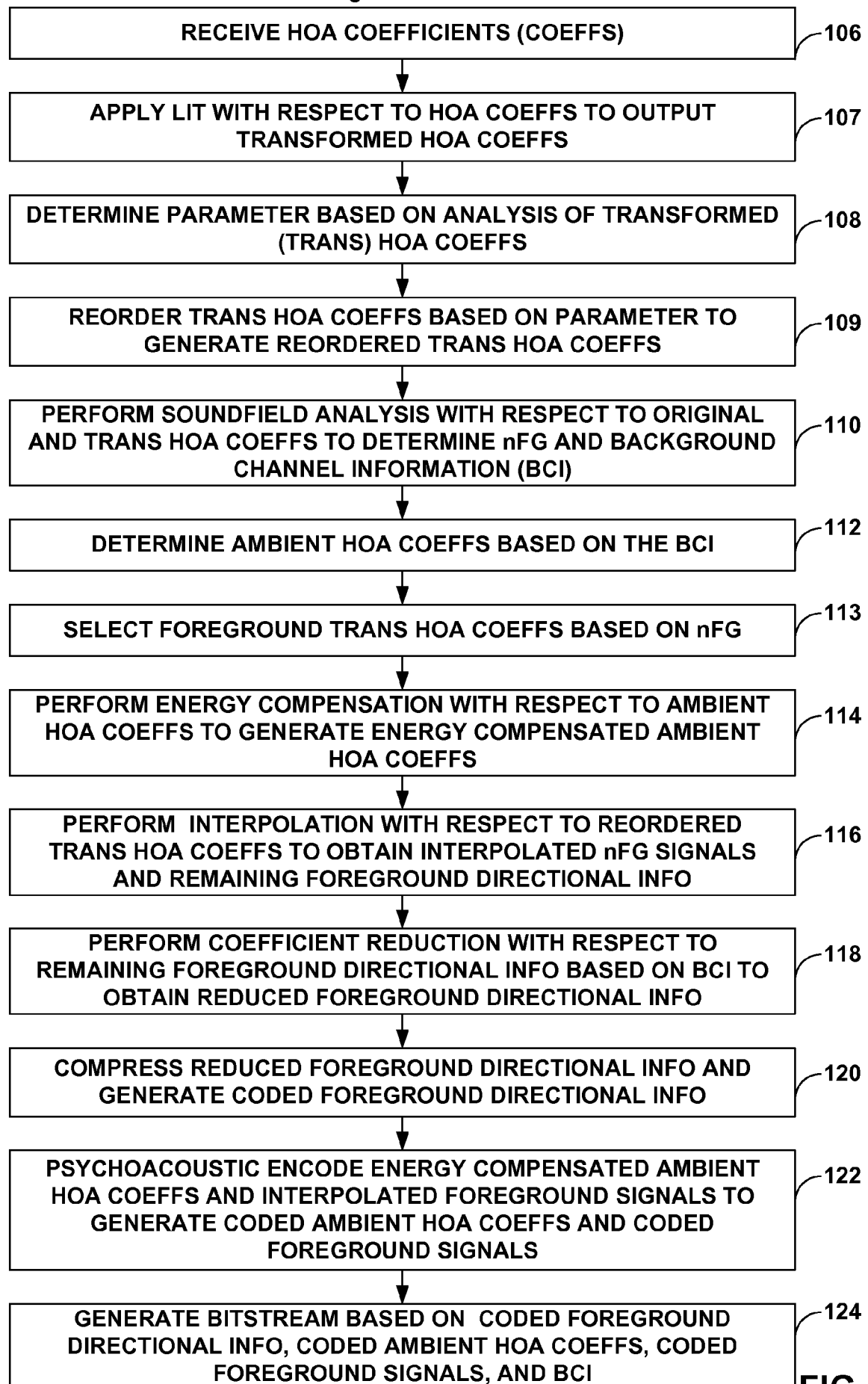


FIG. 7

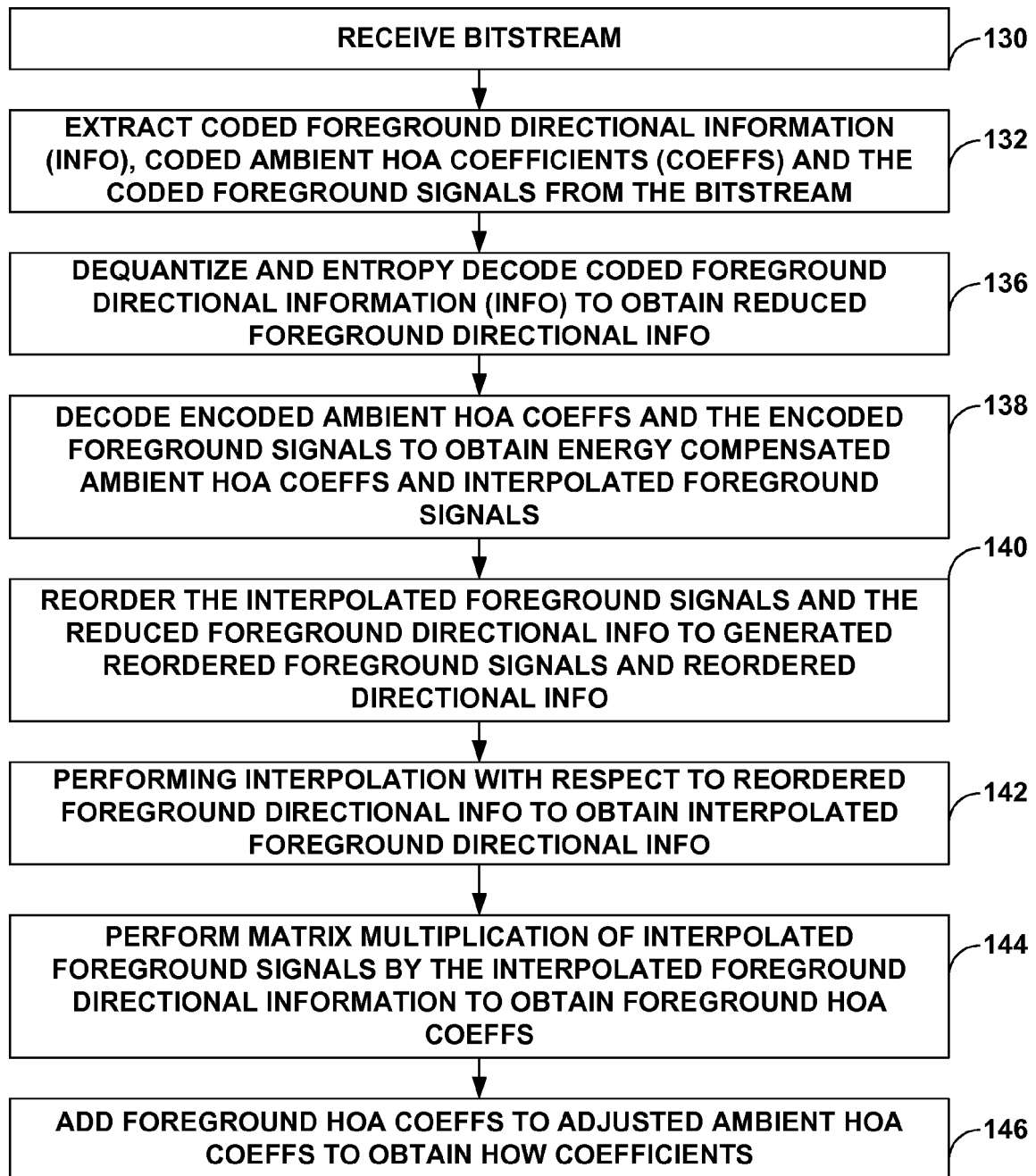


FIG. 8

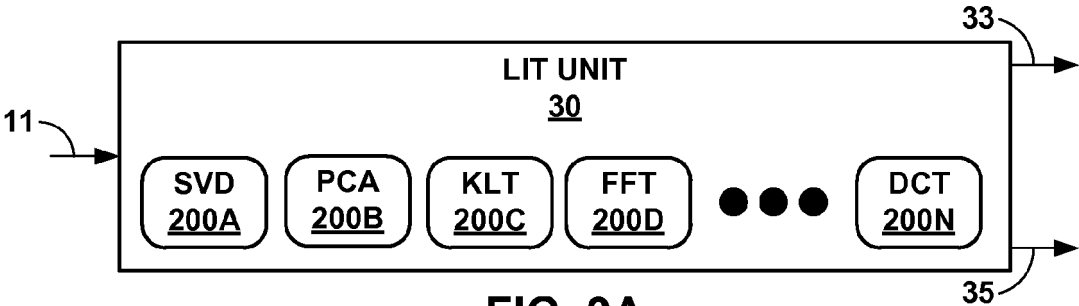


FIG. 9A

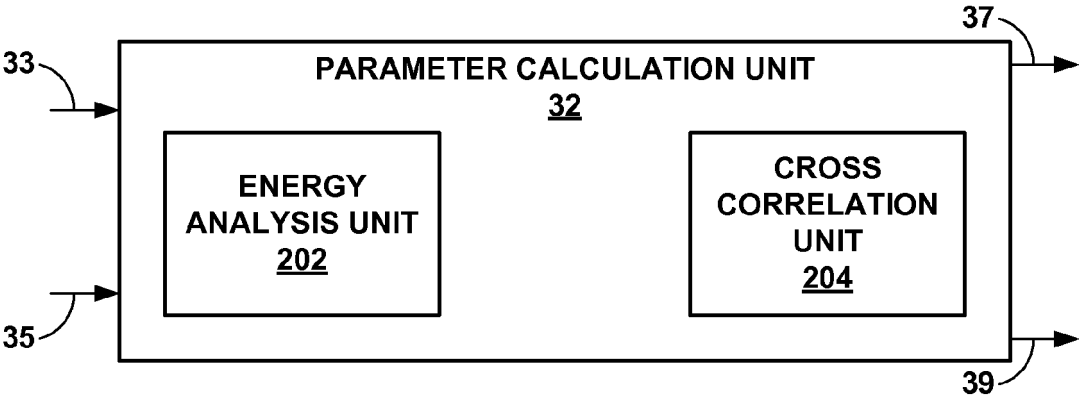


FIG. 9B

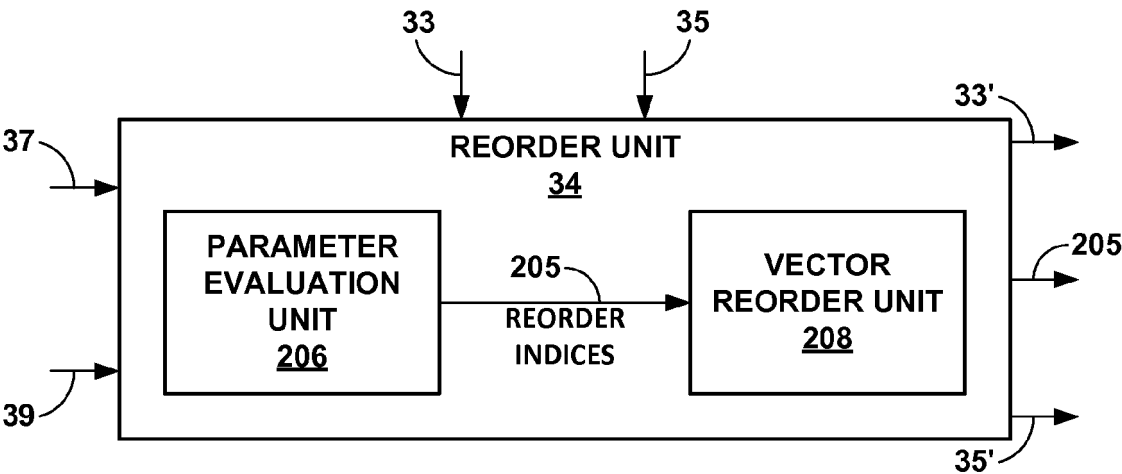


FIG. 9C

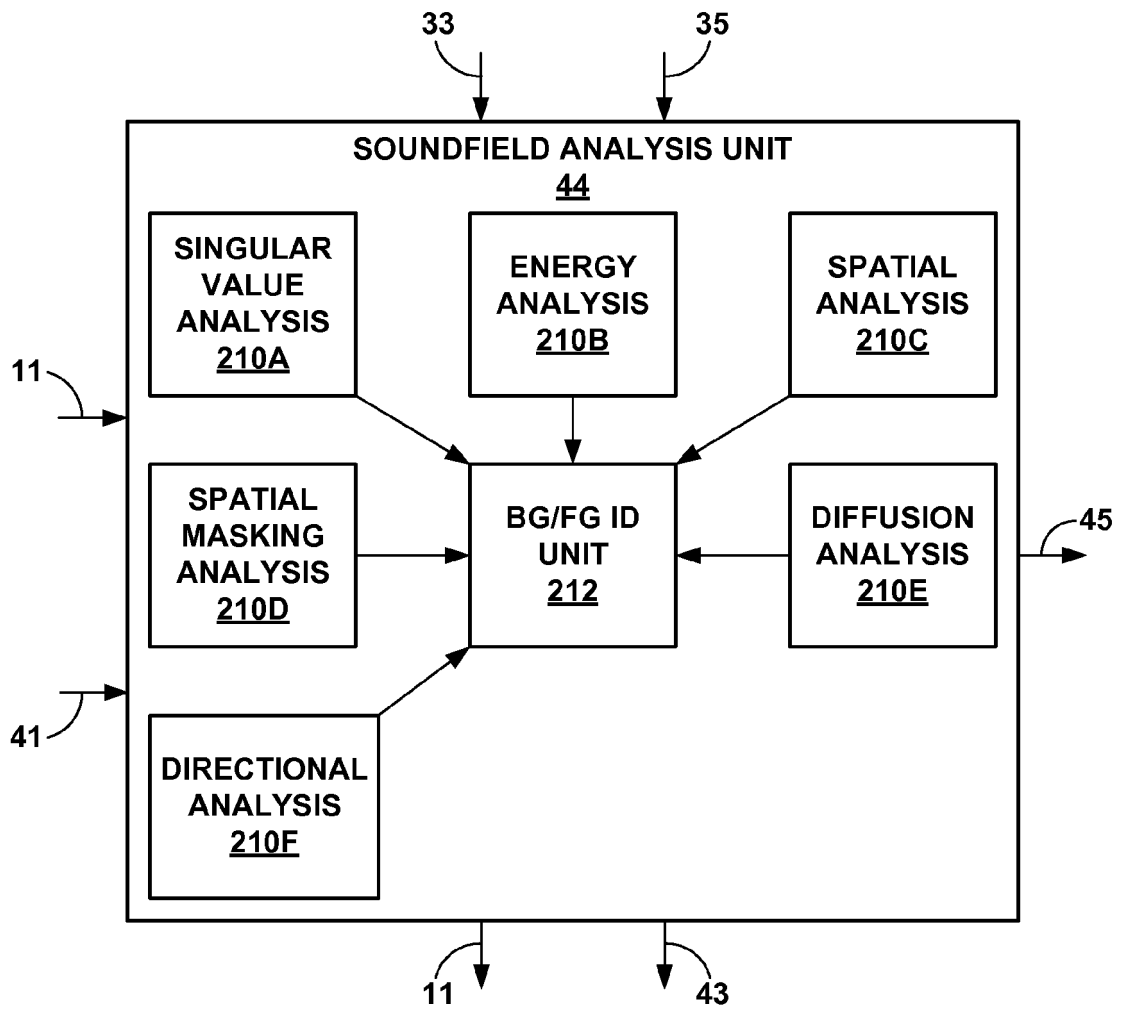


FIG. 9D

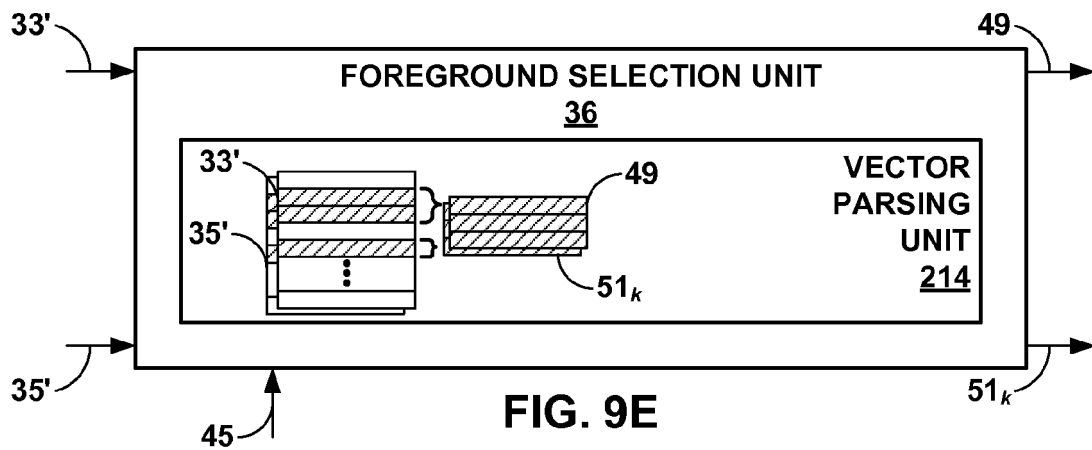


FIG. 9E

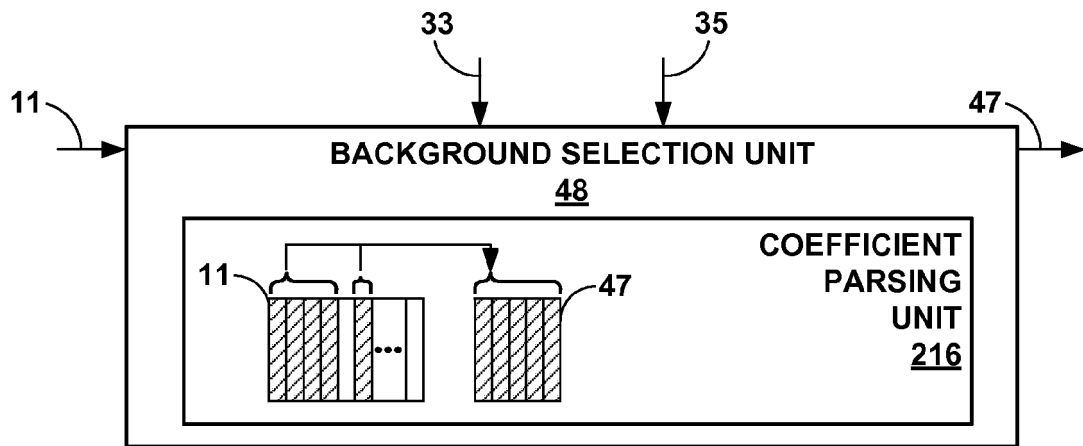


FIG. 9F

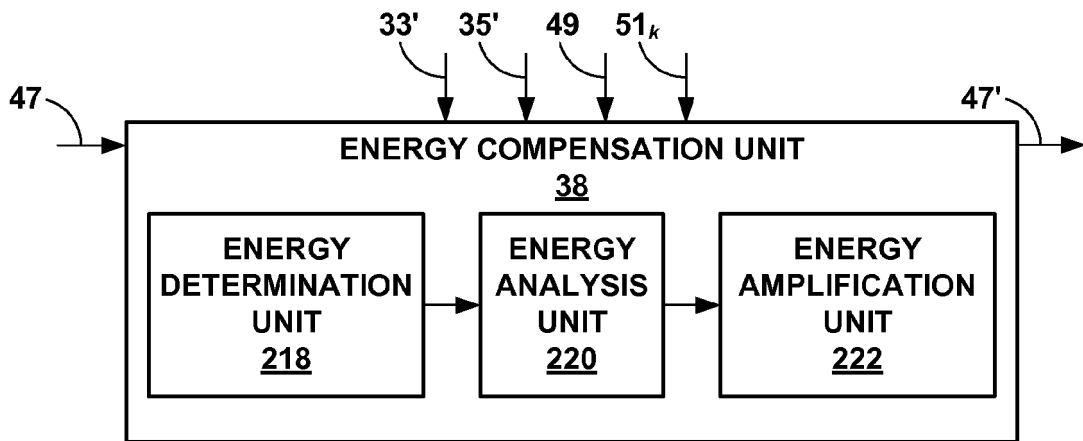


FIG. 9G

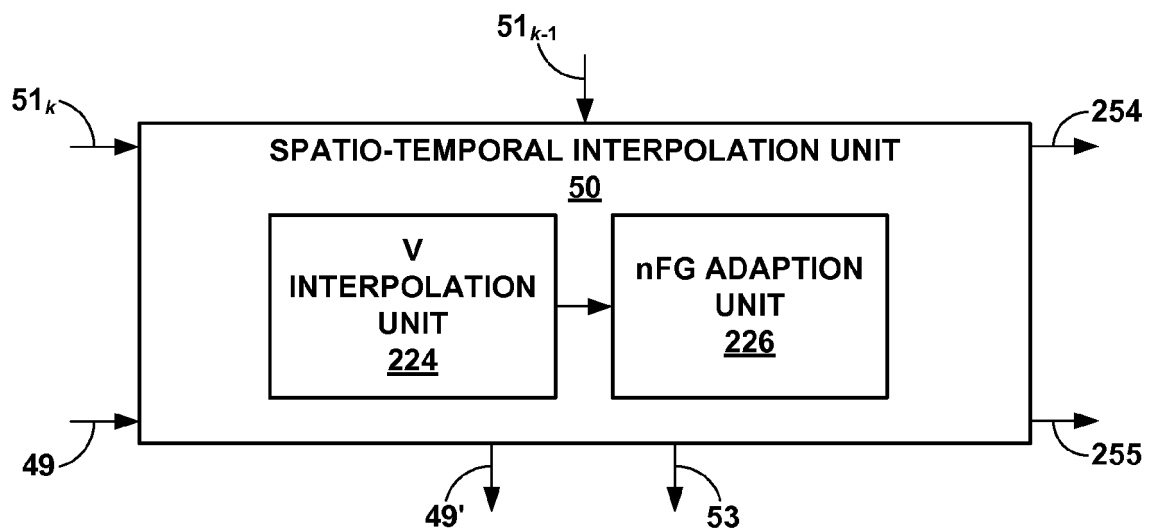


FIG. 9H

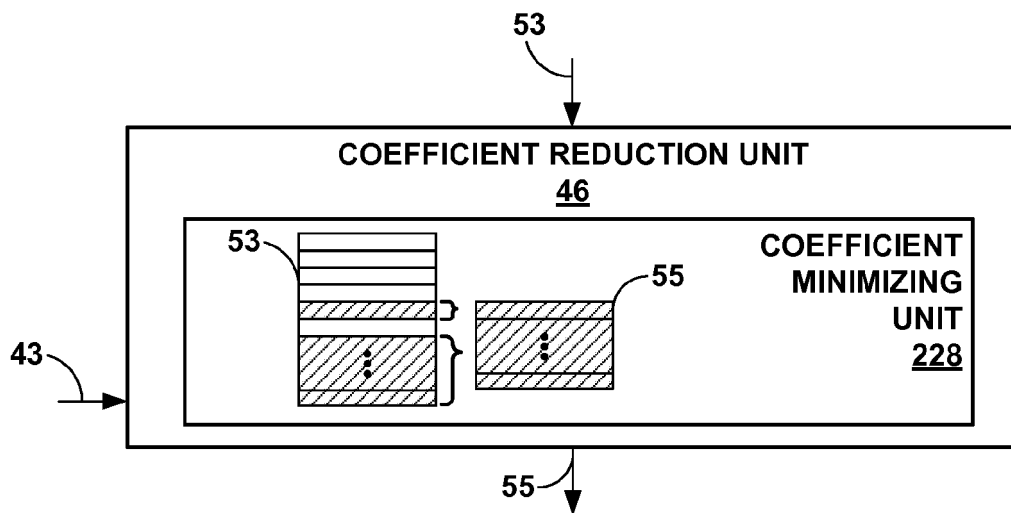


FIG. 9I

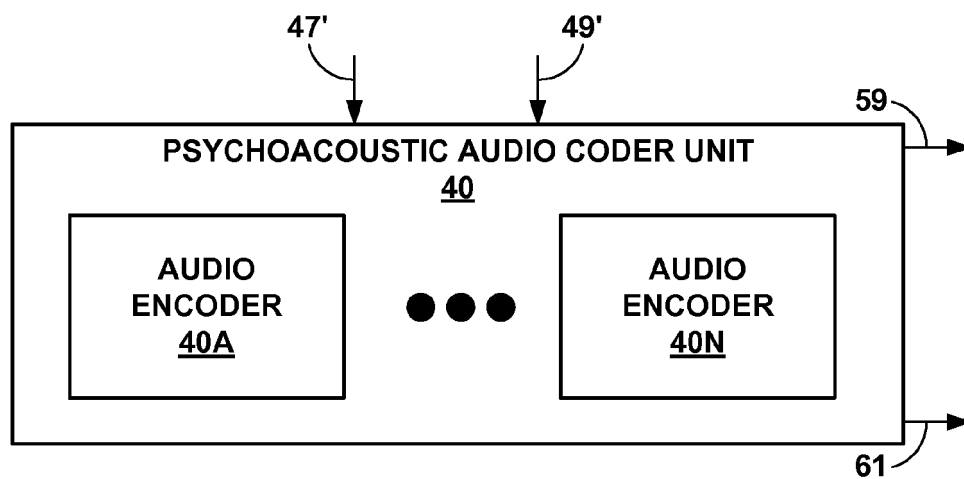


FIG. 9J

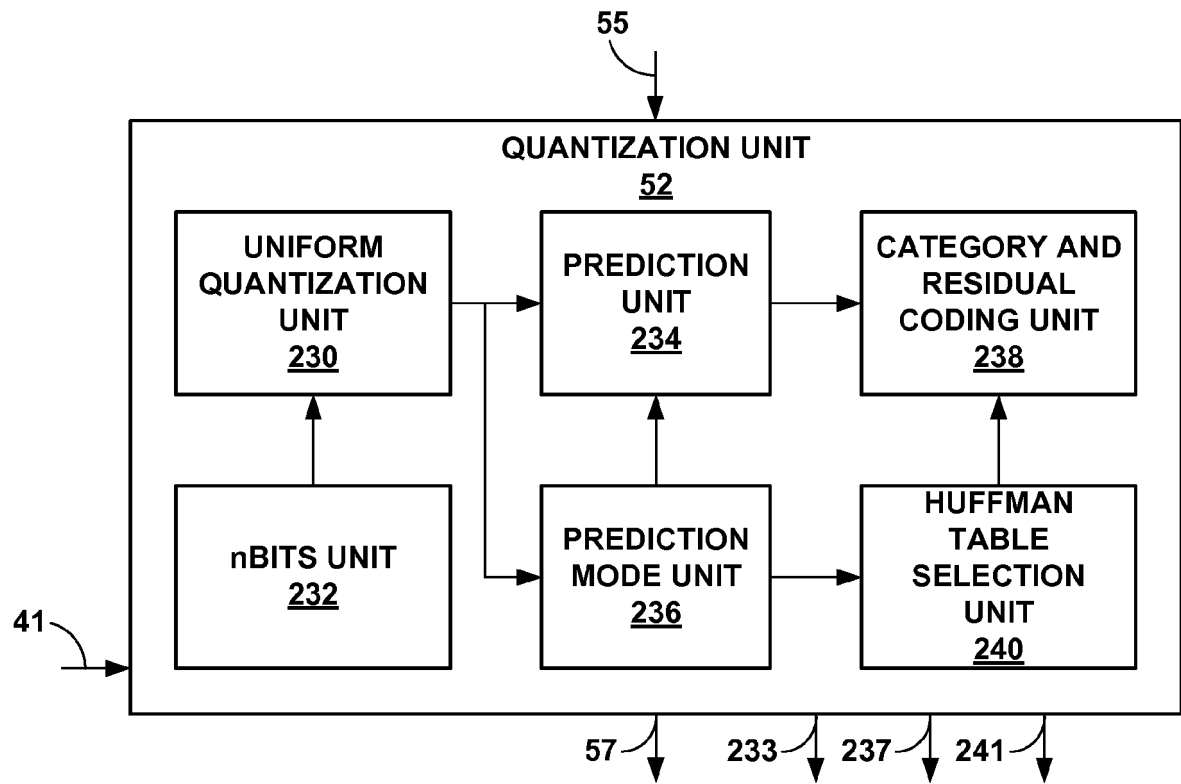


FIG. 9K

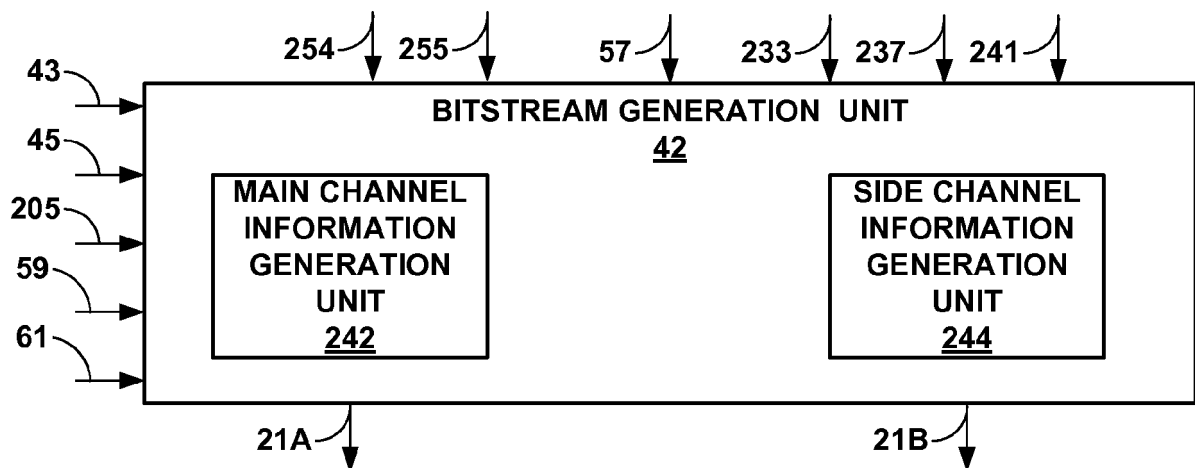


FIG. 9L

250

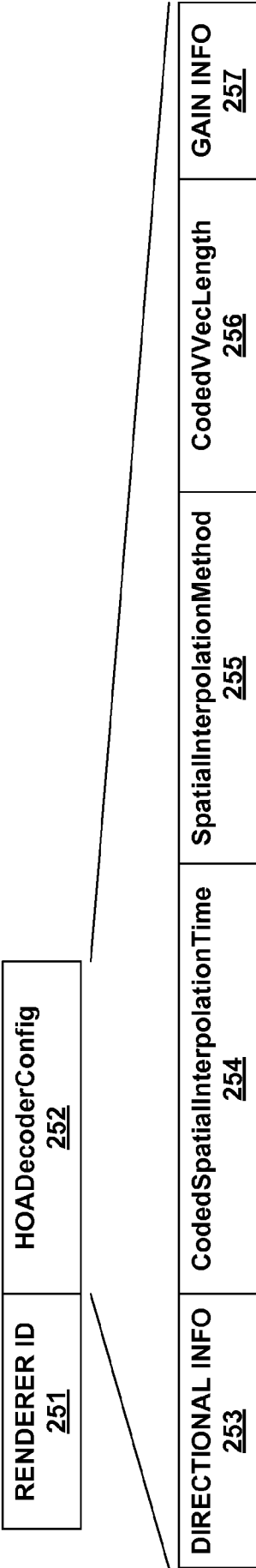


FIG. 10A

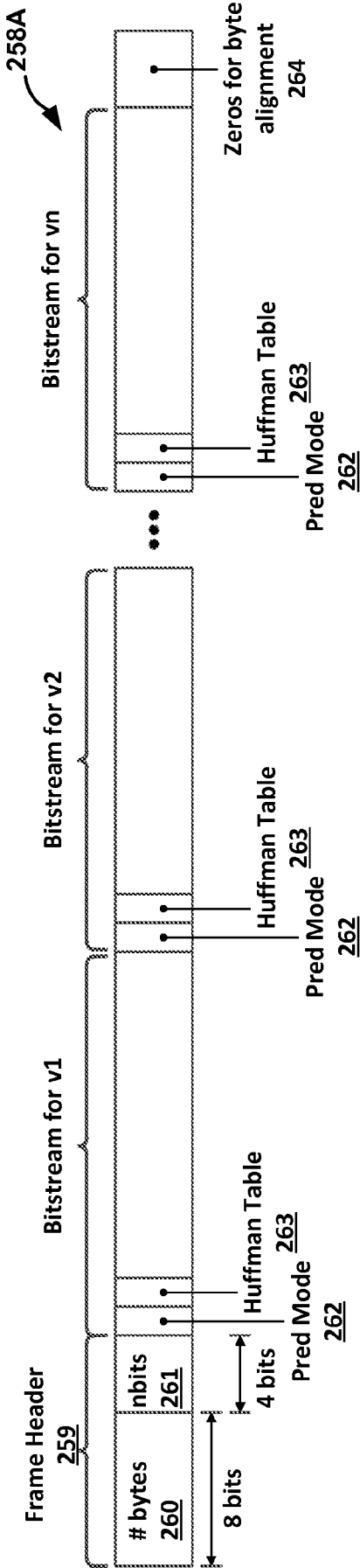


FIG. 10B

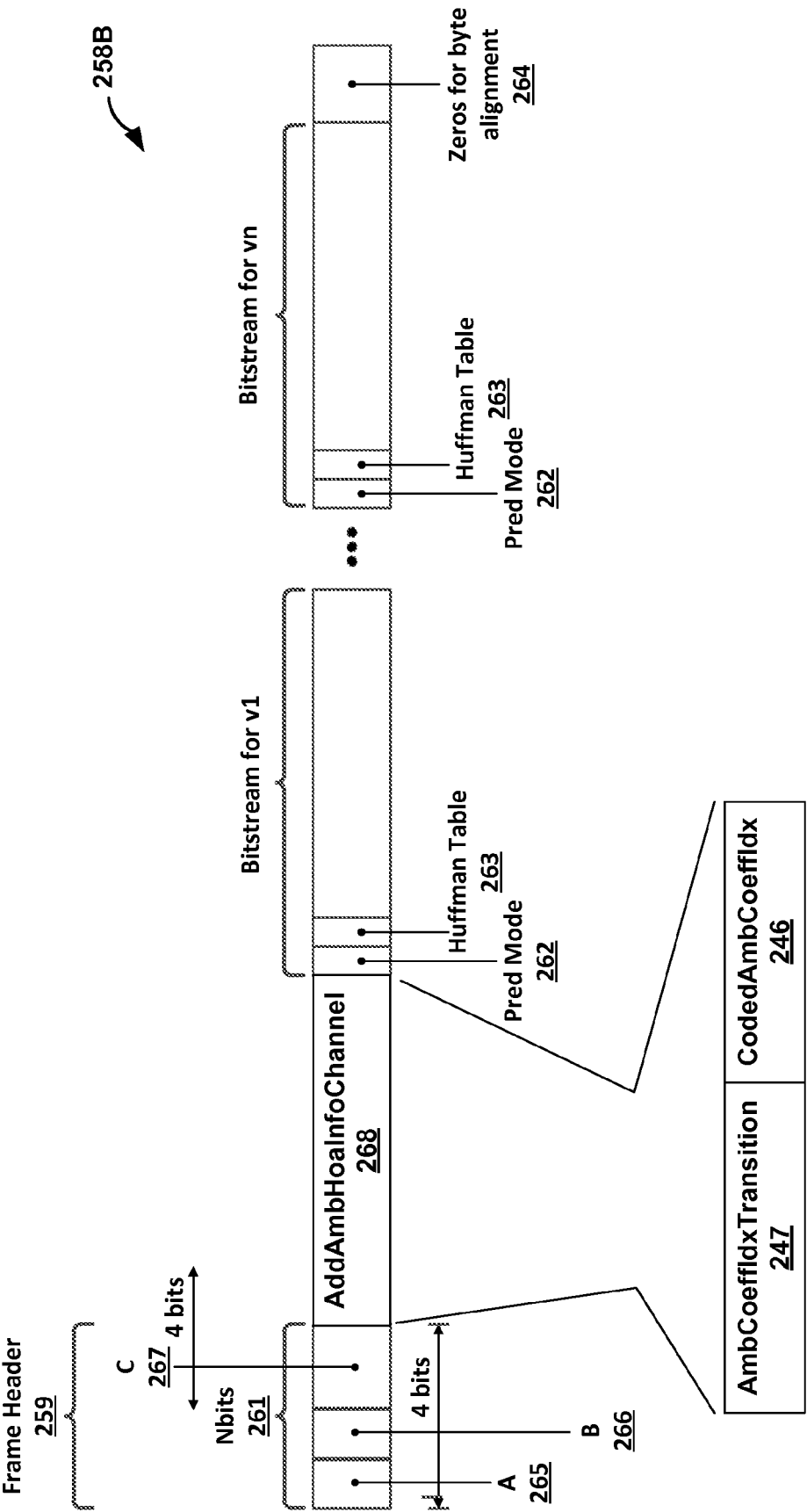


FIG. 10C

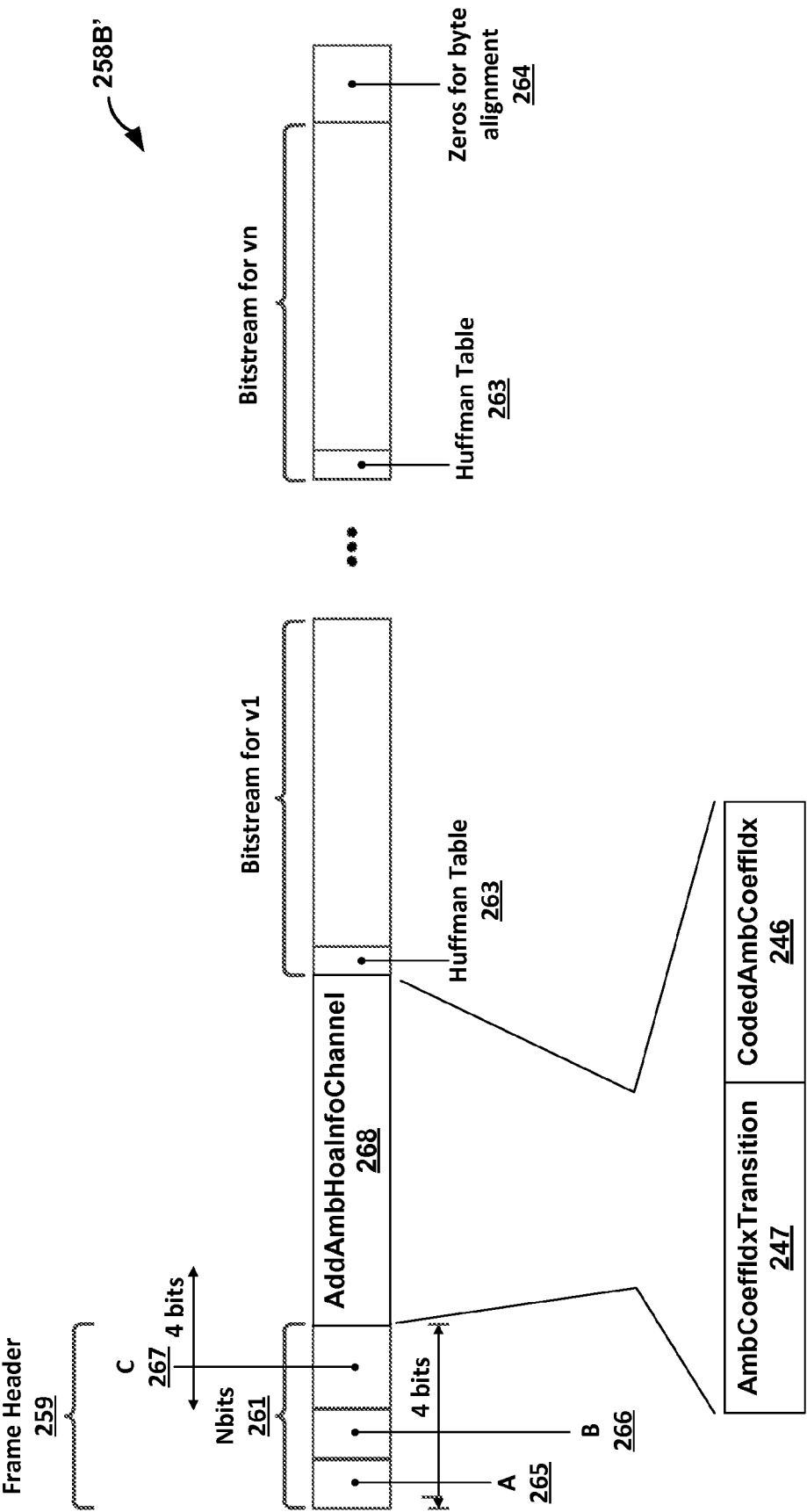


FIG. 10C(i)

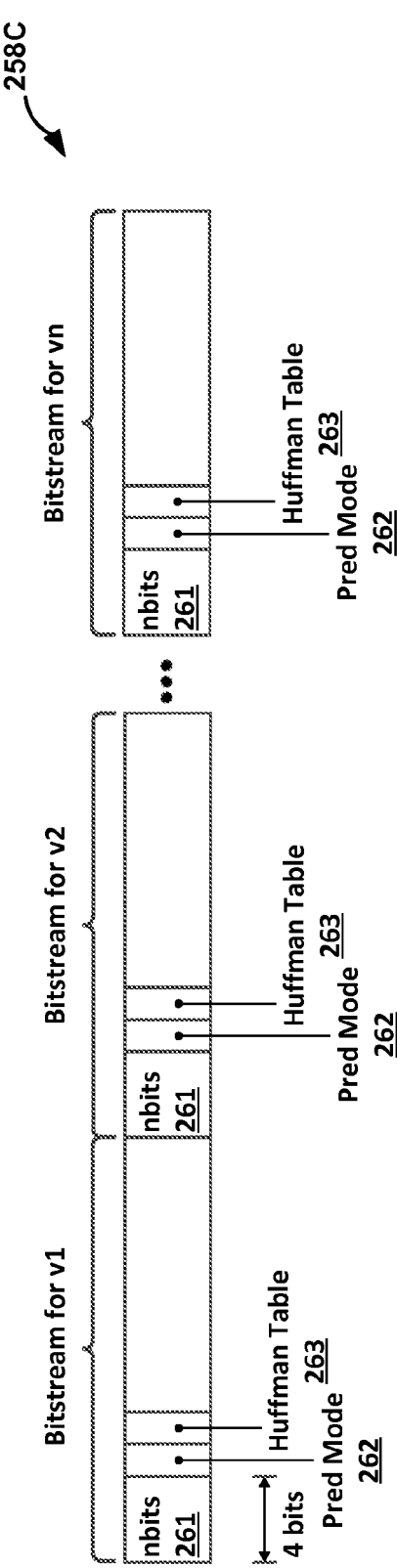


FIG. 10D

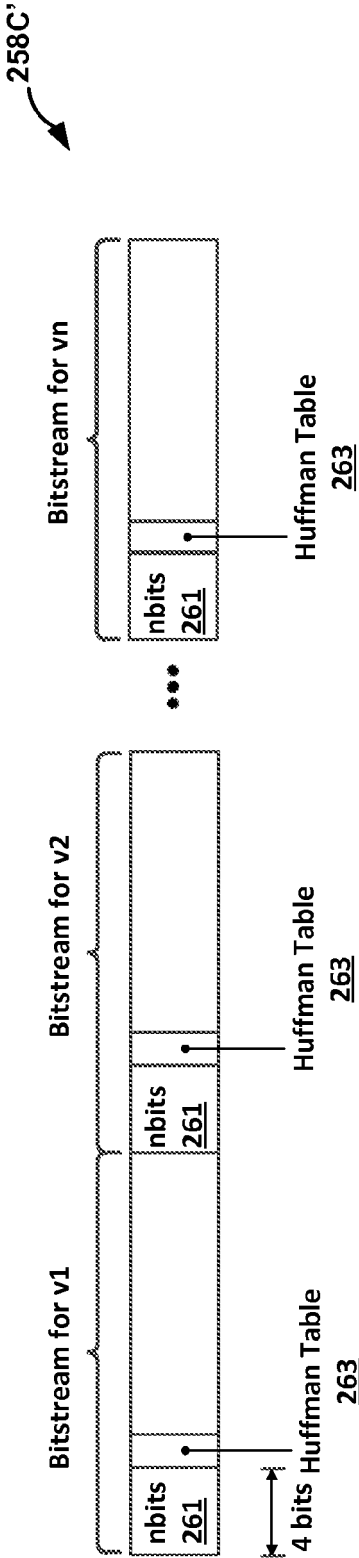


FIG. 10D(i)

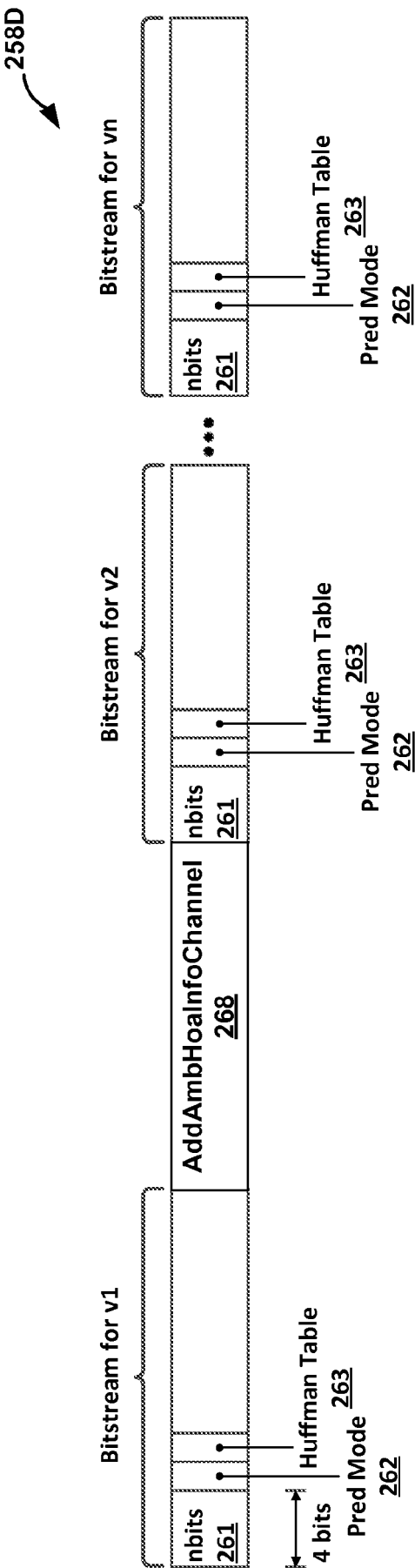


FIG. 10E

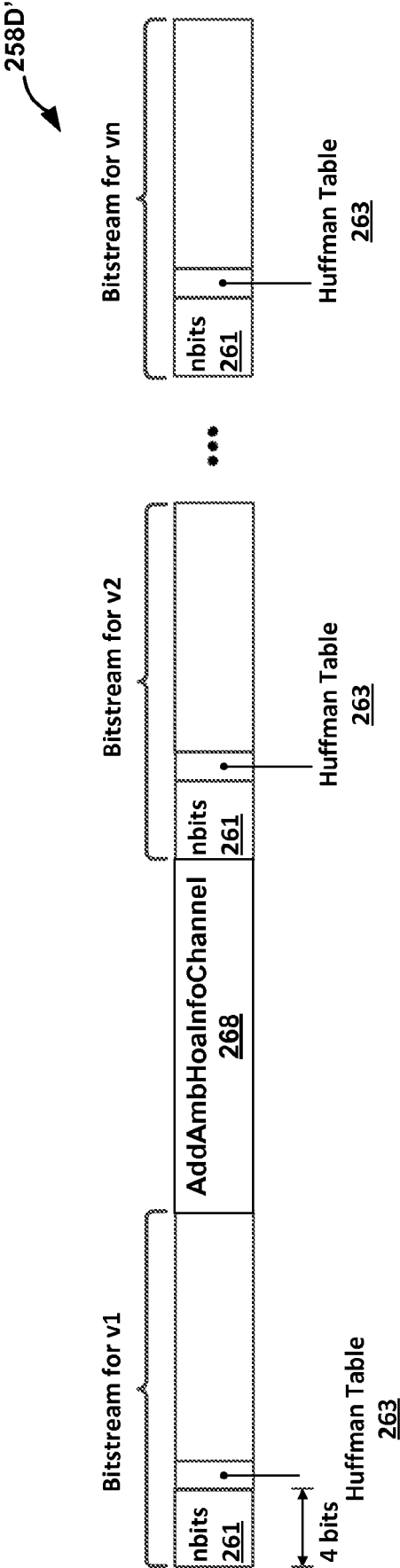


FIG. 10E(i)

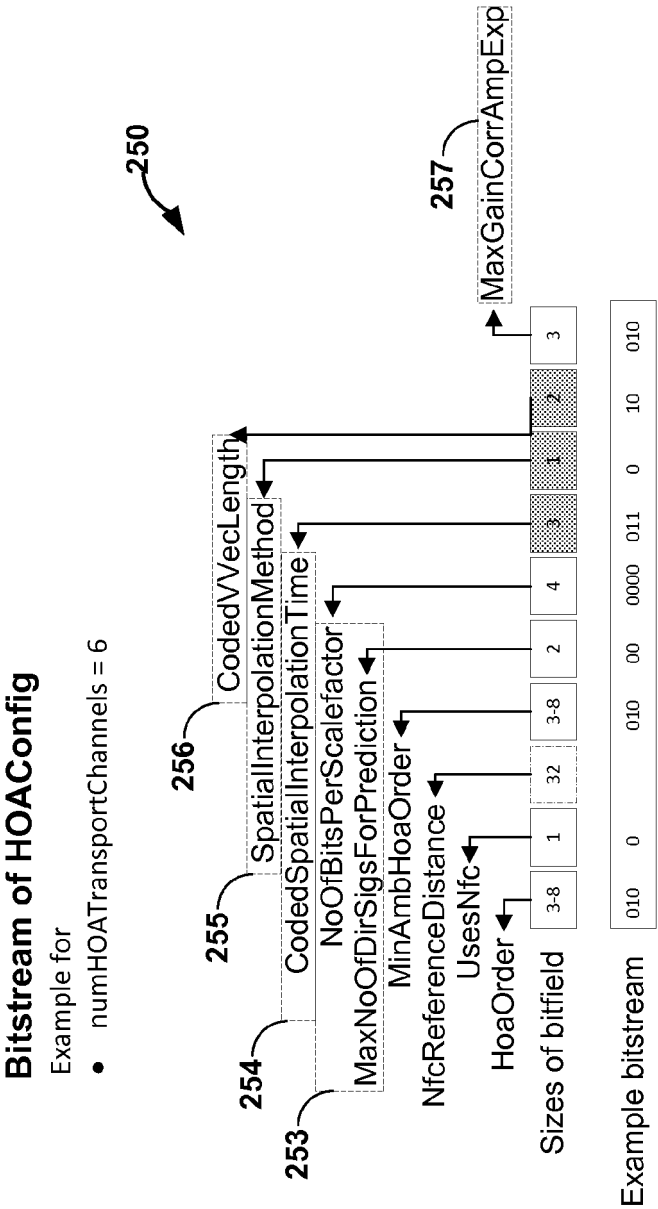


FIG. 10F

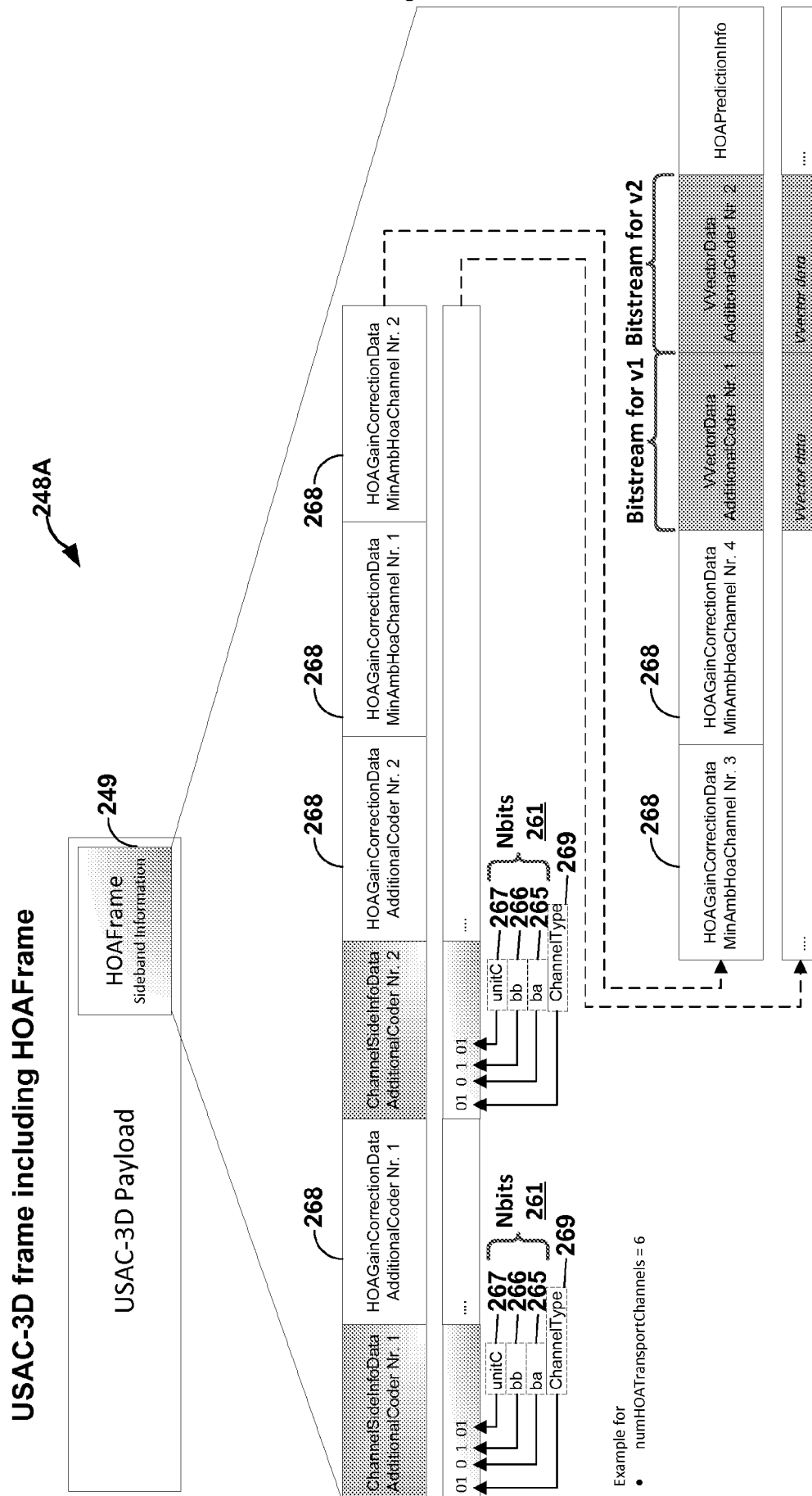


FIG. 10G

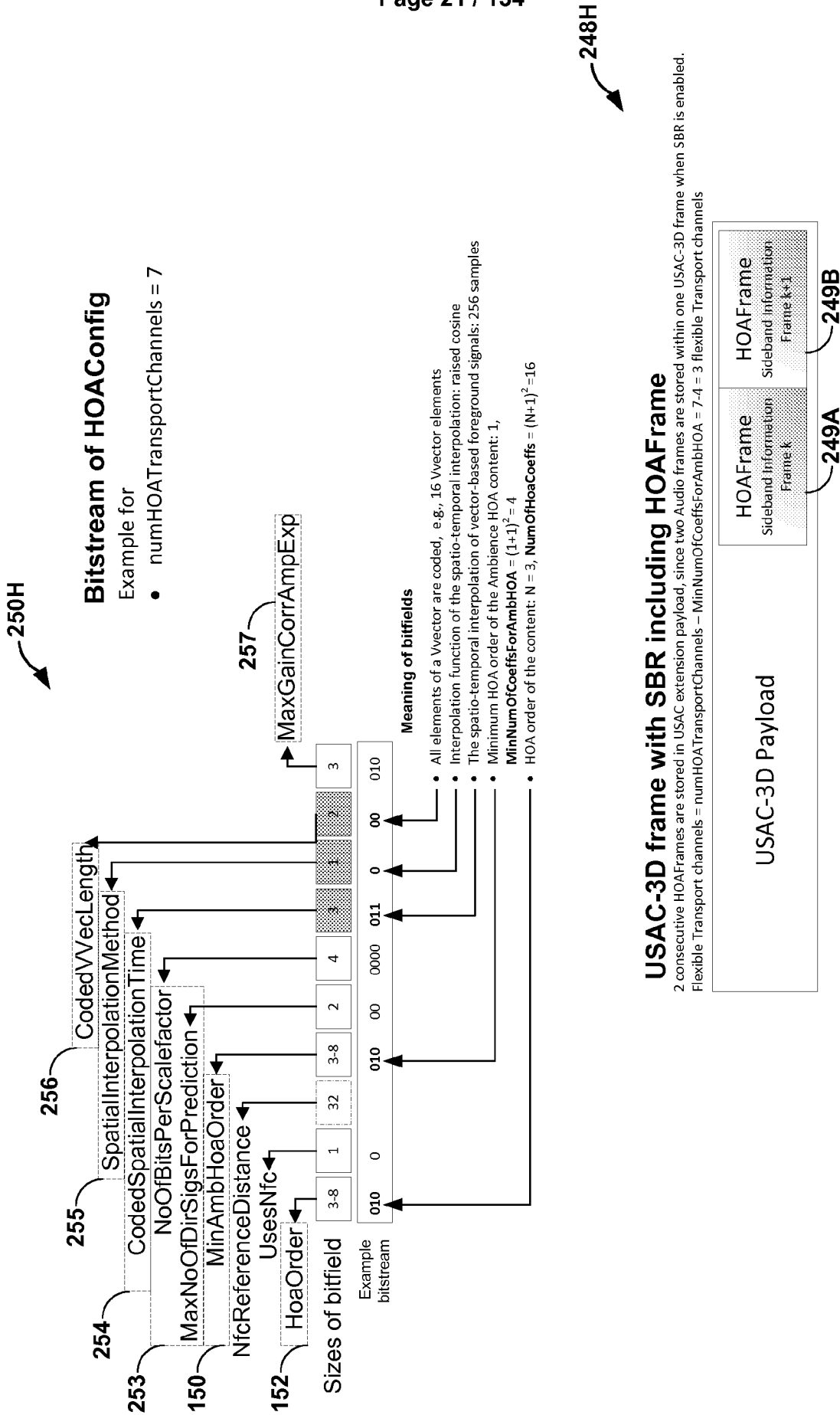


FIG. 10H(i)

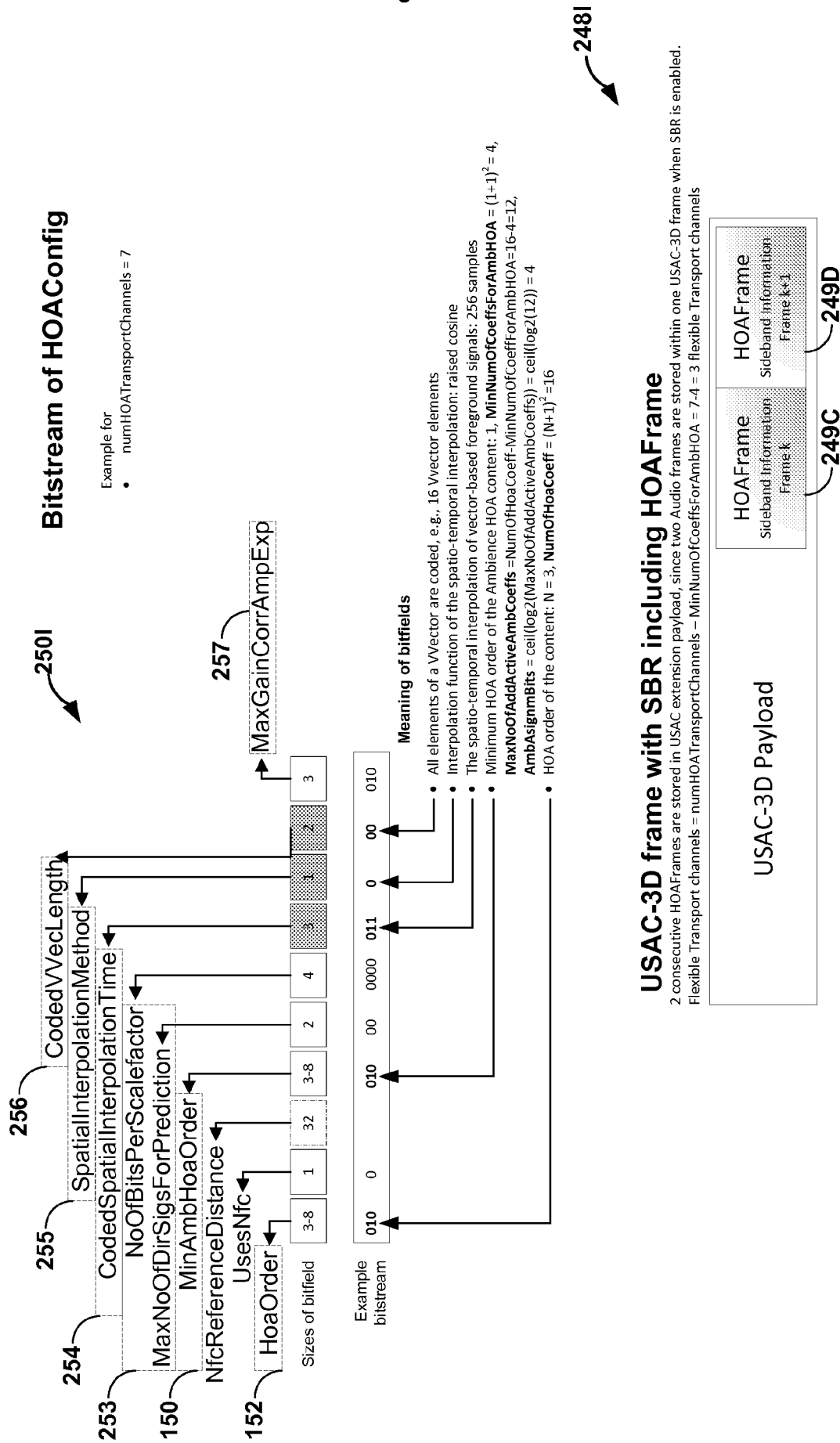
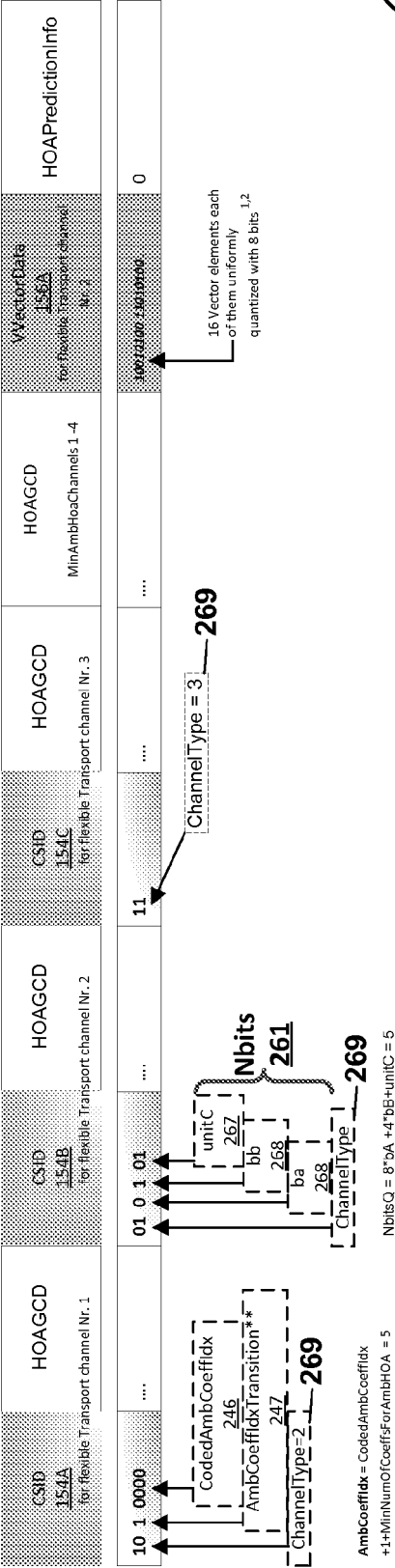


FIG. 10I(i)

249C

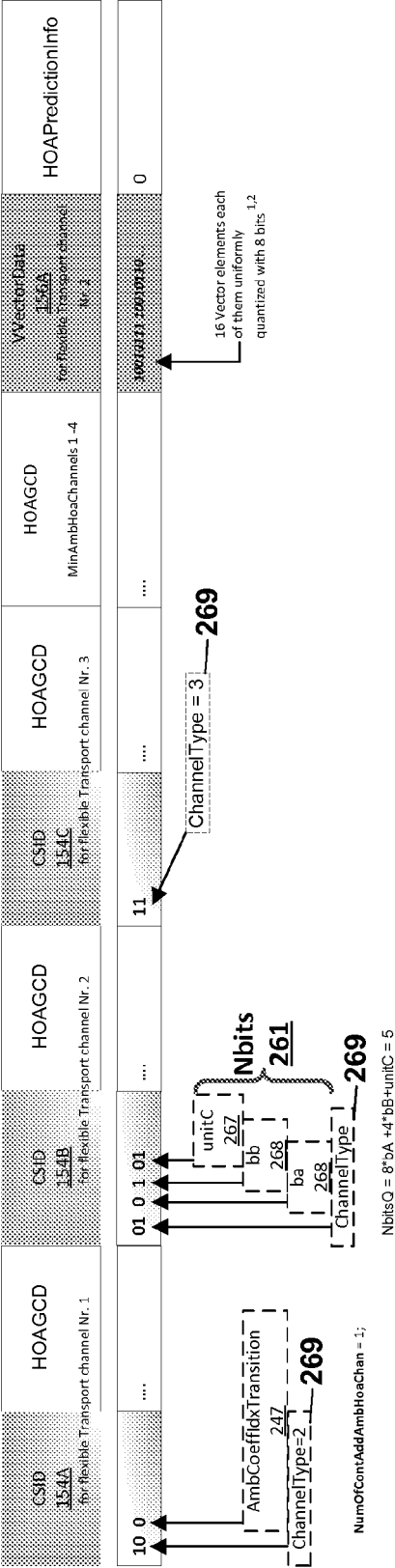
Frame k

In this example the flexible Transport channels contain one additional HOA Background channel, and one vector-based Foreground channel.



249D

Frame k+1



¹ Number and Indices of coded VVectorData elements specified by the parameter CodedVVecLength = 0

² Coding scheme signaled by NbBitsQ = 5 in the ChannelSideInfo for flexible Transport channel Nr. 2

** For the flexible Transport channel Nr.1 the decoder's internal state is here assumed to be AmbCoeffIdxTransitionState = 2. Hence the CodedAmbCoeffIdx bitfield is signaled.

FIG. 10(ii)

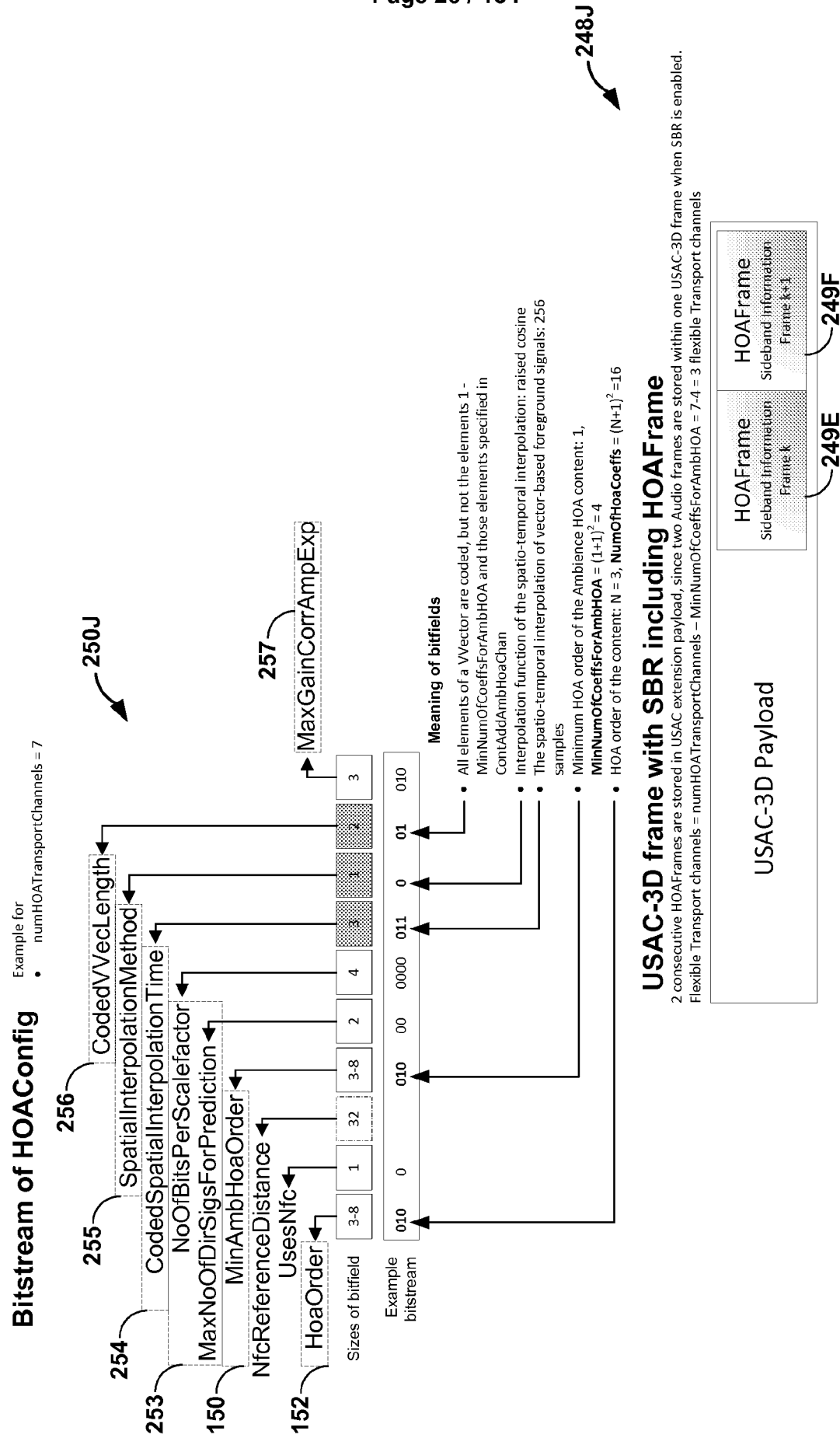
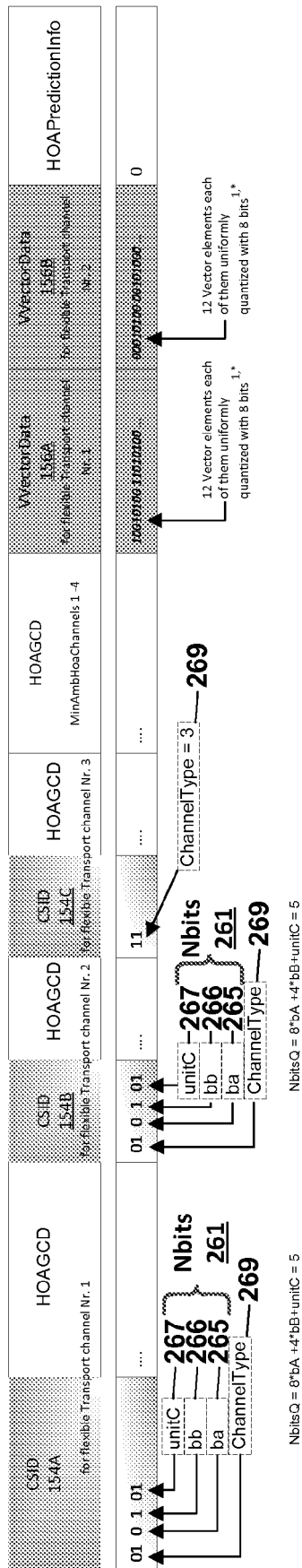


FIG. 10J(i)

249E

Frame k

In this example the flexible Transport channels contain two vector-based Foreground Channels in the frame k and three vector-based Foreground Channels in the second frame $k+1$


$$\text{NbitsQ} = 8 * \text{bA} + 4 * \text{bB} + \text{unitC} = 5$$
$$\text{NbitsQ} = 8 * \text{bA} + 4 * \text{bB} + \text{unitC} = 5$$

Frame k+1

249F

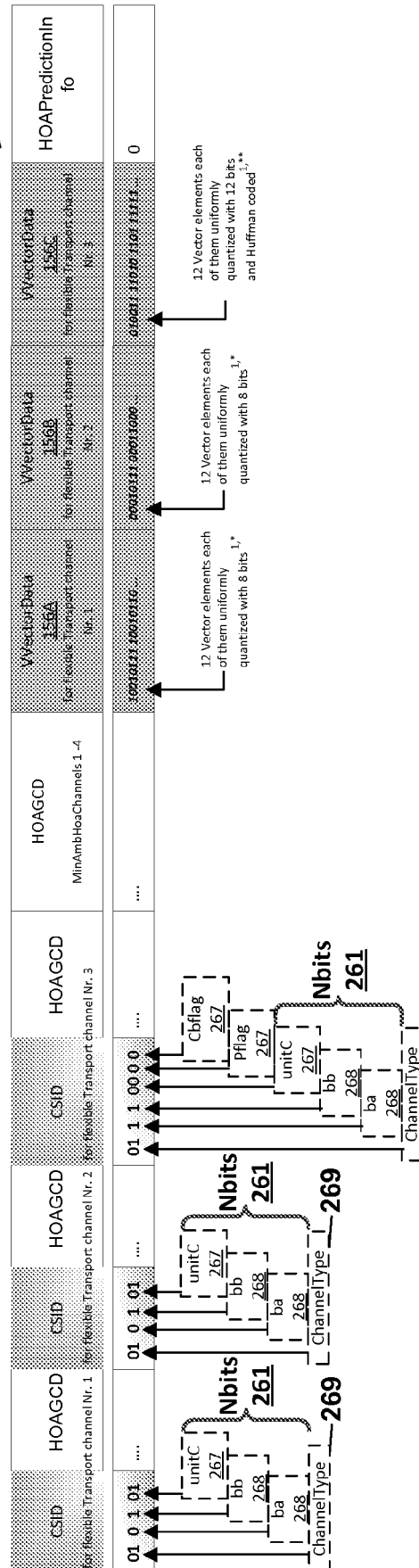
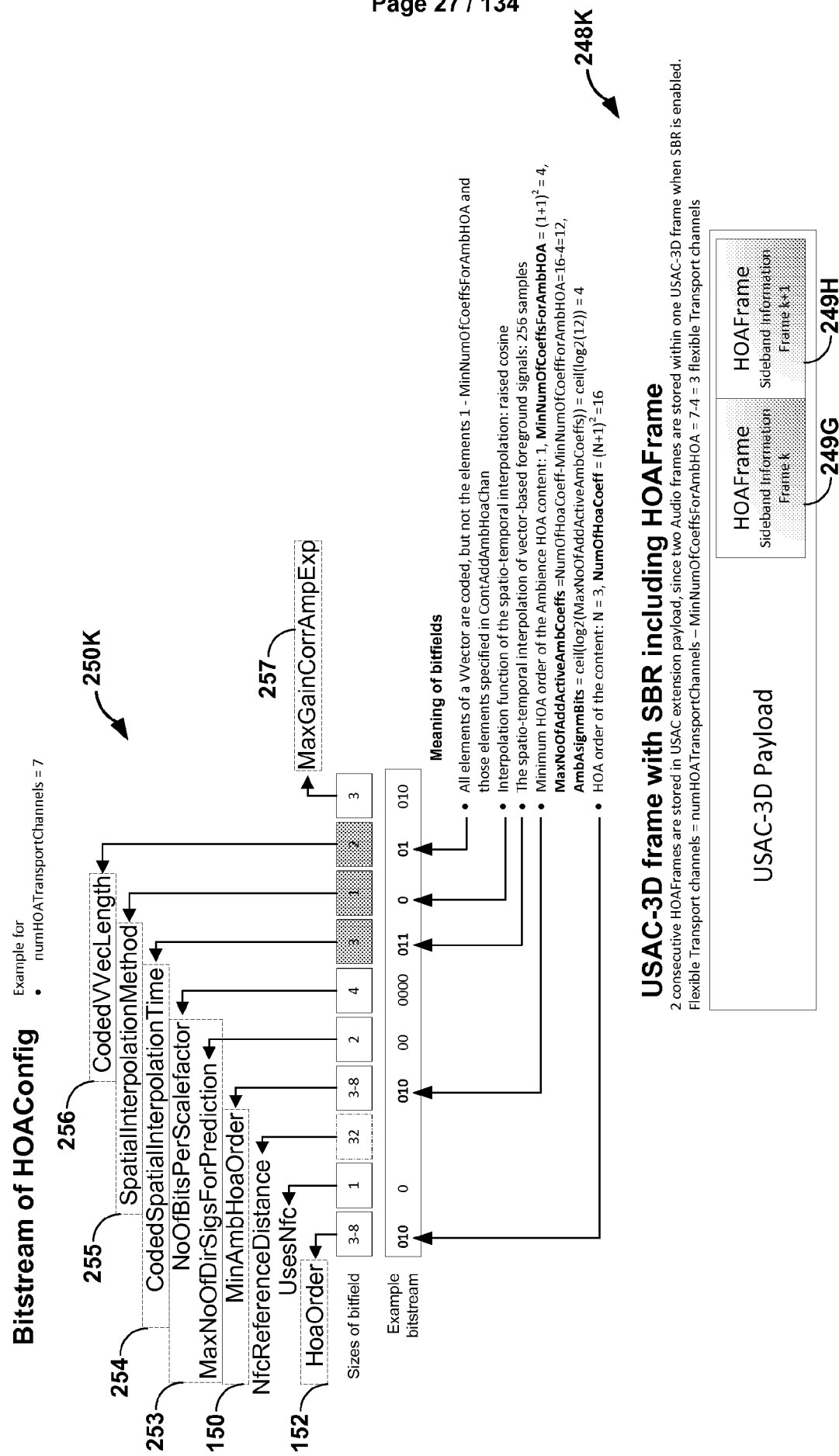


FIG. 10J(ii)

¹Number and Indices of coded VVectorData elements specified by the parameter CodedVVecLength, MinAmbHoaOrder, HoaOrder, no additional HOA channels are signaled in these frames.

* Coding scheme signaled by NbitsQ = 5 in the ChannelSideInfo for this particular transport channel

** Huffman coding scheme signaled by NbitsQ = 12, CbFlag = 0, and Pflag = 0 in the ChannelsSideInfo for this particular transport channel



USAC-3D frame with SBR including HOAFrame

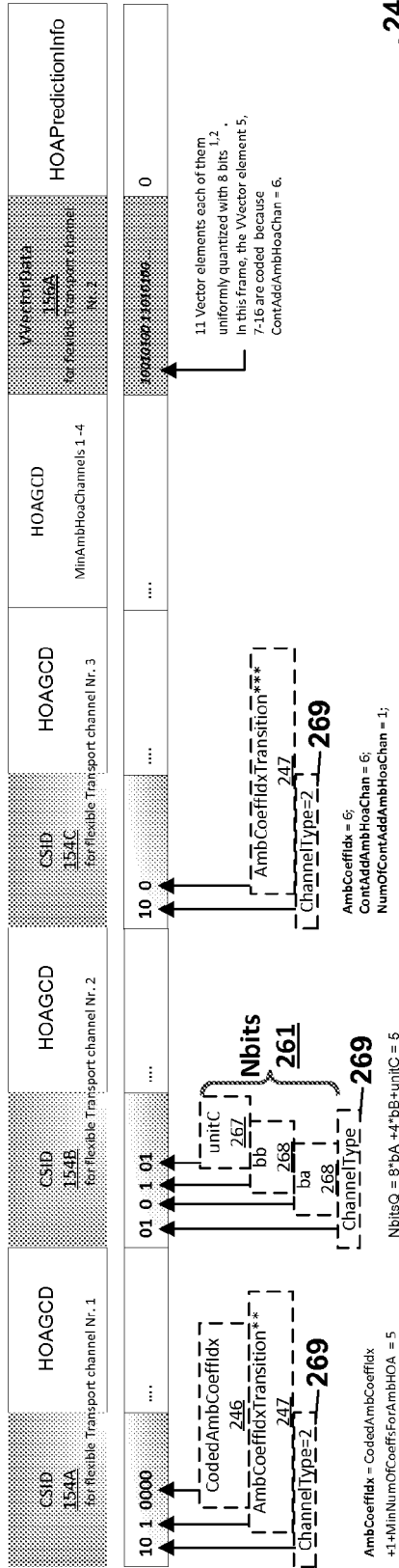
2 consecutive HOAFrames are stored in USAC extension payload, since two Audio frames are stored within one USAC-3D frame when SBR is enabled.
Flexible Transport channels = numHOATransportChannels - MinNumOfCoeffsForAmbHOA = 7-4 = 3 flexible Transport channels

FIG. 10K(i)

249G

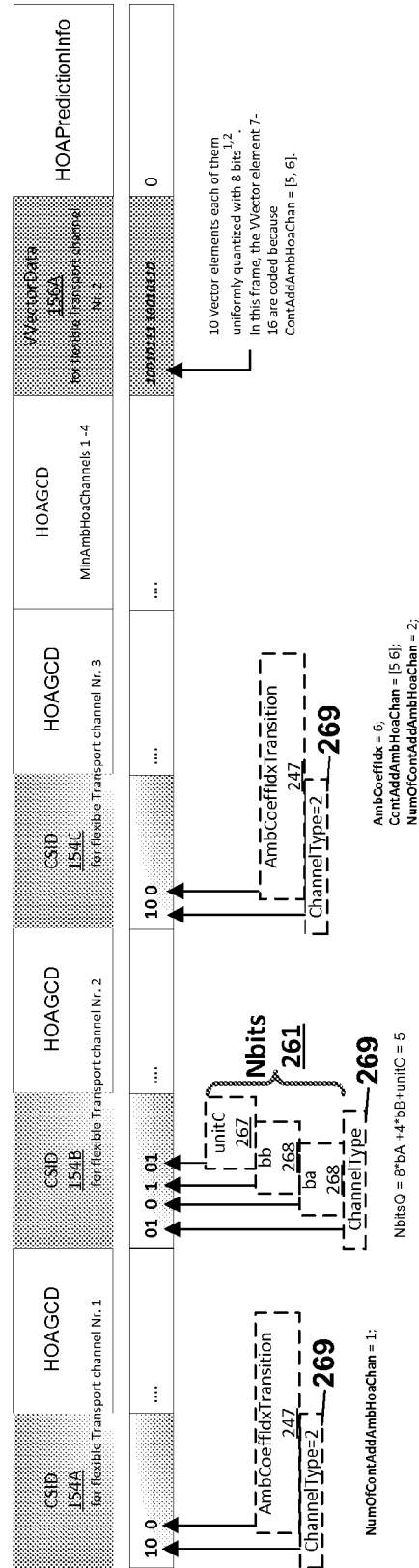
Frame k

In this example the flexible Transport channels contain one additional HOA Background channel, and one vector-based Foreground channel.



249H

Frame k+1



¹ Number and Indices of coded VVectorData elements specified by the parameter CodedVVecLength, MinNumOfCoeffsForAmbHOA, NumOfHoaCoeff

² Coding scheme signaled by NbBitsQ = 5 in the ChannelSideInfo for flexible Transport channel Nr. 2

** For the flexible Transport channel Nr.1 the decoder's internal state is here assumed to be AmbCoeffIdxTransitionState = 2. Hence the CodedAmbCoeffIdx bitfield is signaled.

*** The flexible Transport Channel Nr. 3 has been defined in a previous frame to carry the additional HOA coefficient 6. Hence the CodedAmbCoeffIdx bitfield is not signaled.

FIG. 10K(ii)

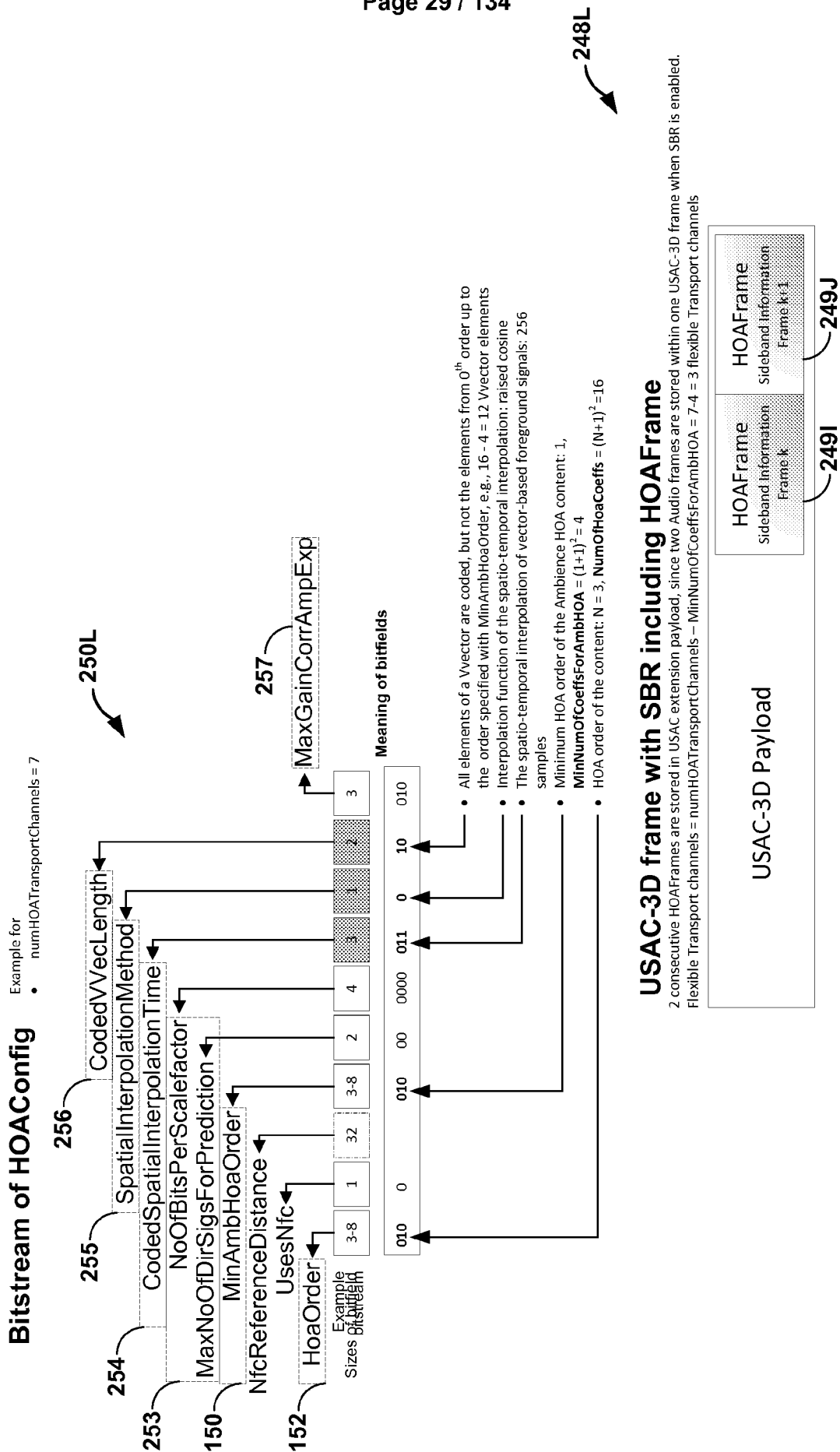
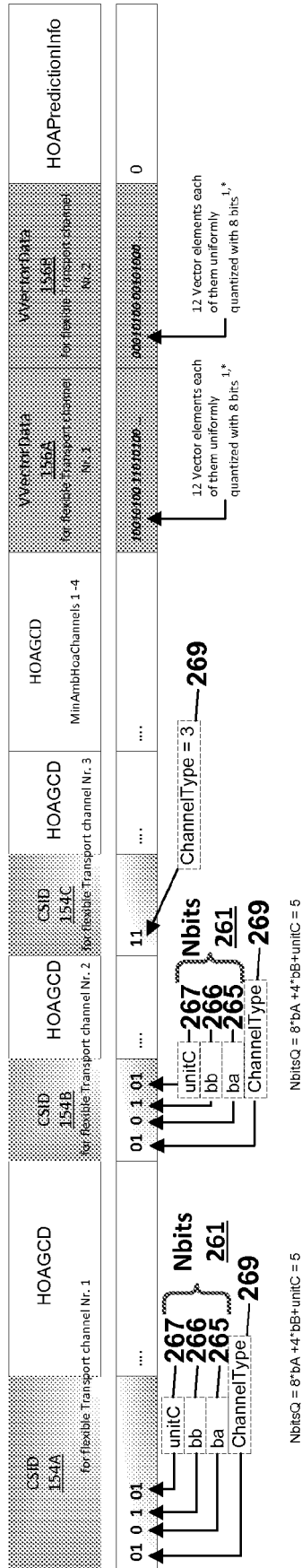


FIG. 10L(i)

249I

Frame k

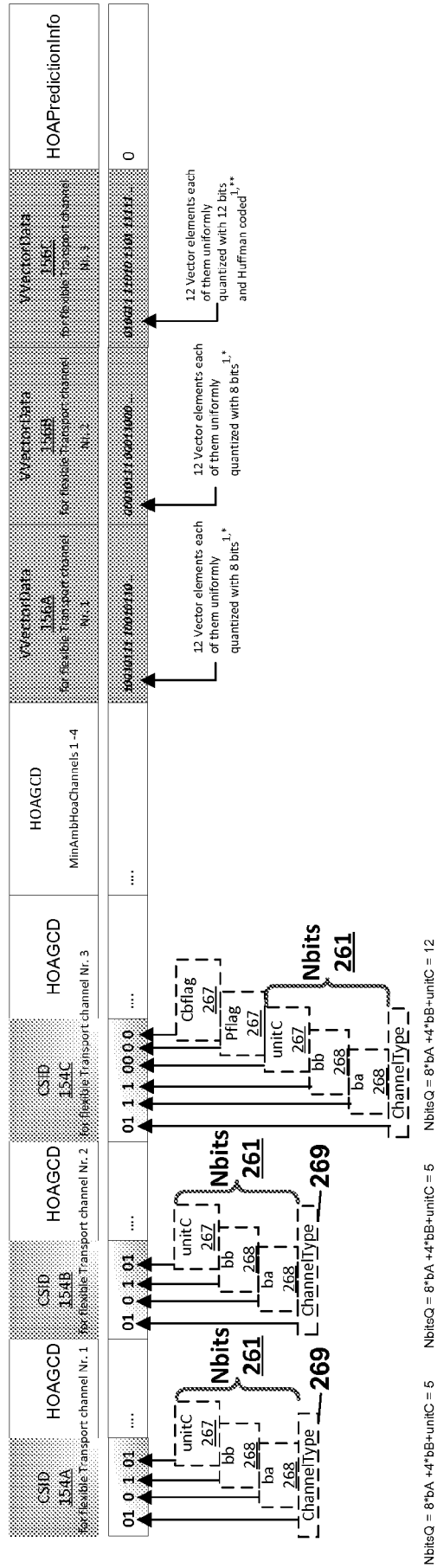
In this example the flexible Transport channels contain two vector-based Foreground channels in the frame k and three vector-based Foreground Channels in the second frame k+1



$$\text{NbitsQ} = 8 \cdot \text{bA} + 4 \cdot \text{bB} + \text{unitC} = 5$$

$$\text{NbitsQ} = 8 \cdot \text{bA} + 4 \cdot \text{bB} + \text{unitC} = 5$$

249J

Frame k+1

$$\text{NbitsQ} = 8 \cdot \text{bA} + 4 \cdot \text{bB} + \text{unitC} = 5 \quad \text{NbitsQ} = 8 \cdot \text{bA} + 4 \cdot \text{bB} + \text{unitC} = 5 \quad \text{NbitsQ} = 8 \cdot \text{bA} + 4 \cdot \text{bB} + \text{unitC} = 12$$

¹ Number and Indices of coded VVectorData elements specified by the parameter CodedVVecLength, MinAmbHoaOrder, HoaOrder
^{*} Coding scheme signaled by NbitsQ = 5 in the ChannelSideInfo for this particular transport channel
^{**} Huffman coding scheme signaled by NbitsQ = 12, CbFlag = 0, and PFlag = 0 in the ChannelSideInfo for this particular transport channel

FIG. 10L(ii)

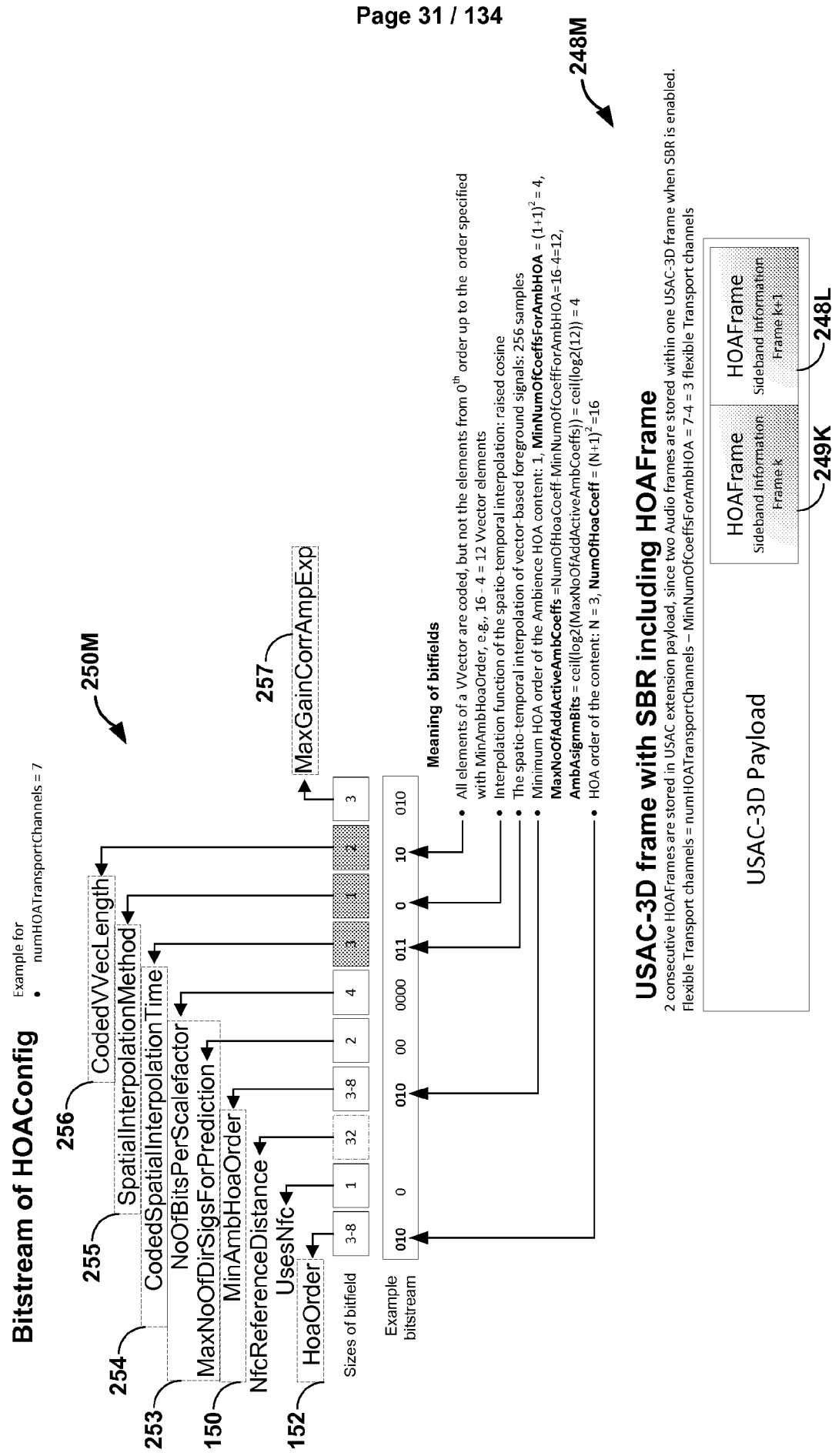


FIG. 10M(i)

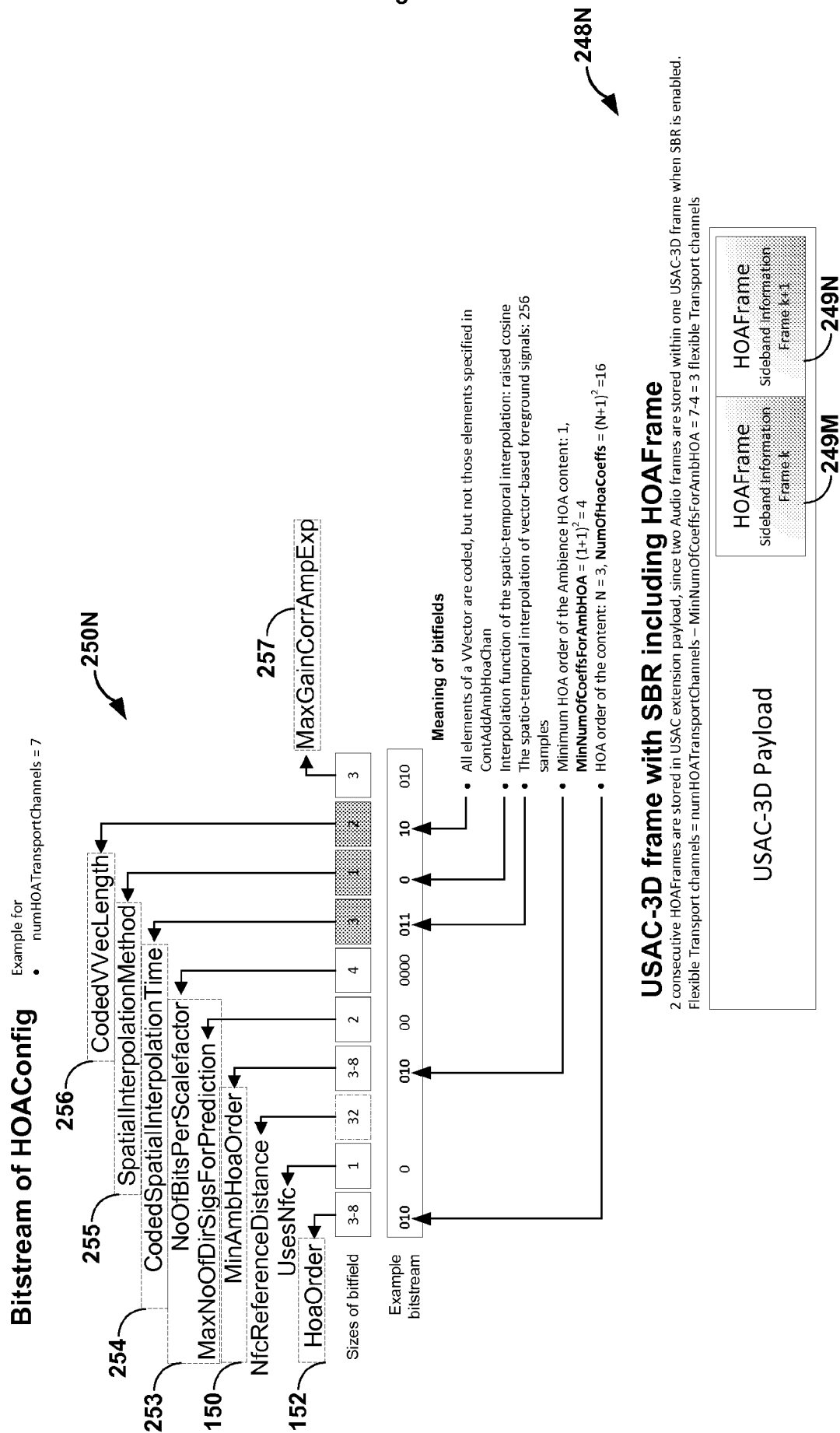
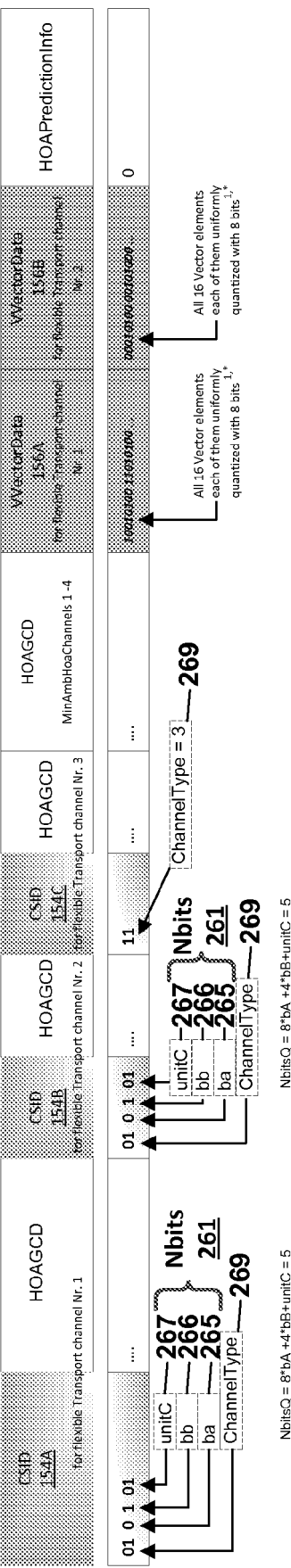


FIG. 10N(i)

249M

Frame k

In this example the flexible Transport channels contain two vector-based Foreground channels in the frame k and three vector-based Foreground Channels in the second frame k+1



249N

Frame k+1

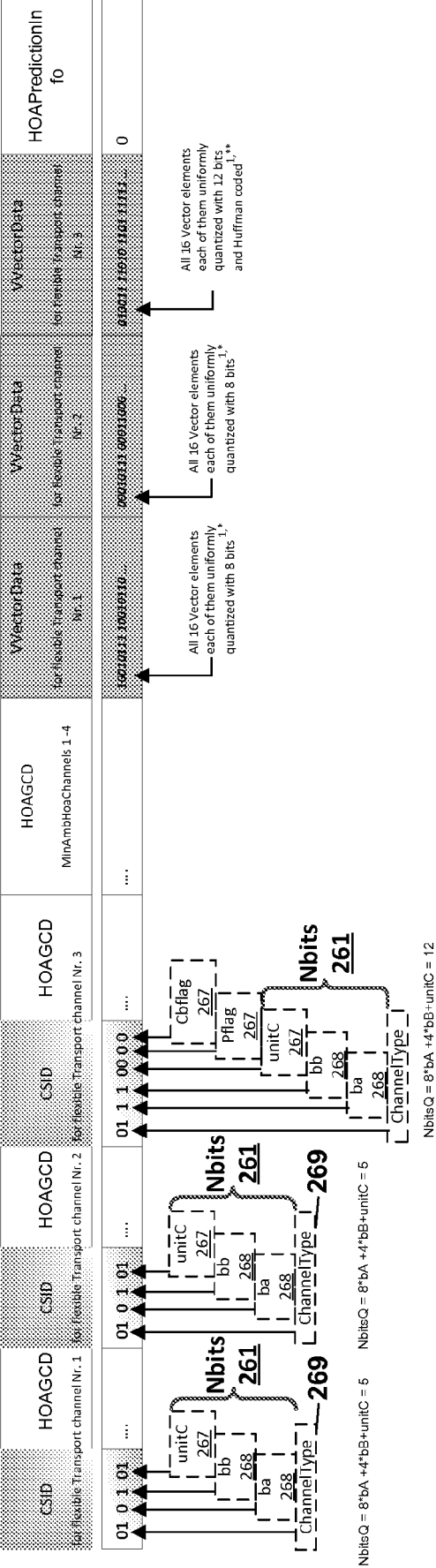


FIG. 10N(ii)

¹ Number and Indices of coded VVectorData elements specified by the parameter CodedVVecLength, MinAmbHoaOrder, HoaOrder, no additional HOA channels are signaled in these frames.
^{*} Coding scheme signaled by NbitsQ = 5 in the ChannelSideInfo for this particular transport channel
^{**} Huffman coding scheme signaled by NbitsQ = 12, CbFlag = 0, and Pflag = 0 in the ChannelSideInfo for this particular transport channel

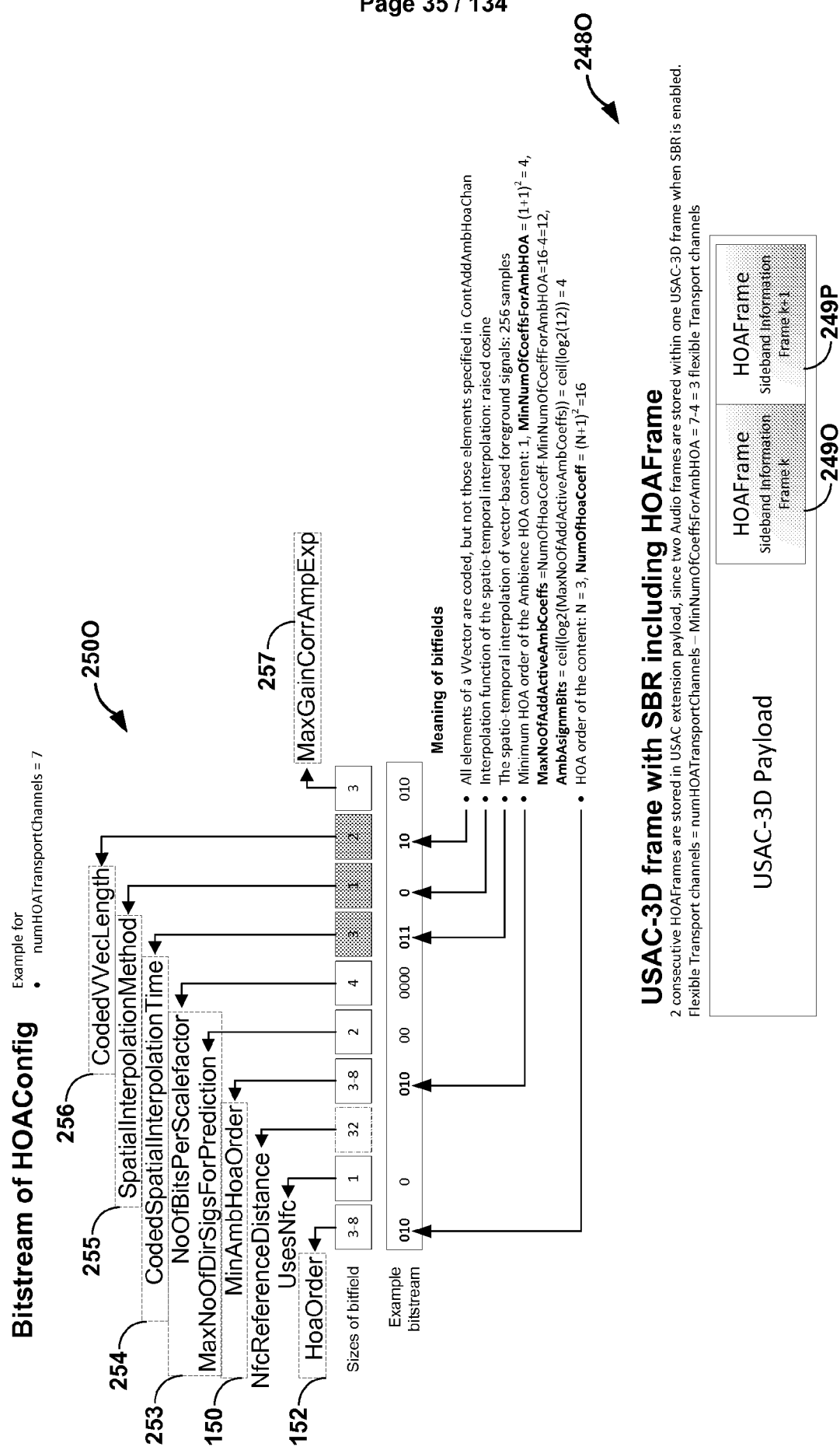


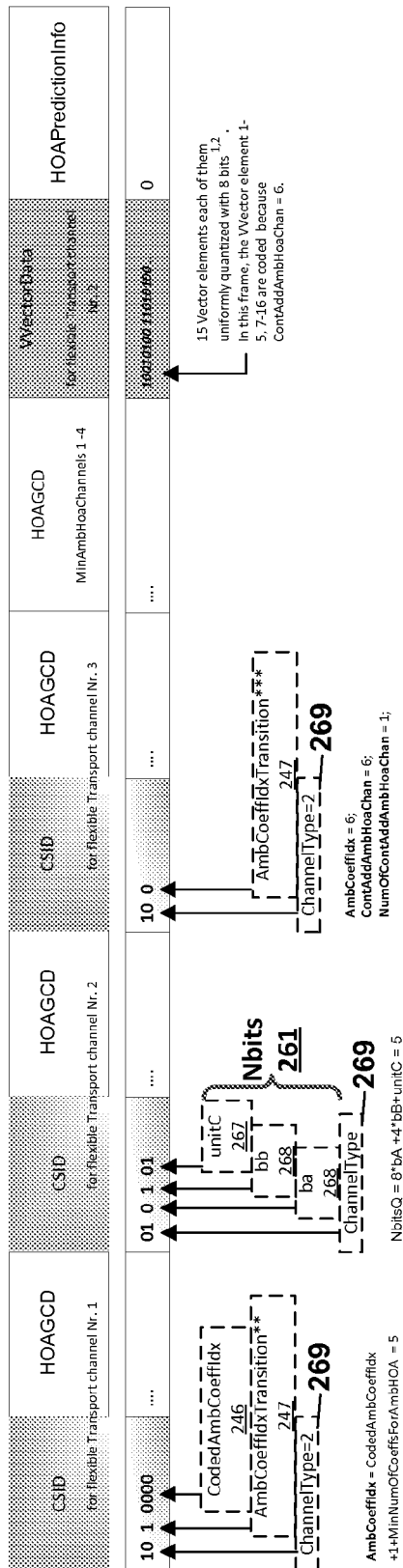
FIG. 100(i)

-2490

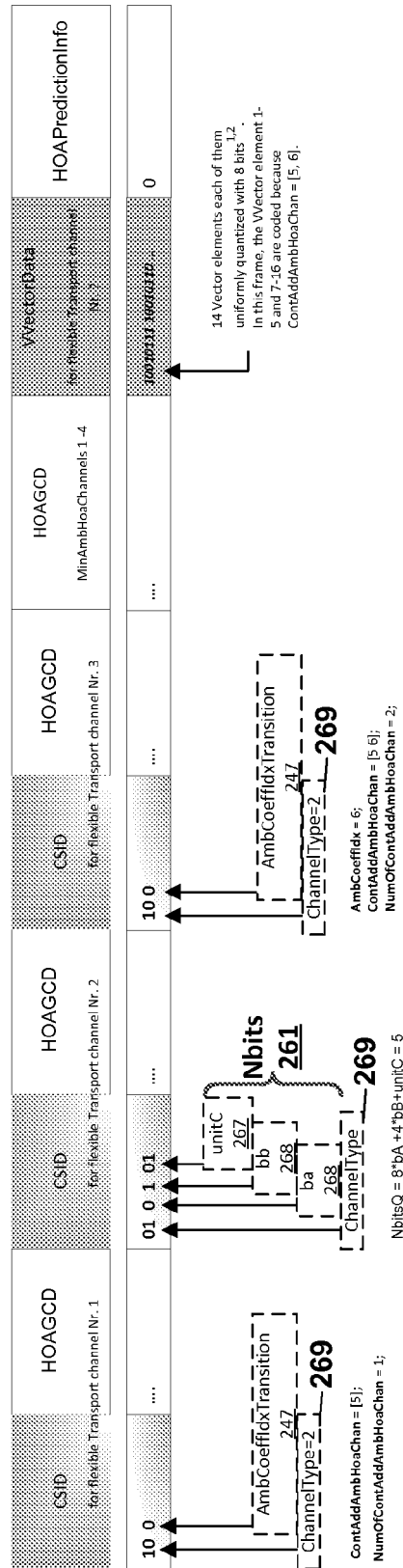
-249P

Frame k

In this example the flexible Transport channels contain one additional HOA Background channel, and one vector-based Foreground channel.



Frame k+1

¹Number and Indices of coded VVectorData elements specified by the parameter CodedVVecLength, MinNumOfCoeffsForAmbHOA, NumOfHocCoeff²Coding scheme signaled by NbitsQ = 5 in the ChannelsSideInfo for flexible Transport channel Nr. 2

^{**} For the flexible Transport channel Nr.1 the decoder's internal state is here assumed to be $\text{AmbCoeffIdxTransitionState} = 2$. Hence the CodedAmbCoeffIdx bitfield is signaled. Coding scheme signaled by $\text{NbOfSQ} = 3$ in the GranuleIdxMin for flexible Transport Channel Nr. 2

**** The flexible Transport Channel Nr. 3 has been defined in a previous frame to carry the additional HOA coefficient 6. Hence the CodedAmbCoeffIdx bitfield is not signaled. For the flexible Transport Channel Nr. 1, the decoder's internal state is here assumed to be AmbCoeffIdx1InitializationState = 2, hence the CodedAmbCoeffIdx bitfield is signaled.

FIG. 100(ii)

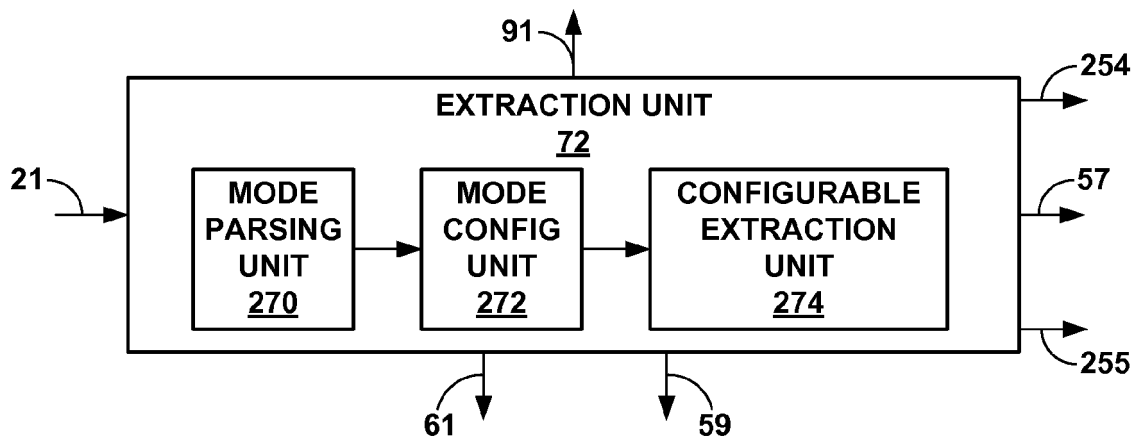


FIG. 11A

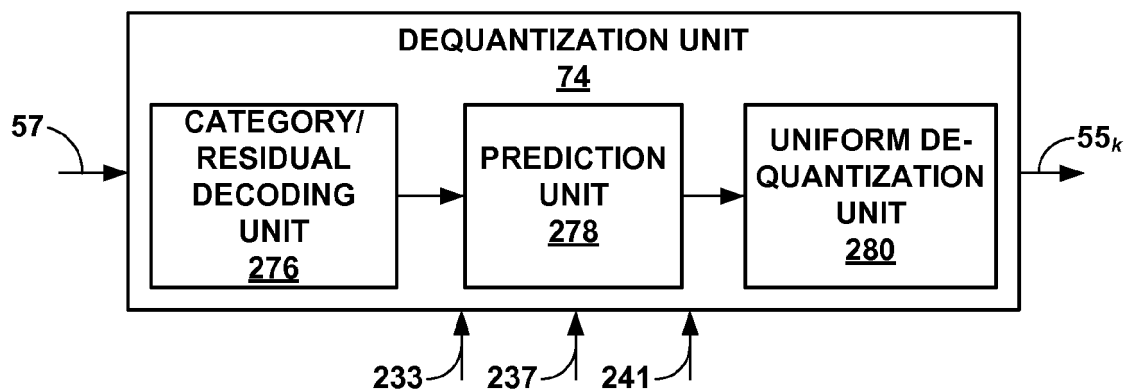


FIG. 11B

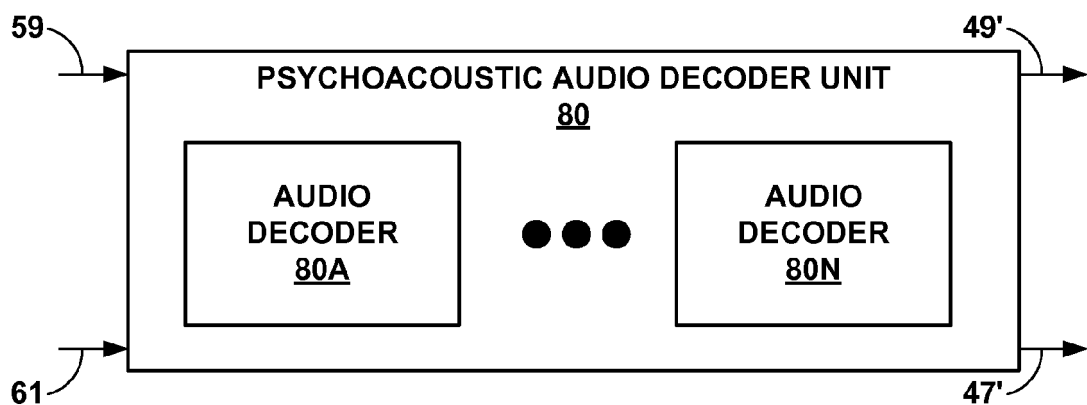


FIG. 11C

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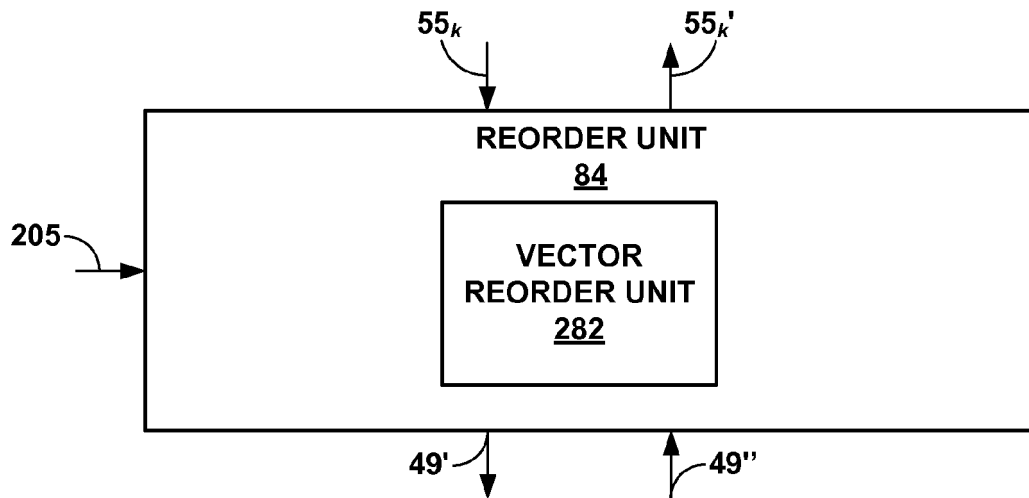


FIG. 11D

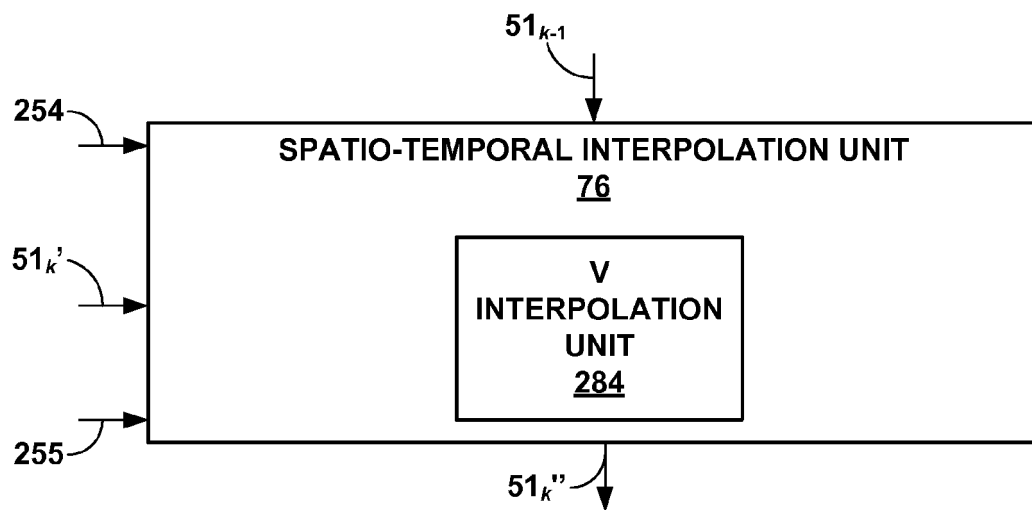


FIG. 11E

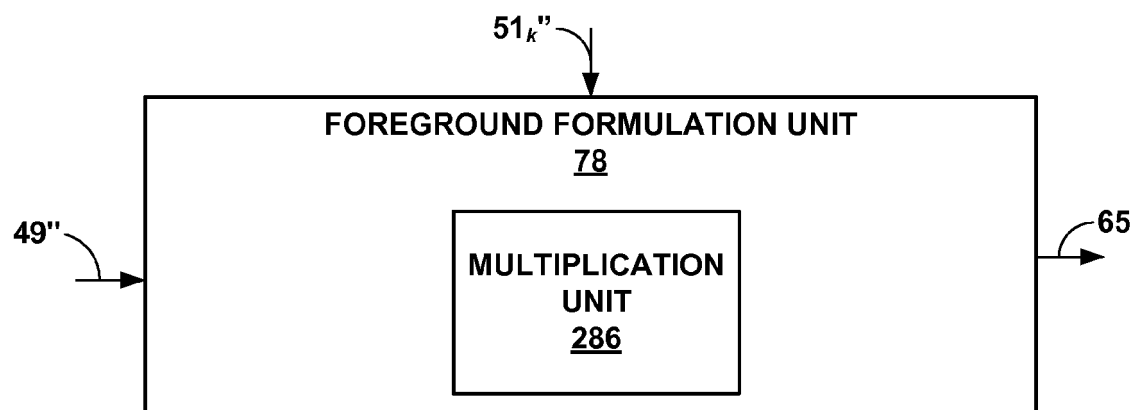


FIG. 11F

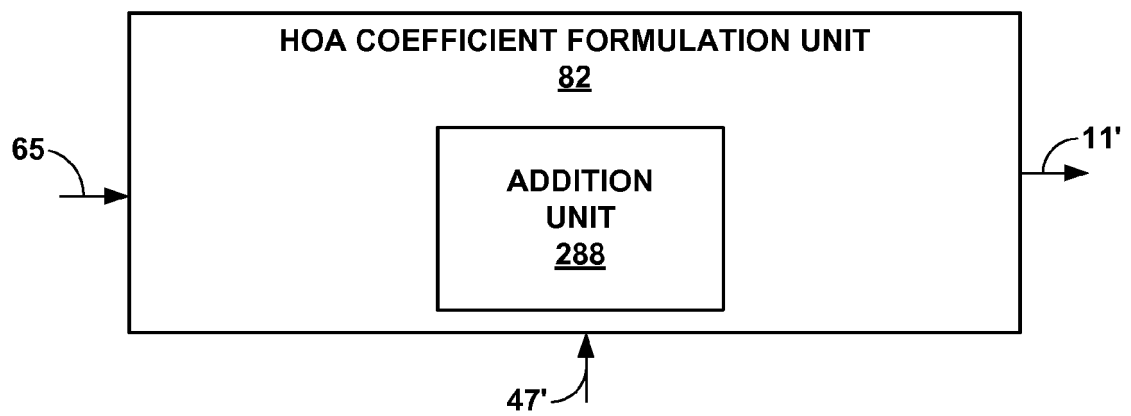


FIG. 11G

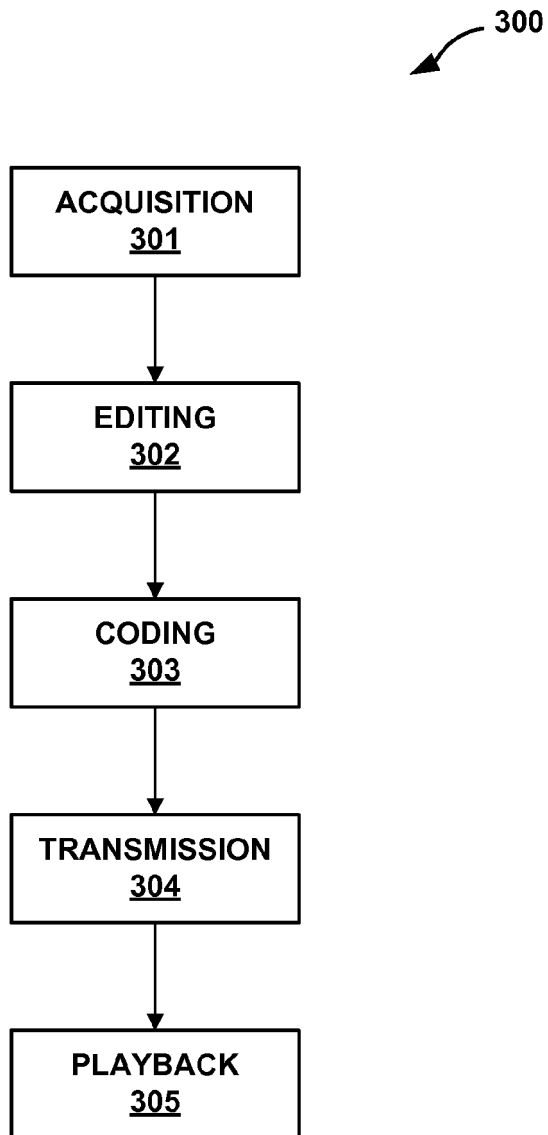


FIG. 12

300A

Current 2D/3D Audio Ecosystem: Professional Audio

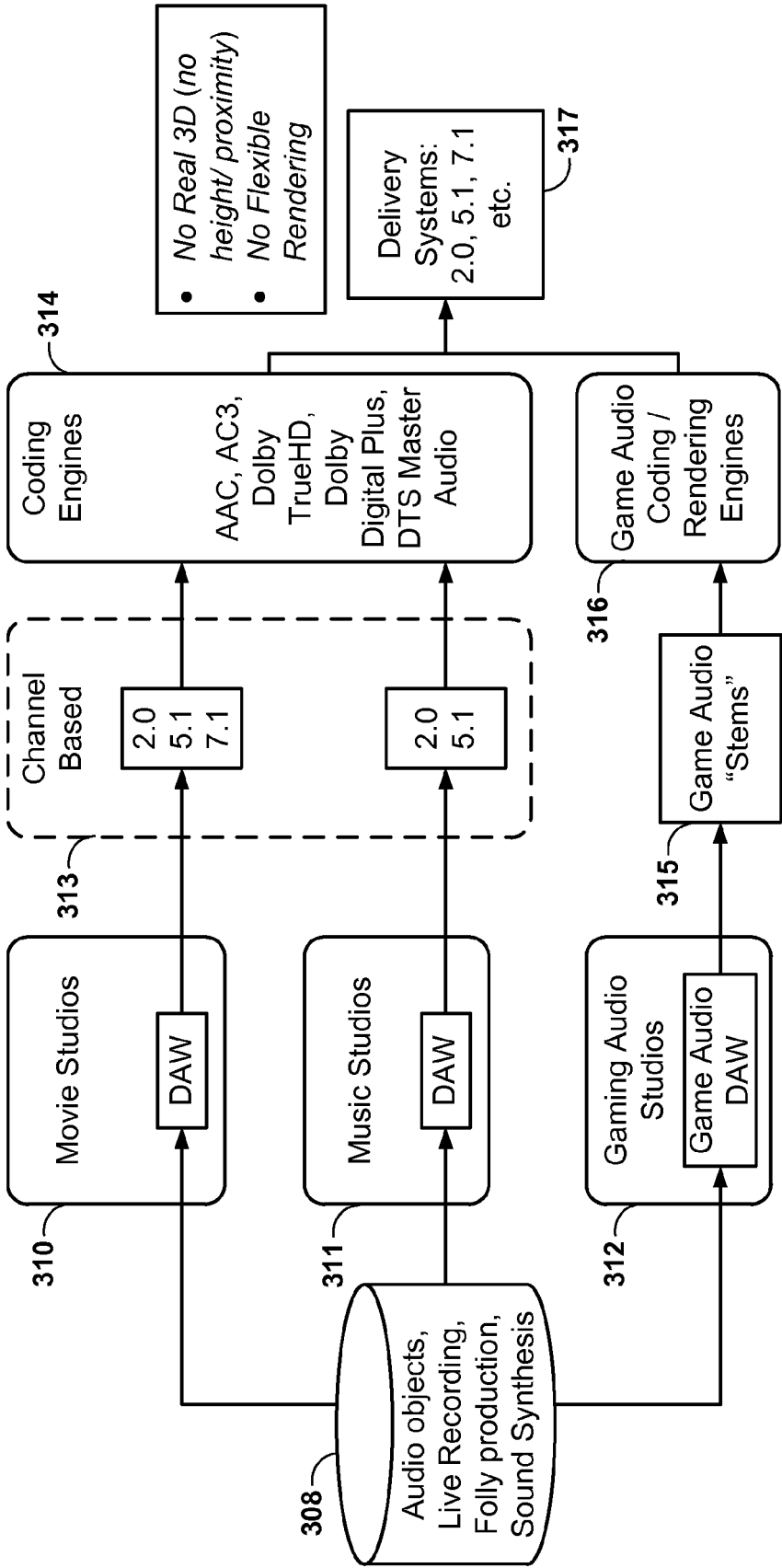


FIG. 13

300B

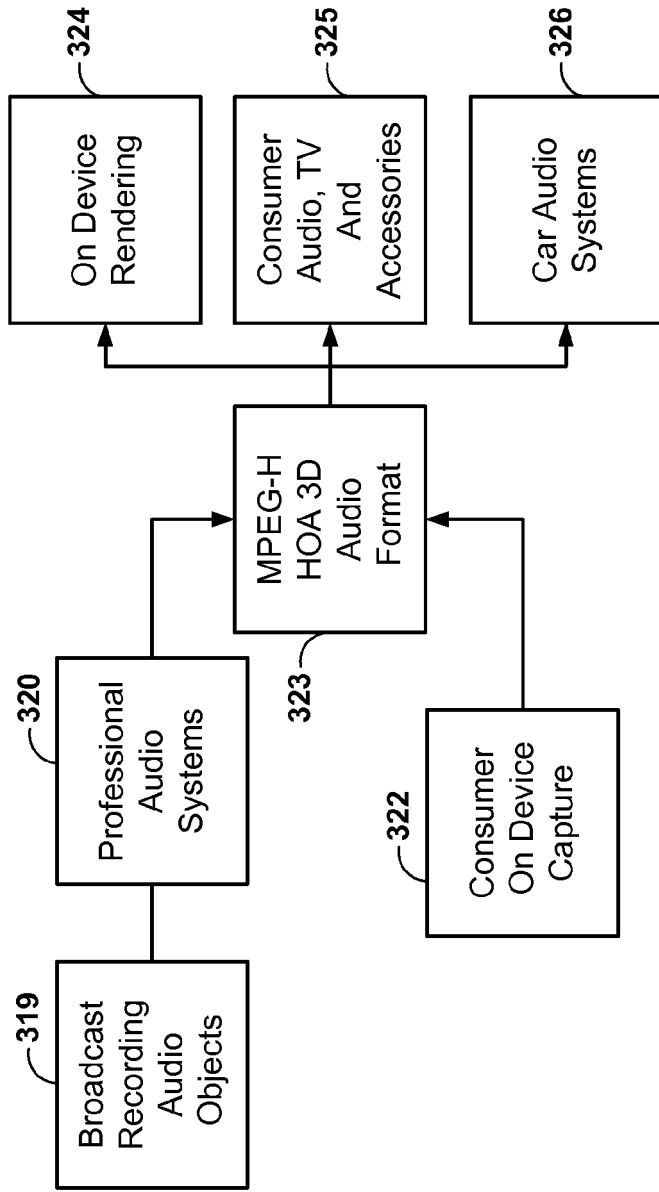


FIG. 14

300C

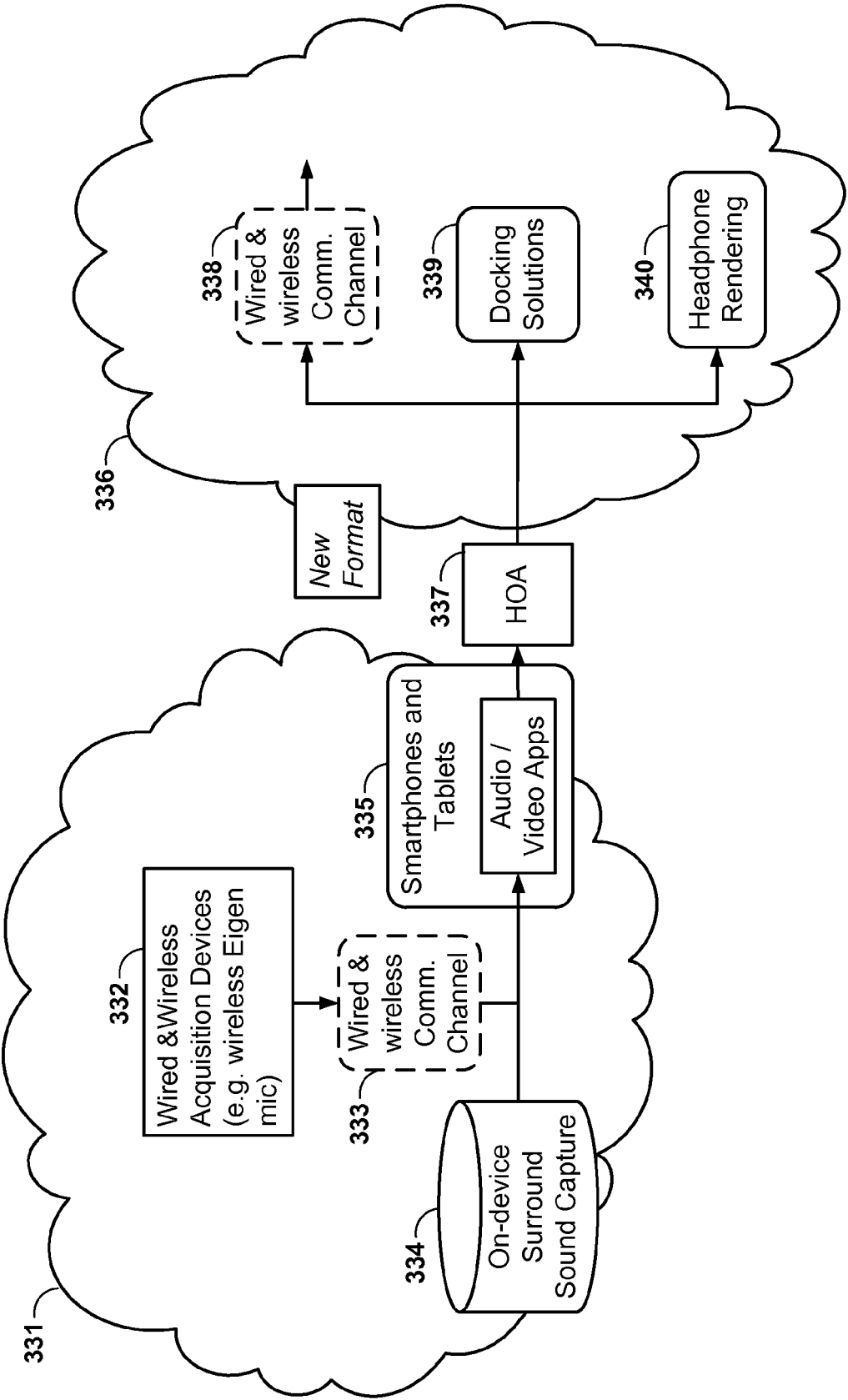


FIG. 15A

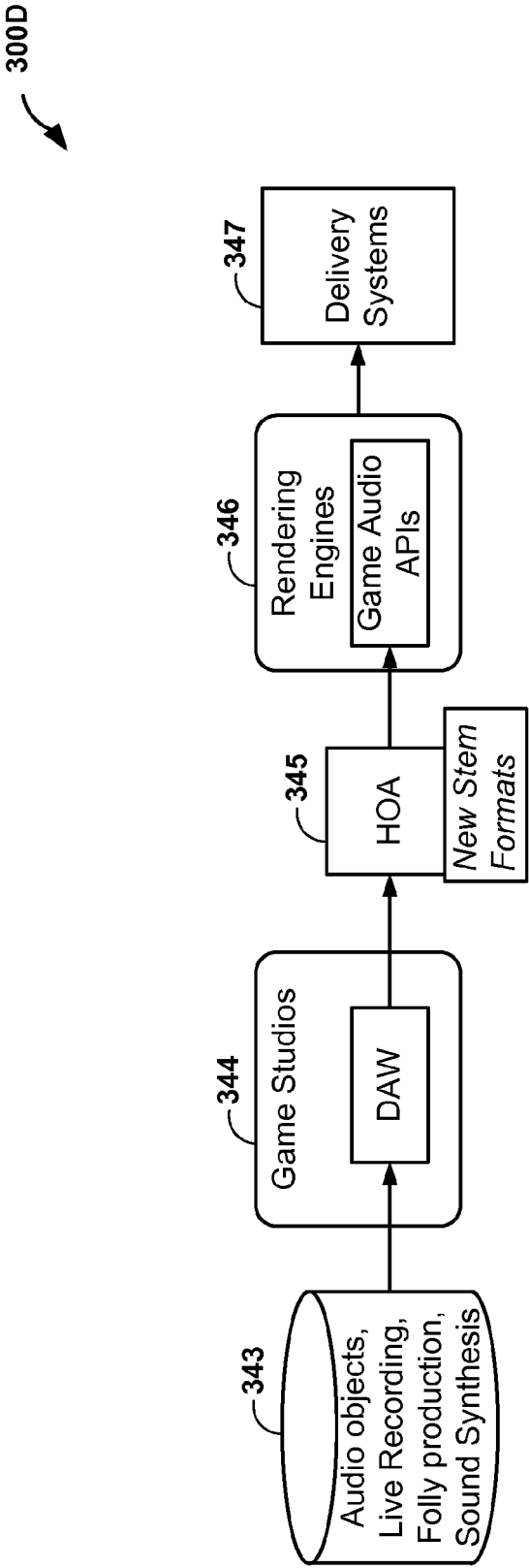


FIG. 15B

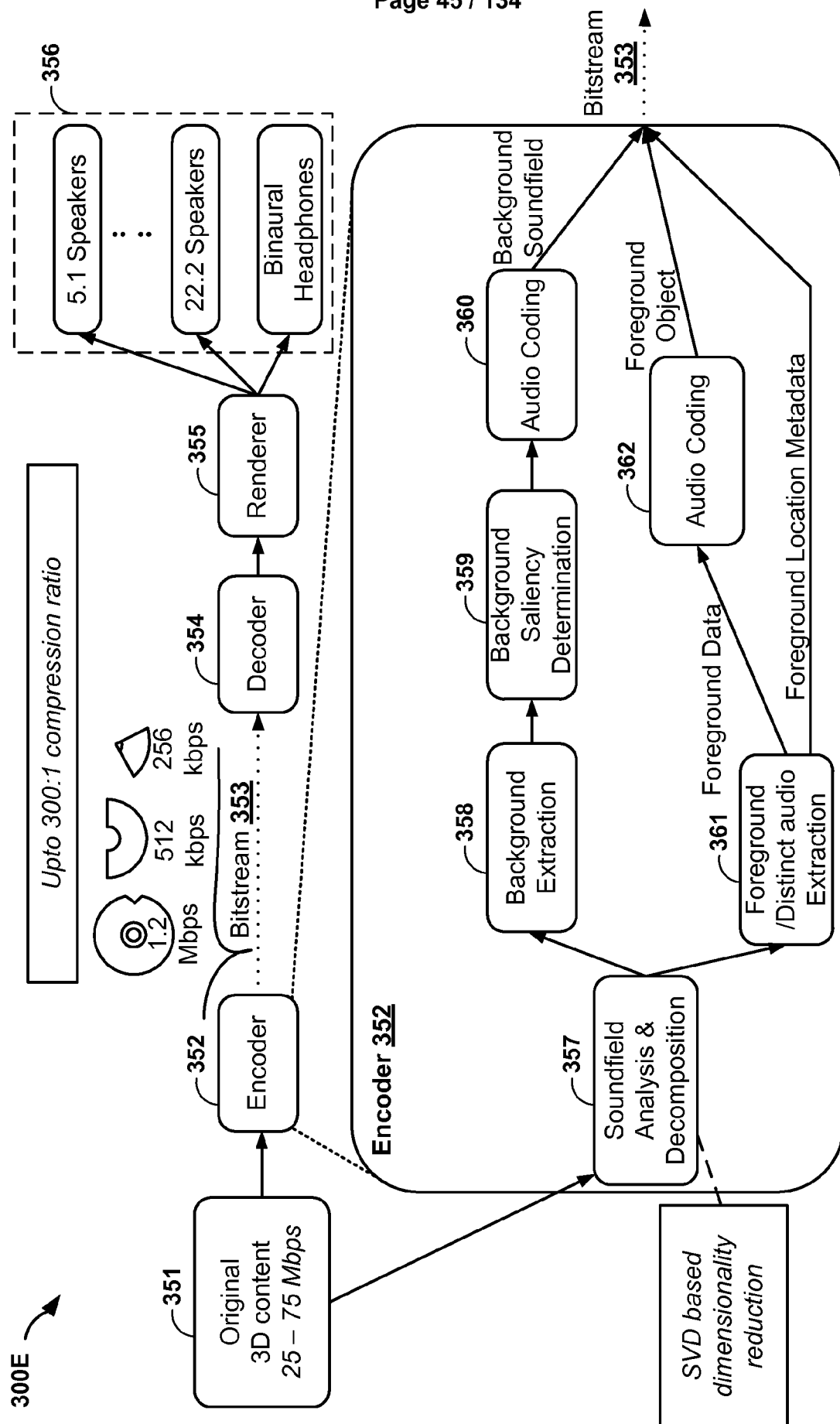


FIG. 16

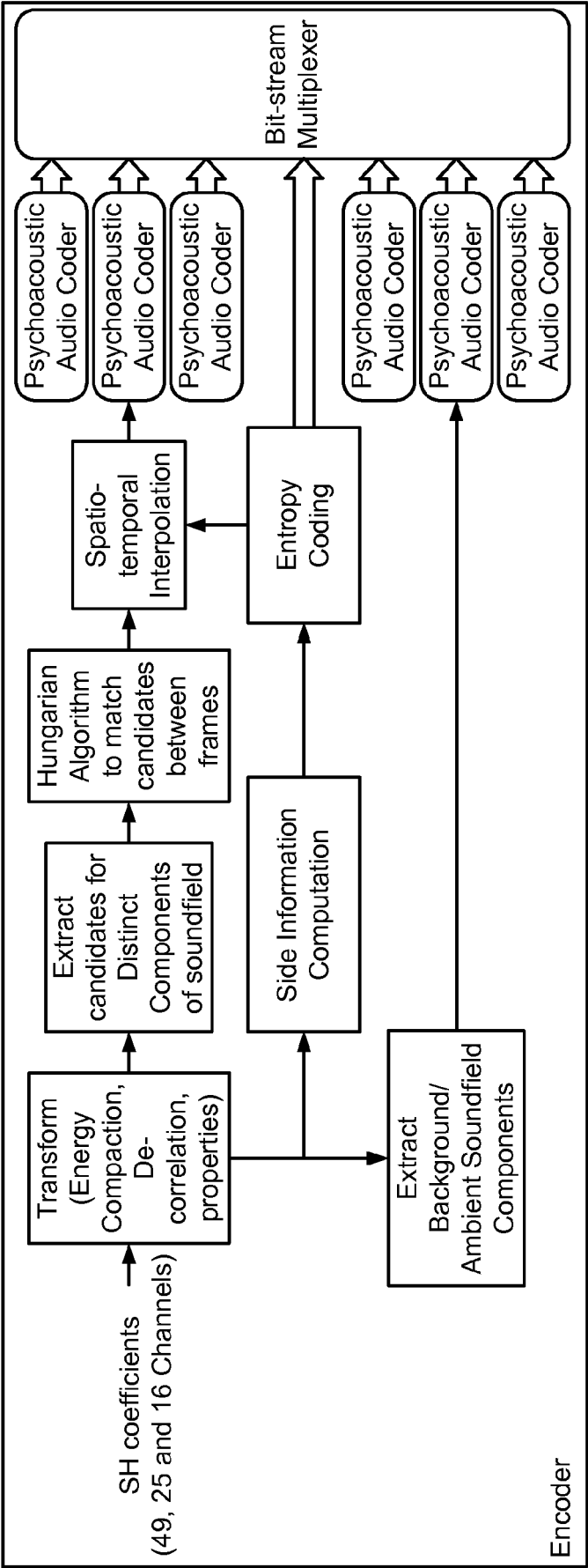


FIG. 17

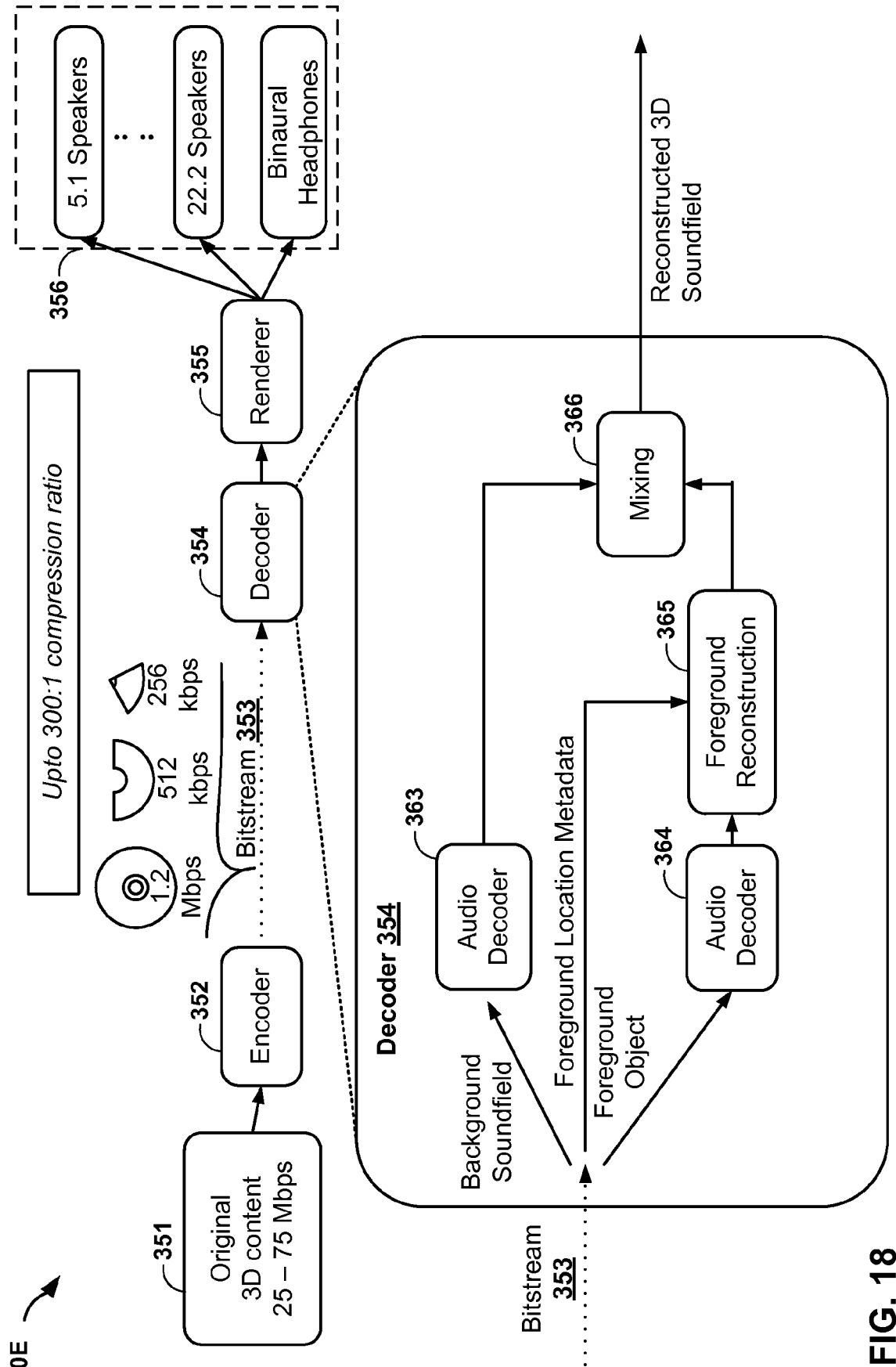


FIG. 18

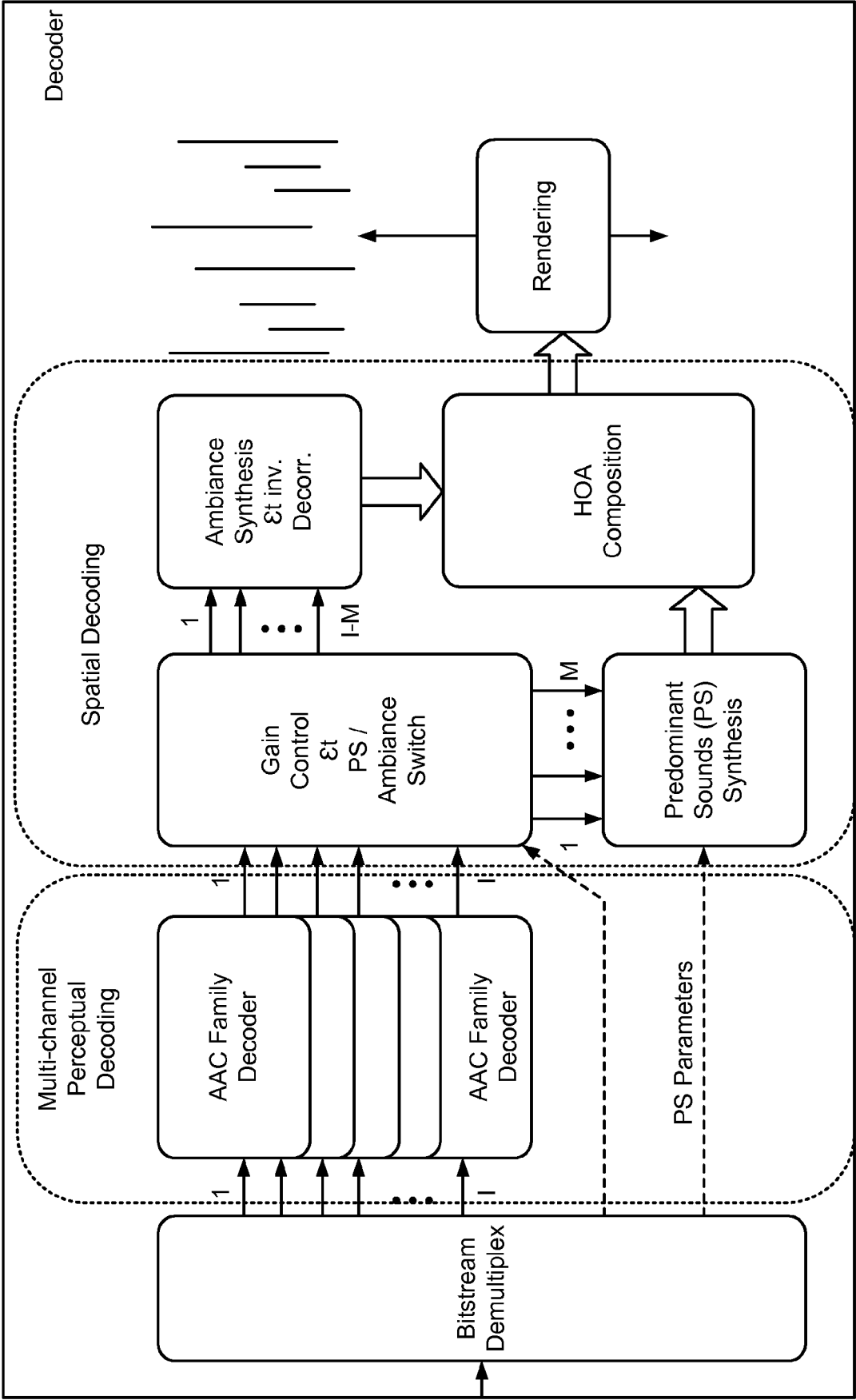


FIG. 19

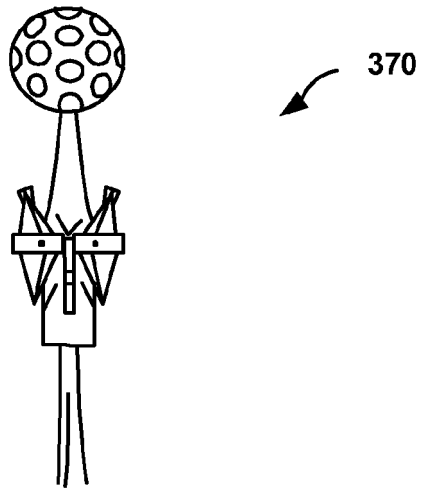


FIG. 20A

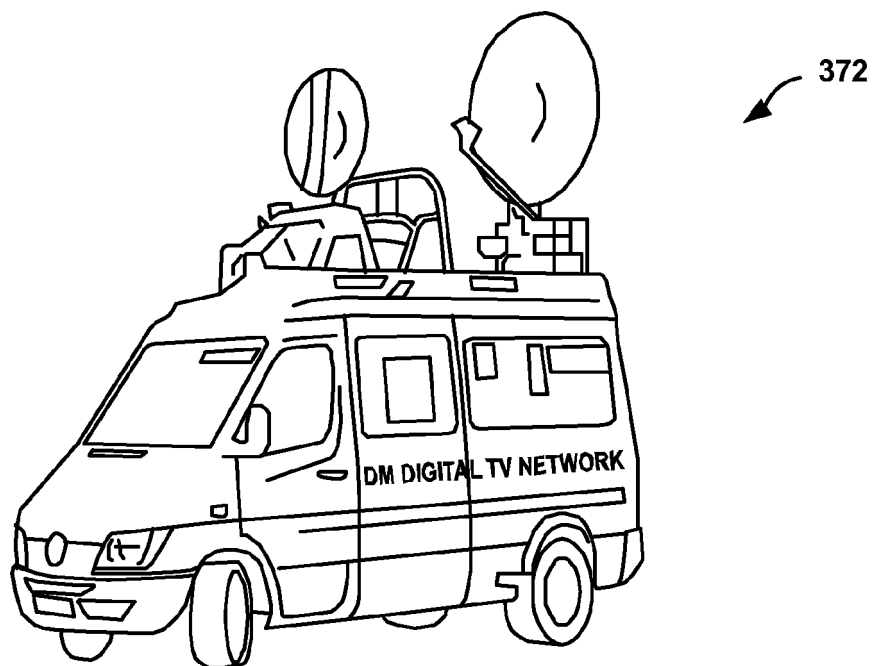


FIG. 20B

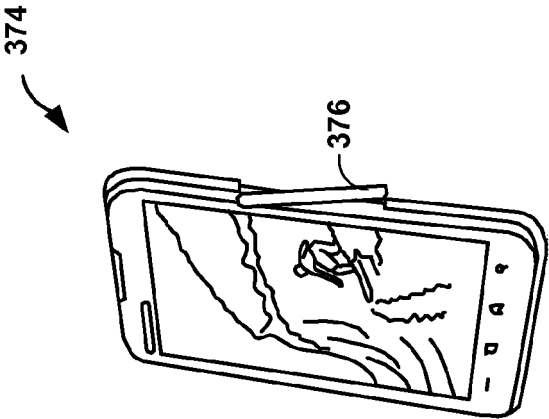


FIG. 20C

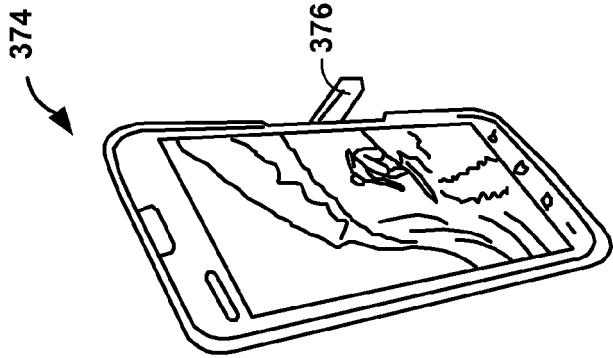


FIG. 20D

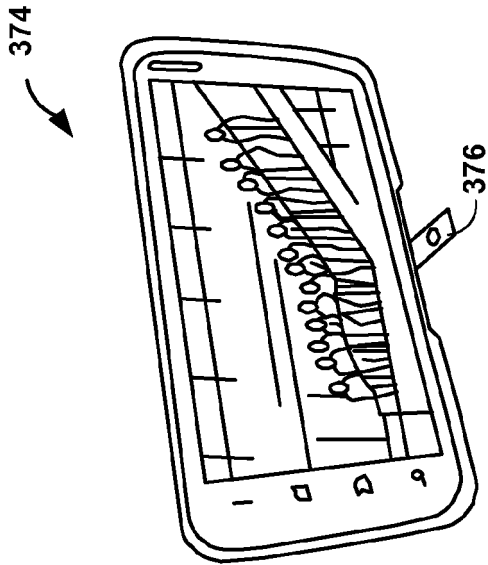


FIG. 20E

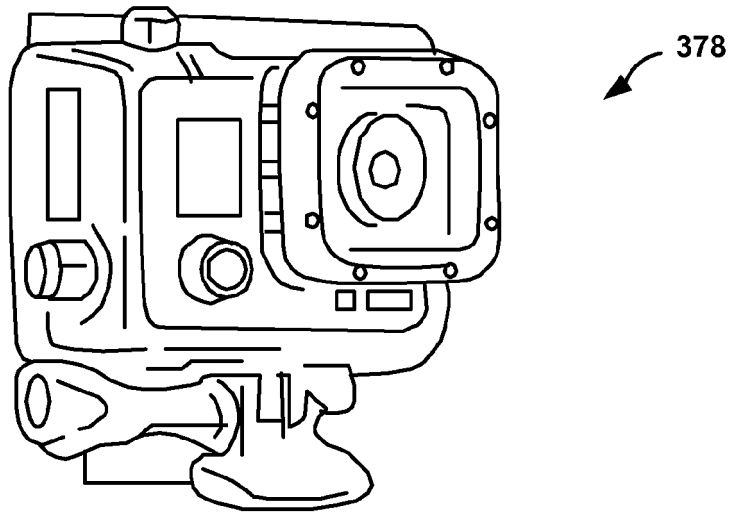


FIG. 20F

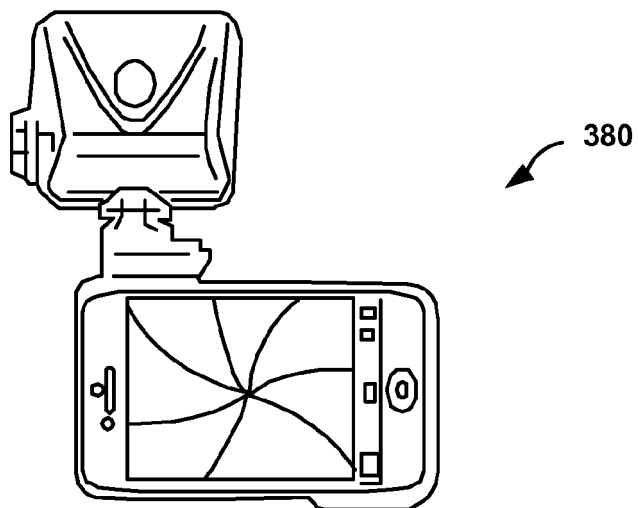


FIG. 20G

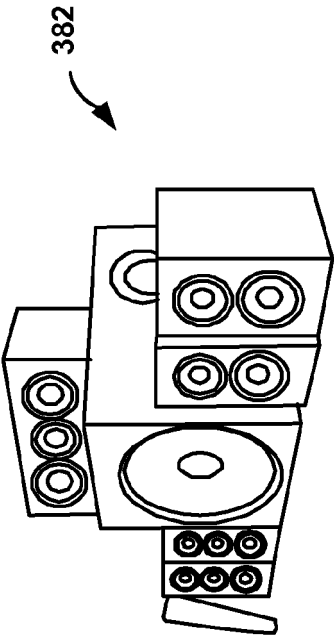


FIG. 21A

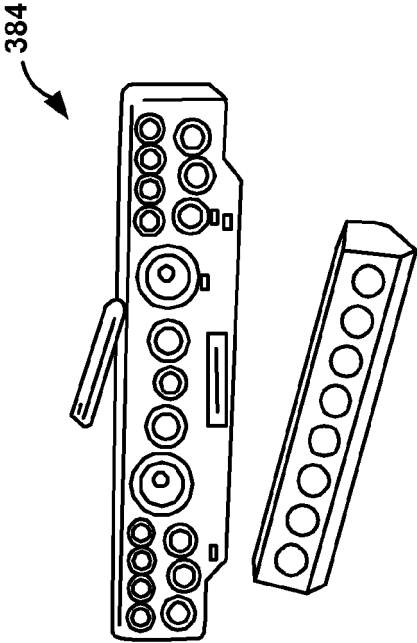


FIG. 21B

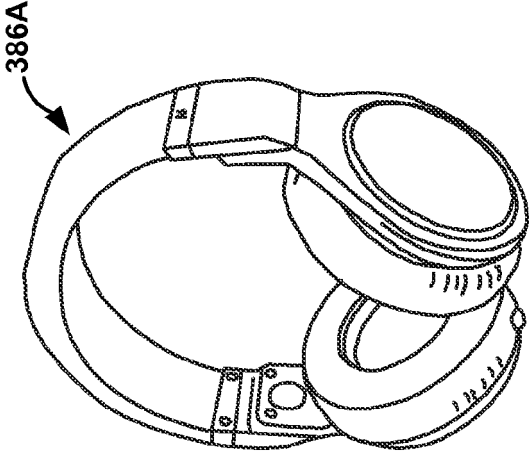


FIG. 21C

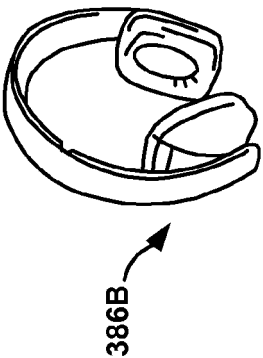


FIG. 21D

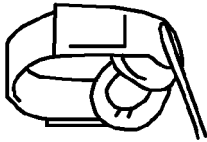


FIG. 21E

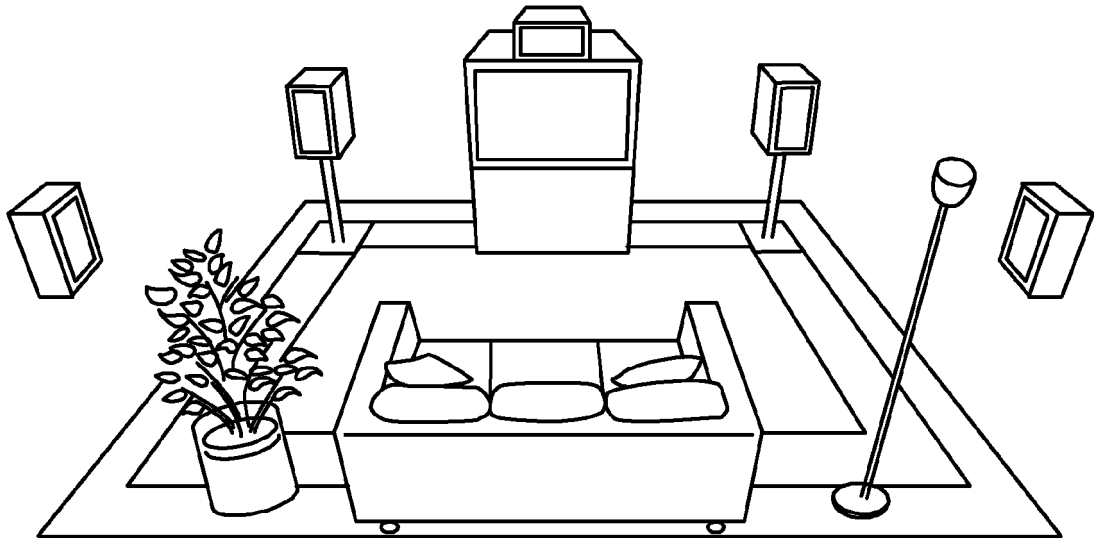


FIG. 22A

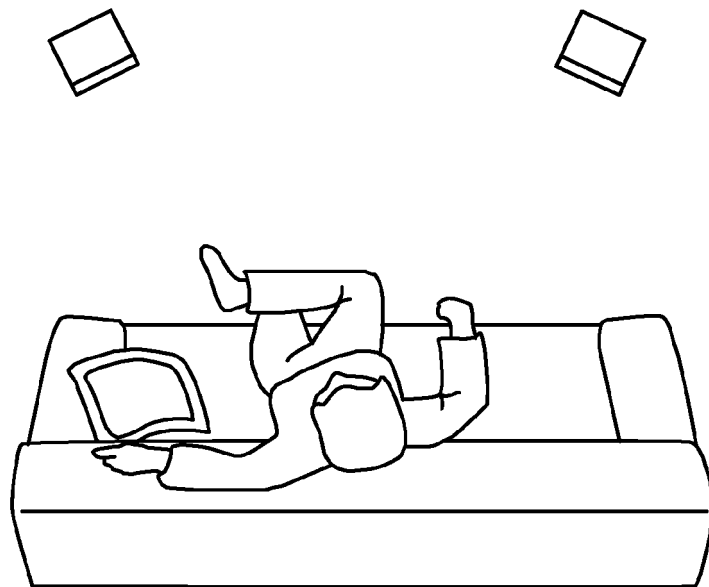
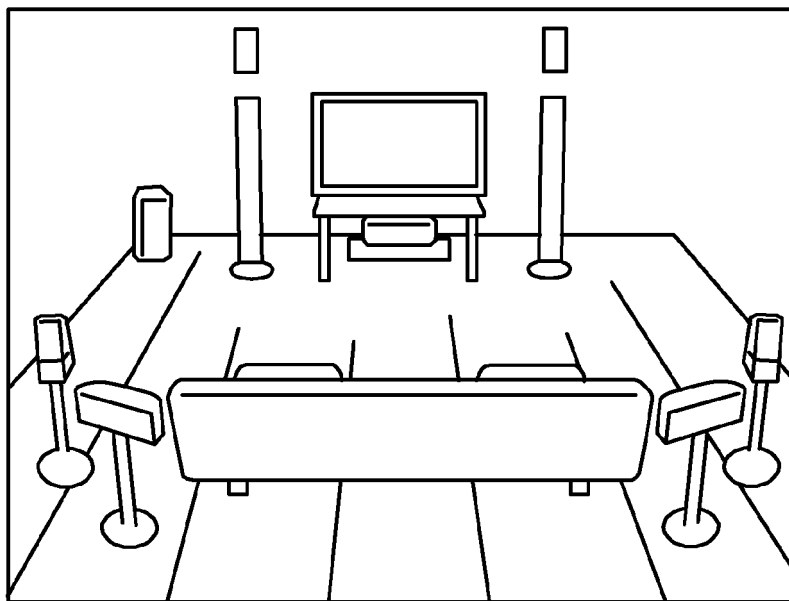
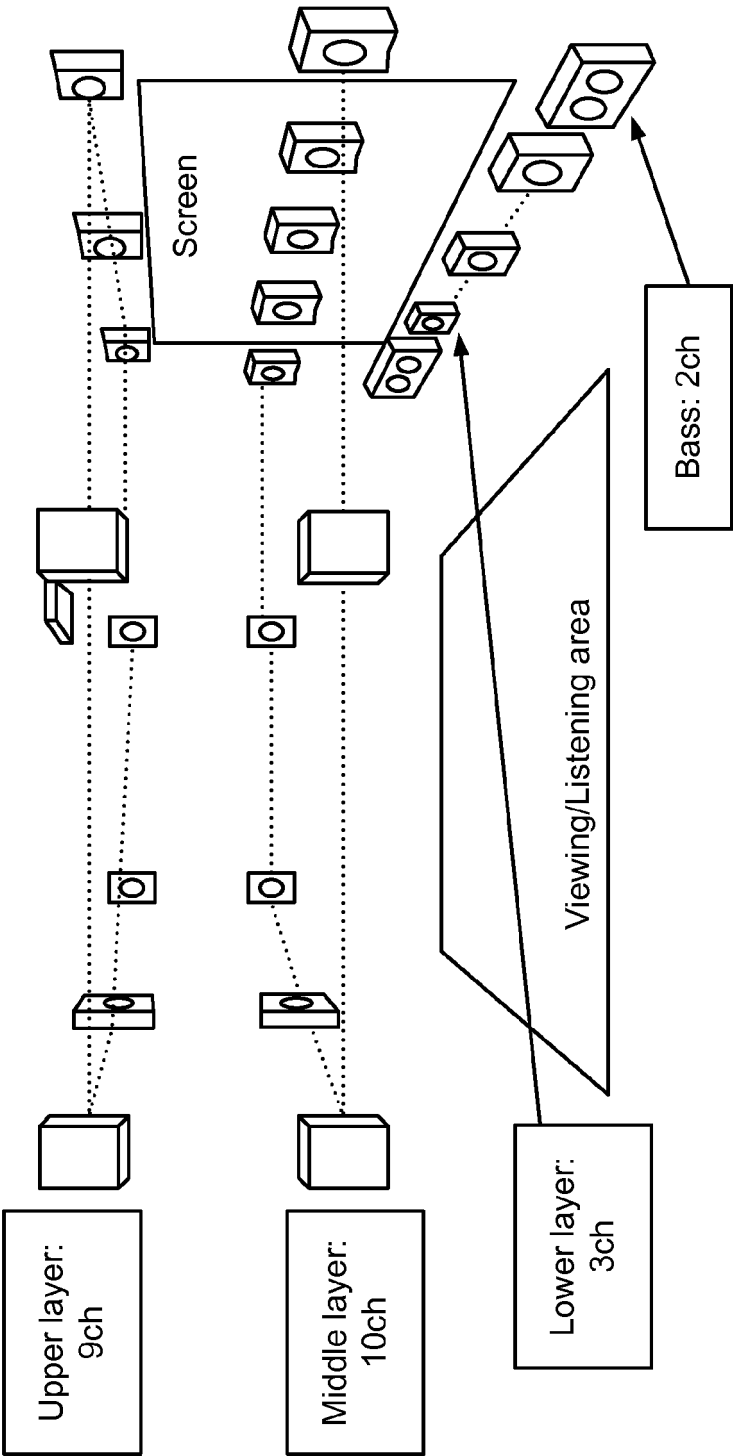


FIG. 22B



9.1 with full height

FIG. 22C



22.2

FIG. 22D

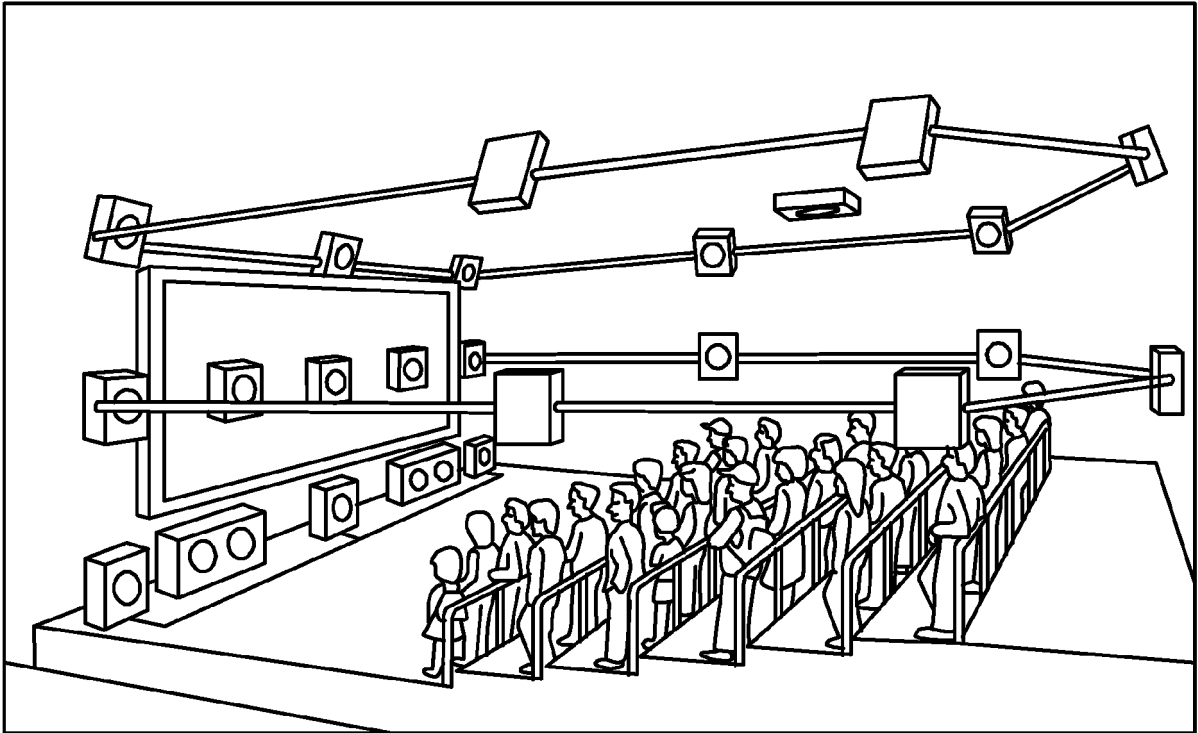


FIG. 22E

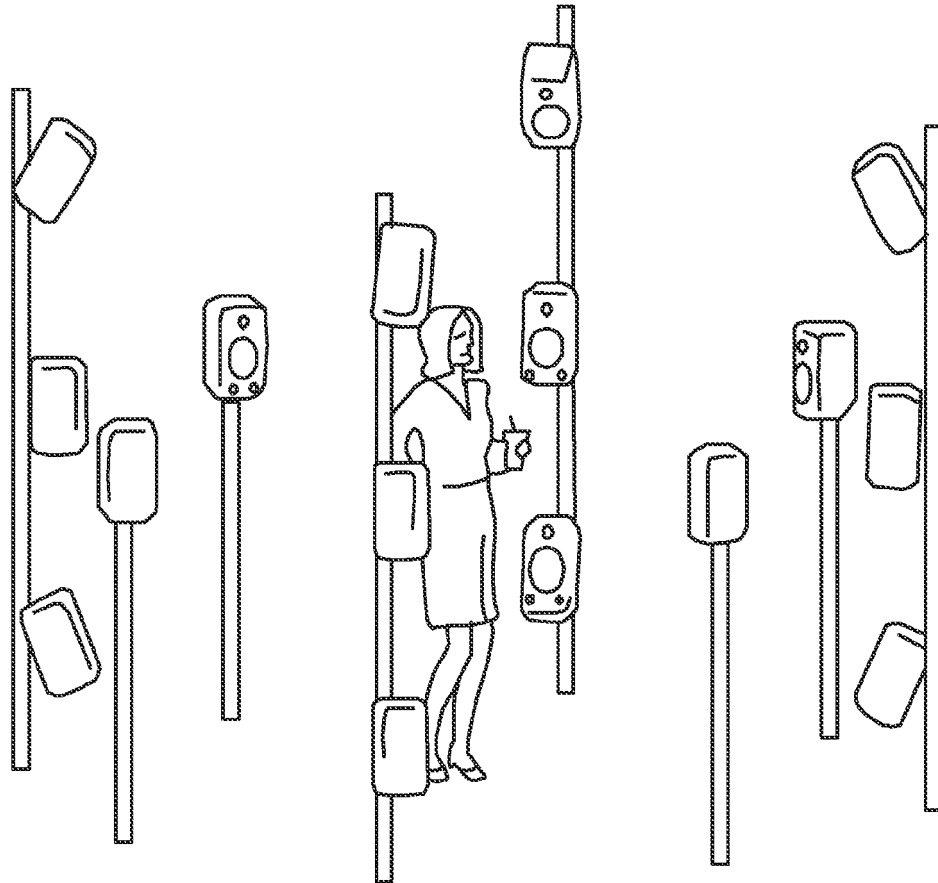


FIG. 22F

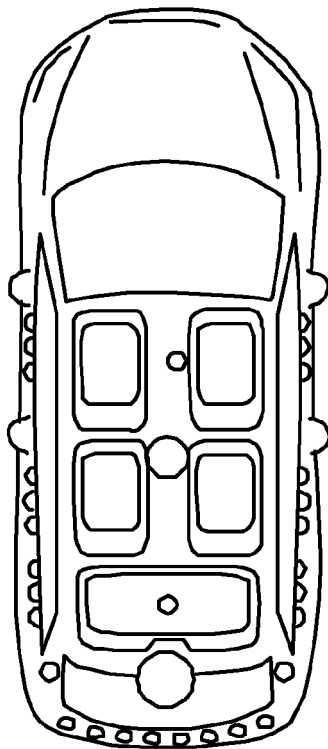


FIG. 22G

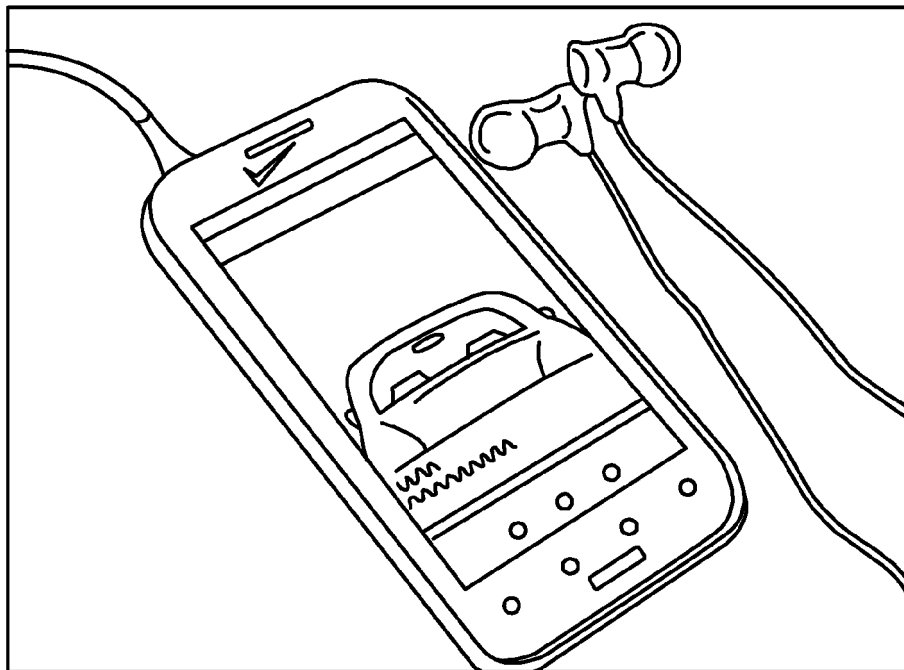


FIG. 22H

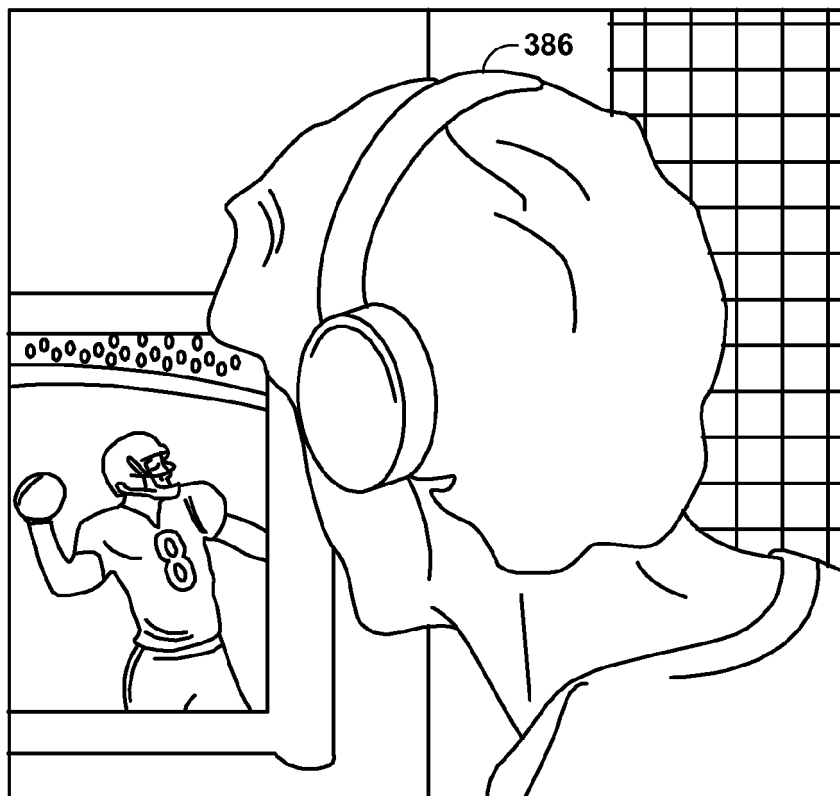


FIG. 23

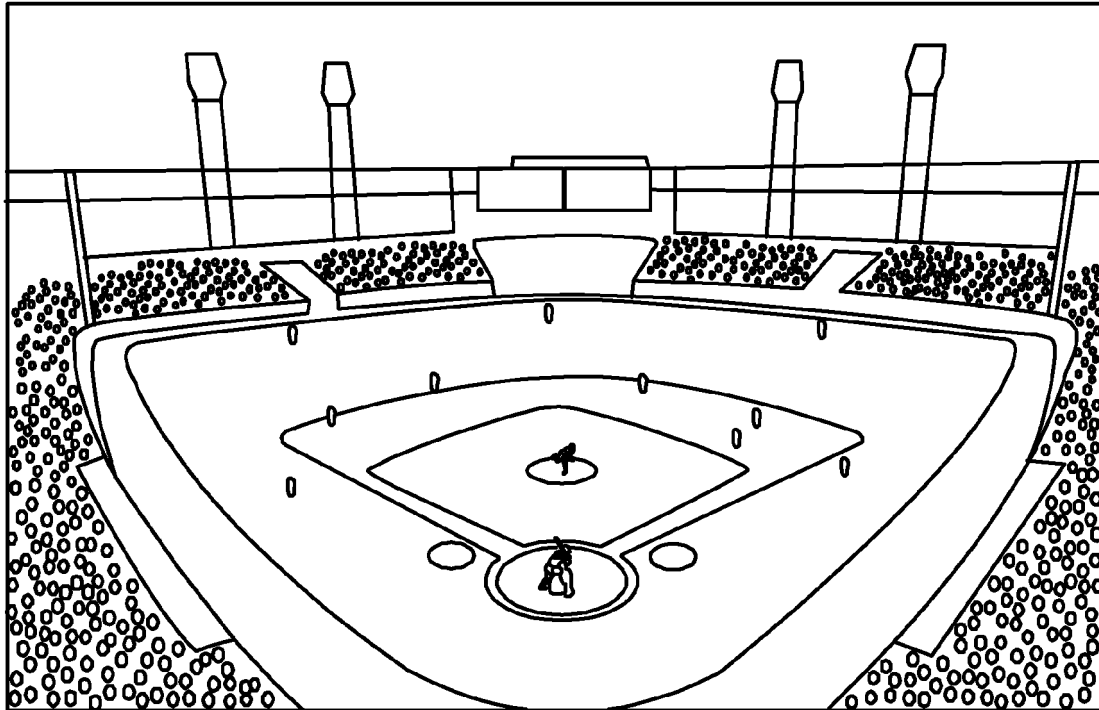


FIG. 24

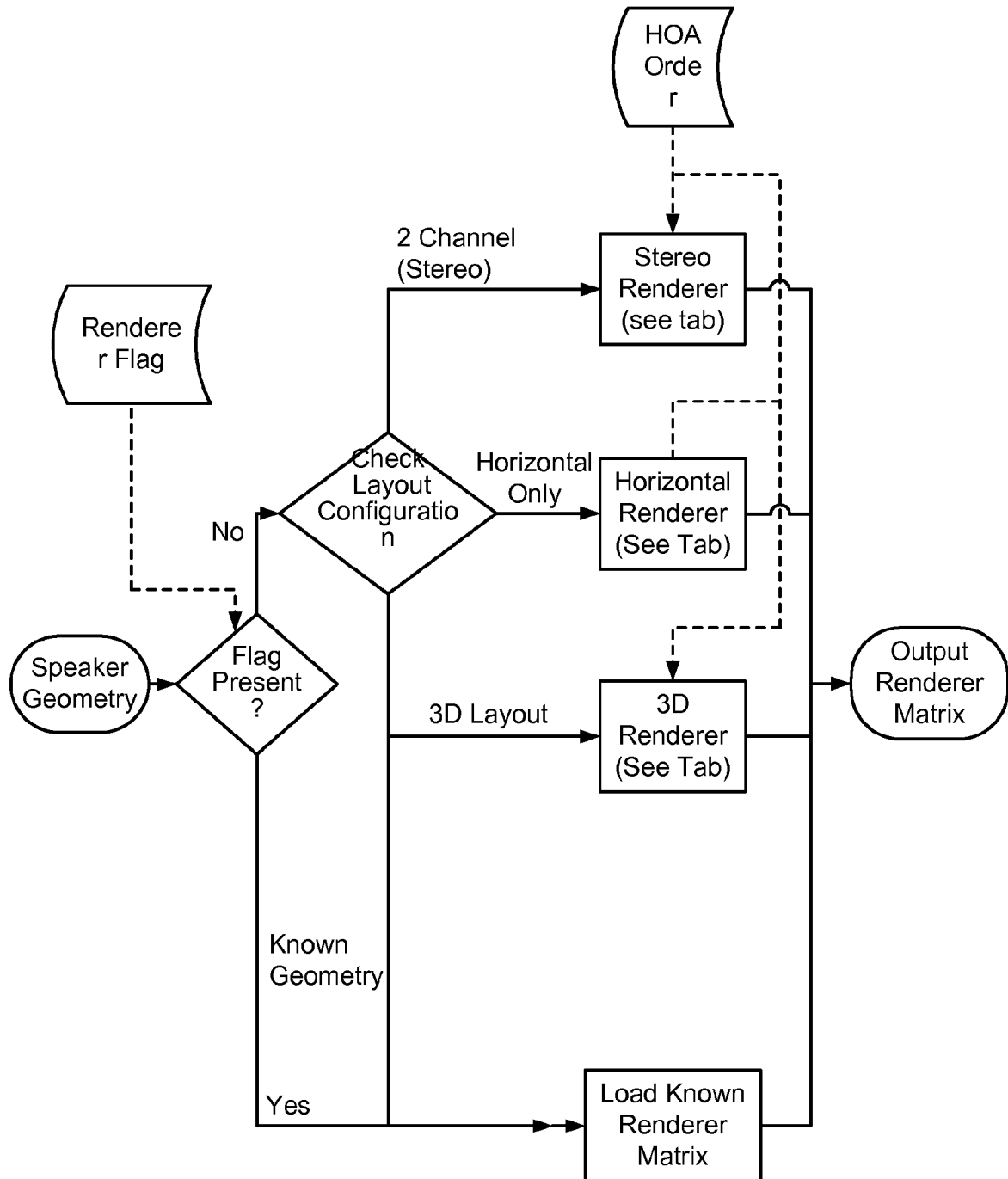


FIG. 25

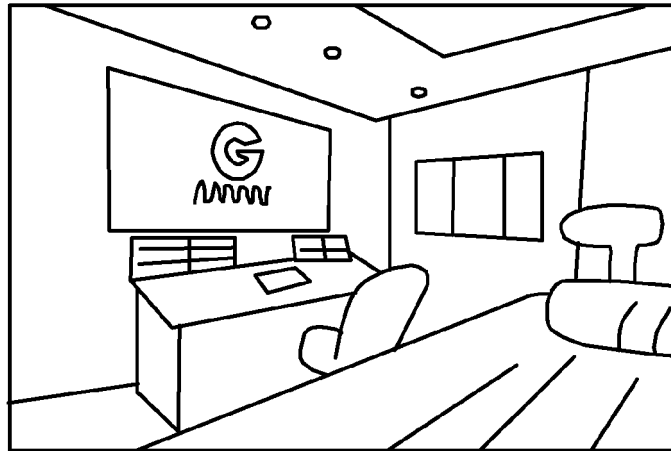


FIG. 26

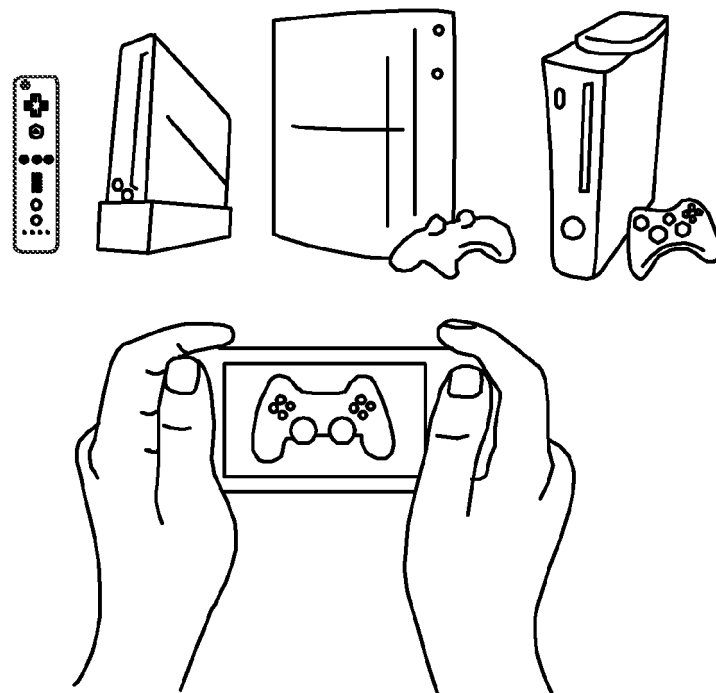


FIG. 27

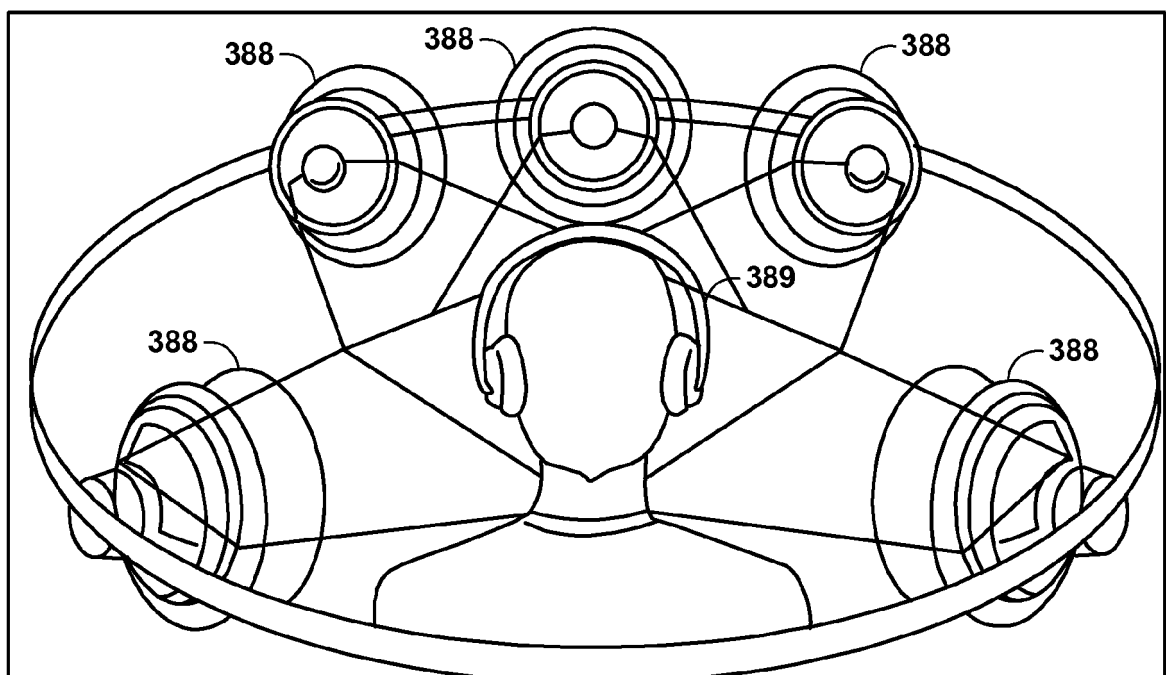


FIG. 28

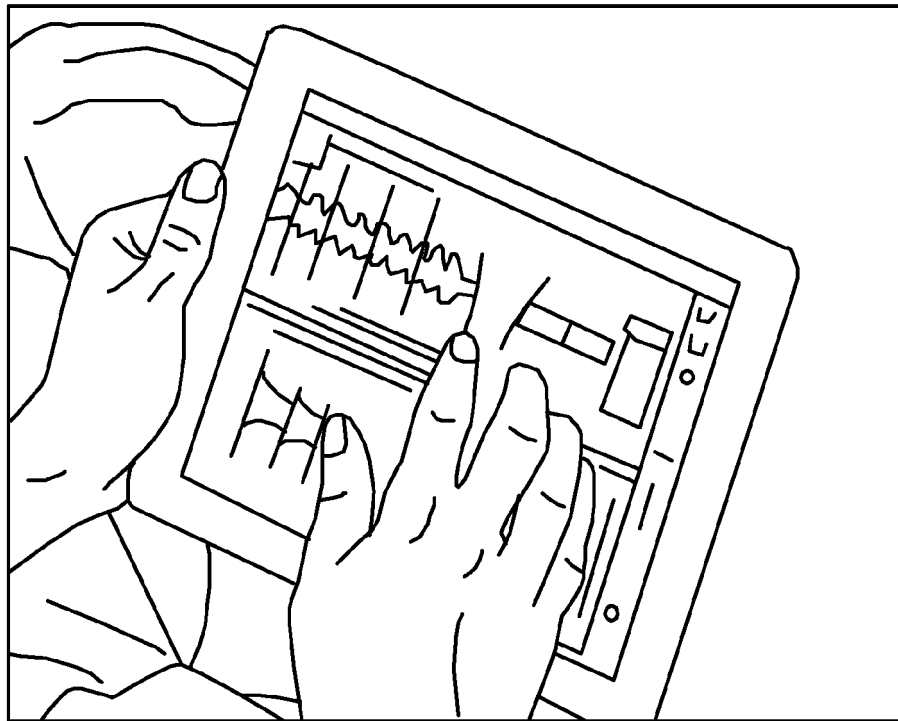
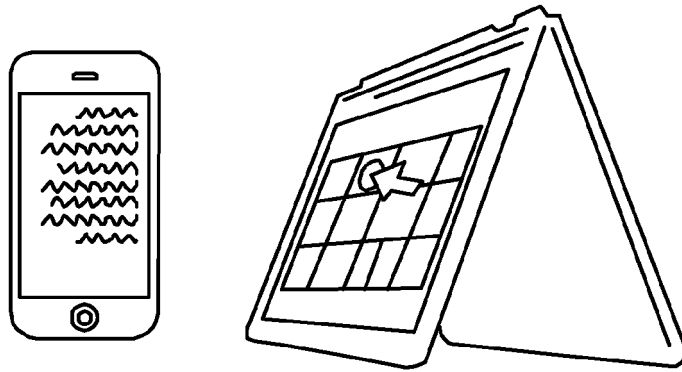


FIG. 29

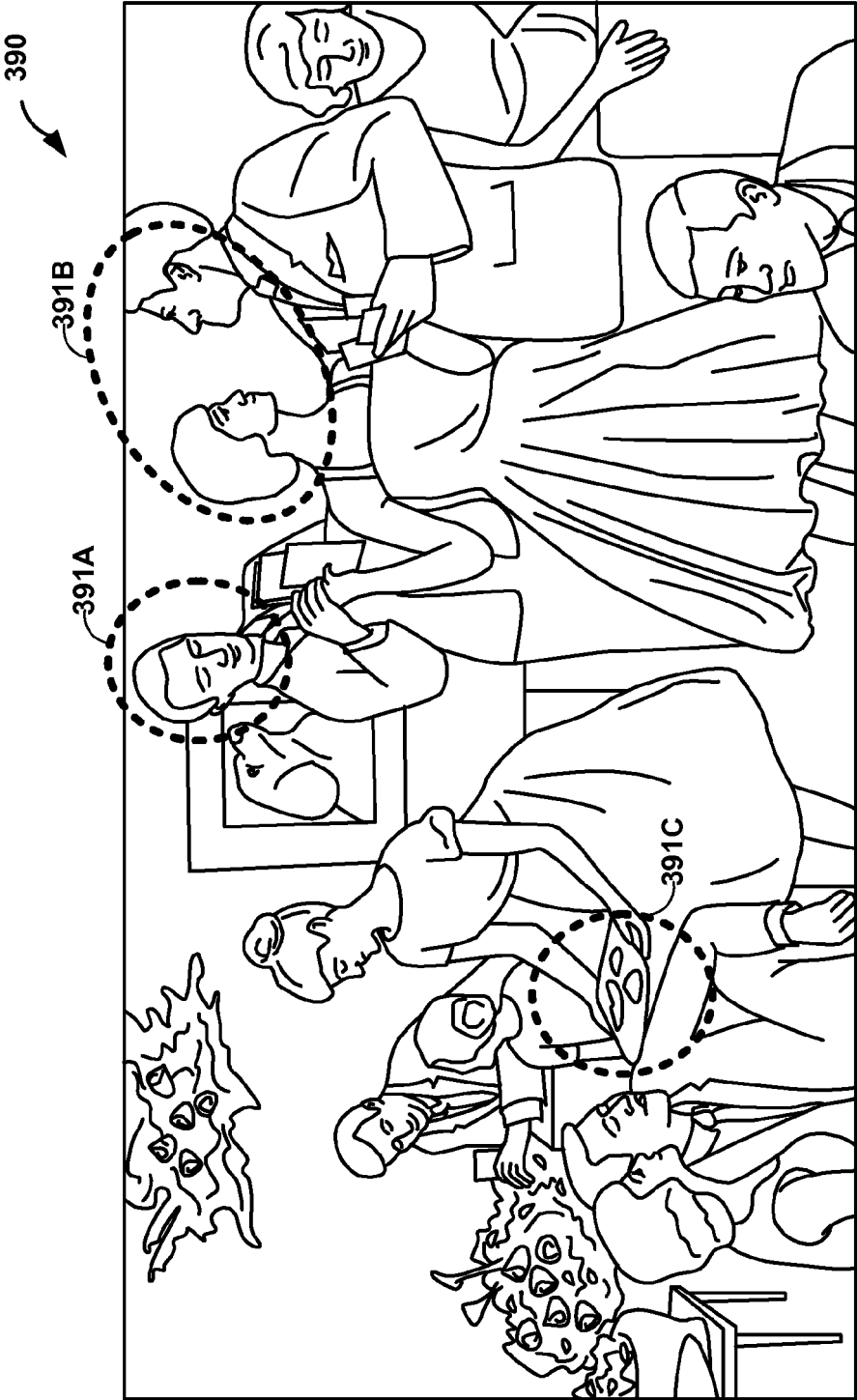


FIG. 30

Result of an automatic frame-by-frame classifier:
DATA >= THR(30) -> RMO Enc/Dec
DATA < THR(30) -> CE Enc/Dec

400A

ITEM 1

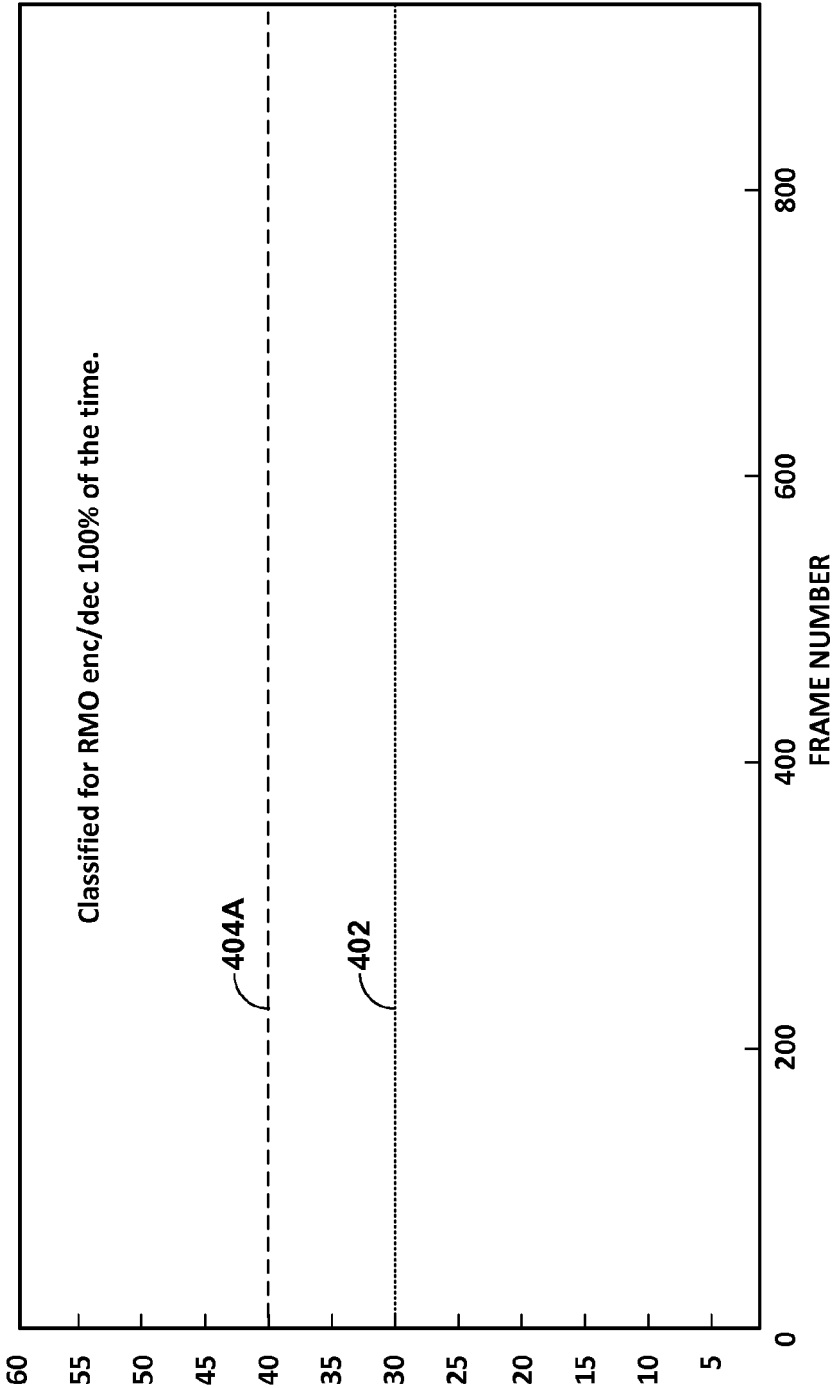


FIG. 31A

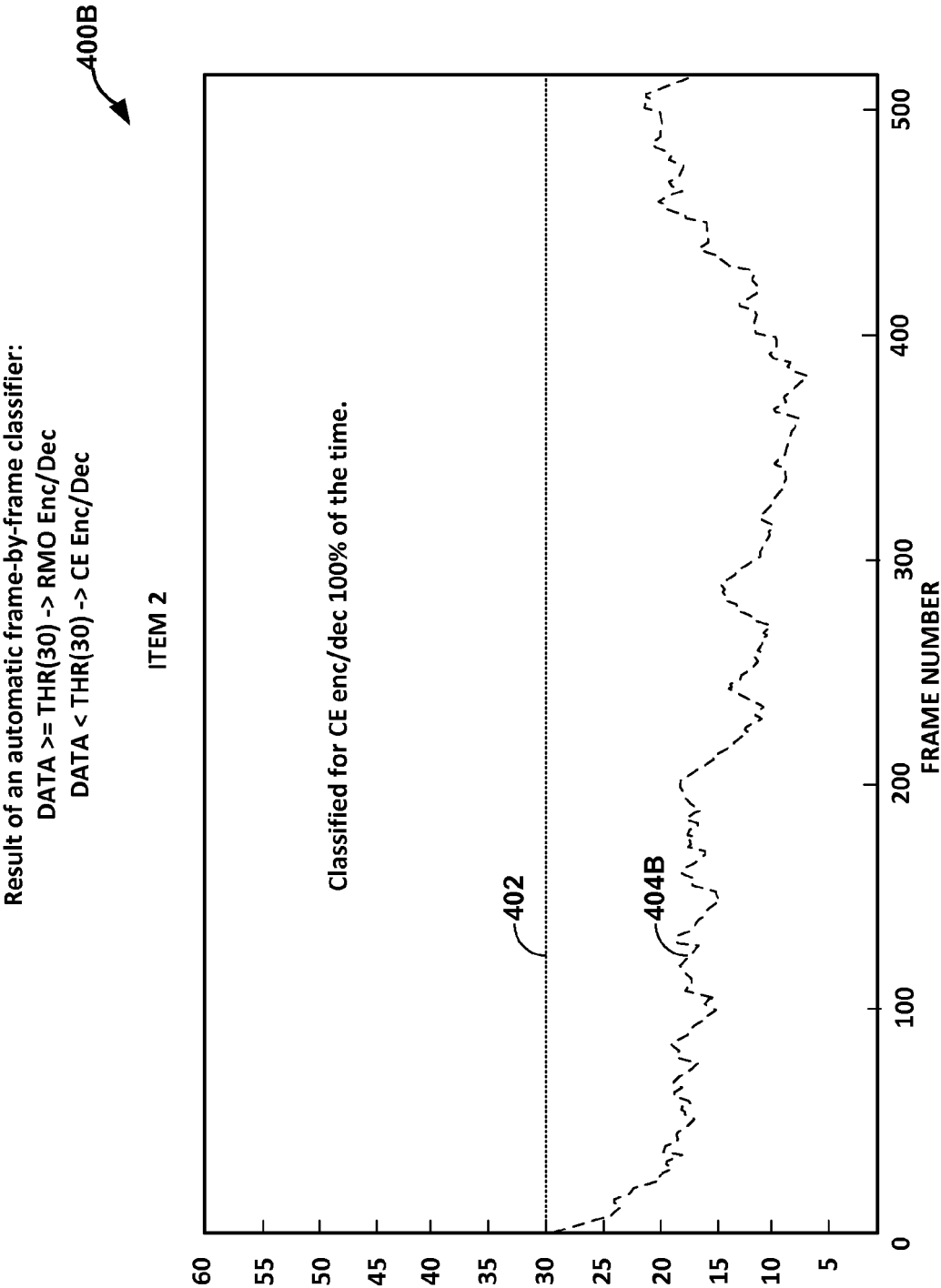


FIG. 31B

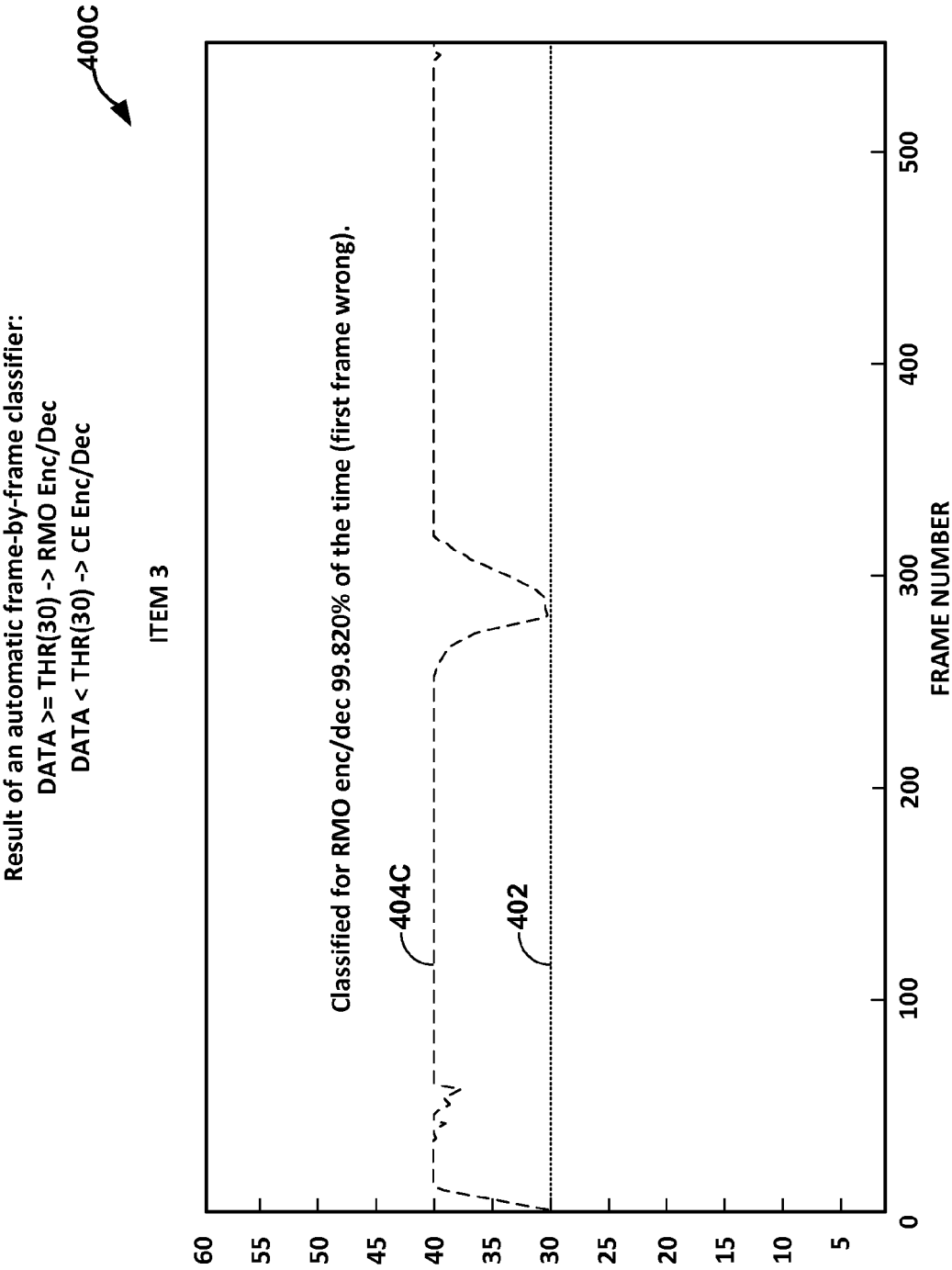


FIG. 31C

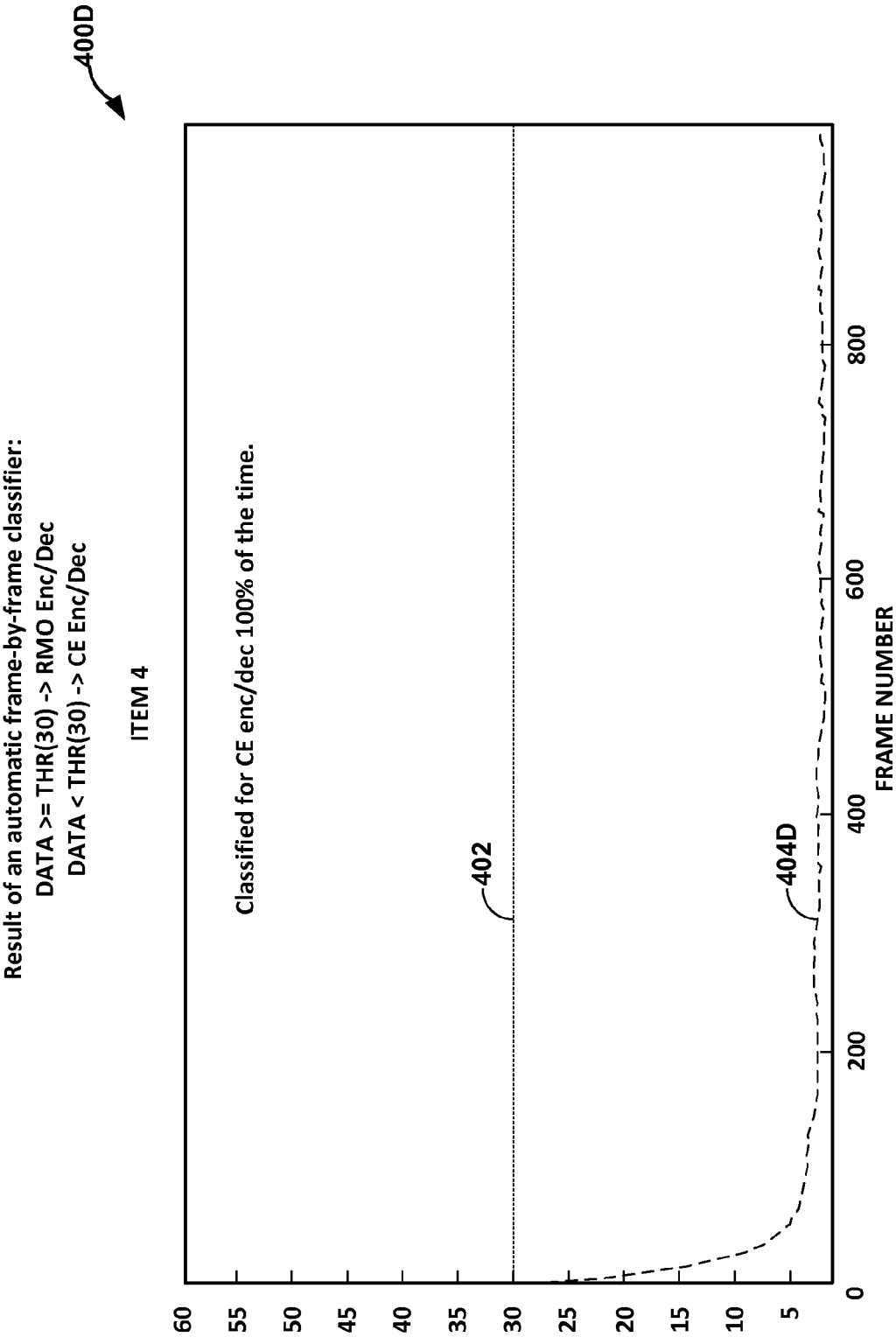


FIG. 31D

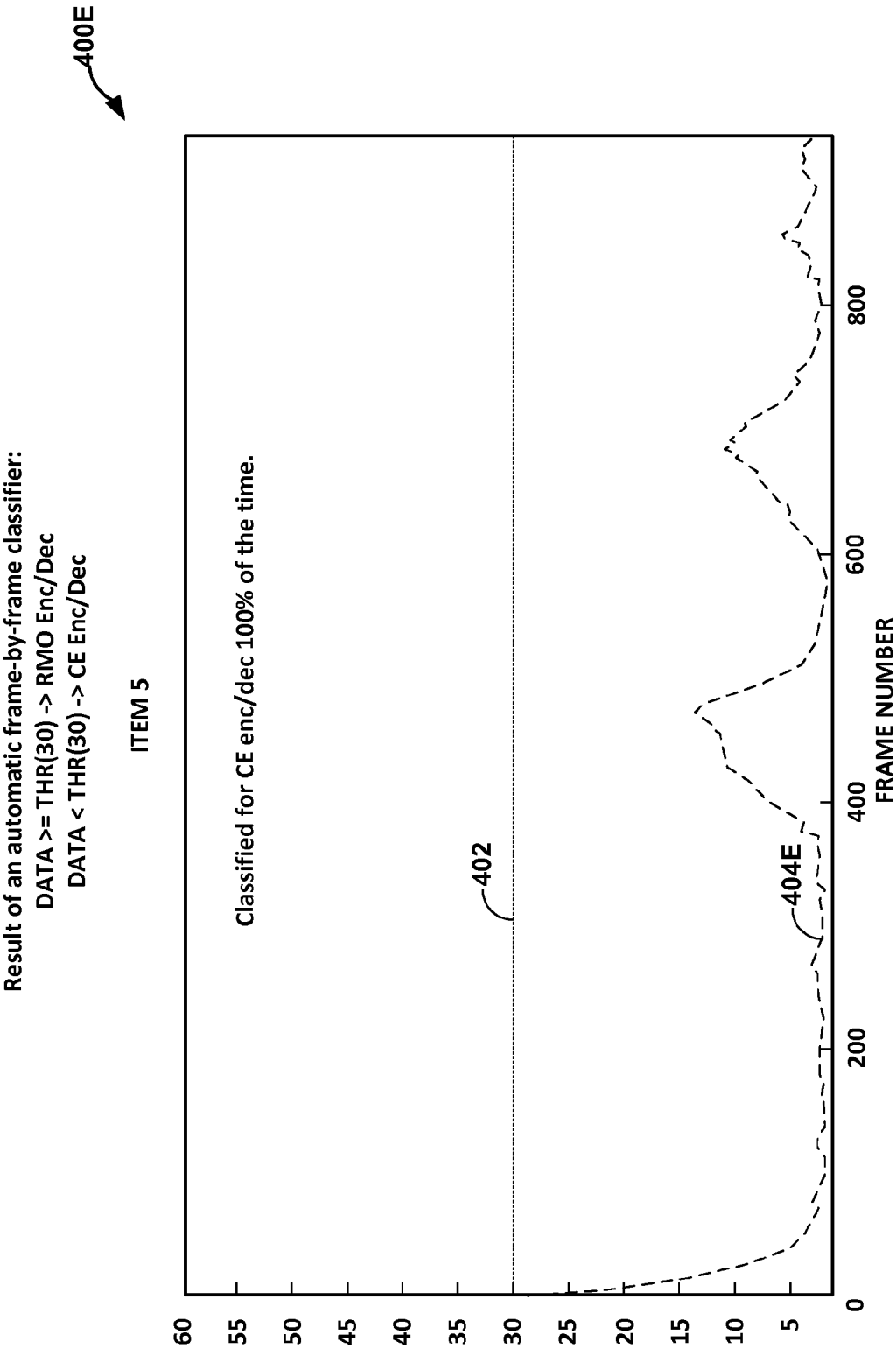


FIG. 31E

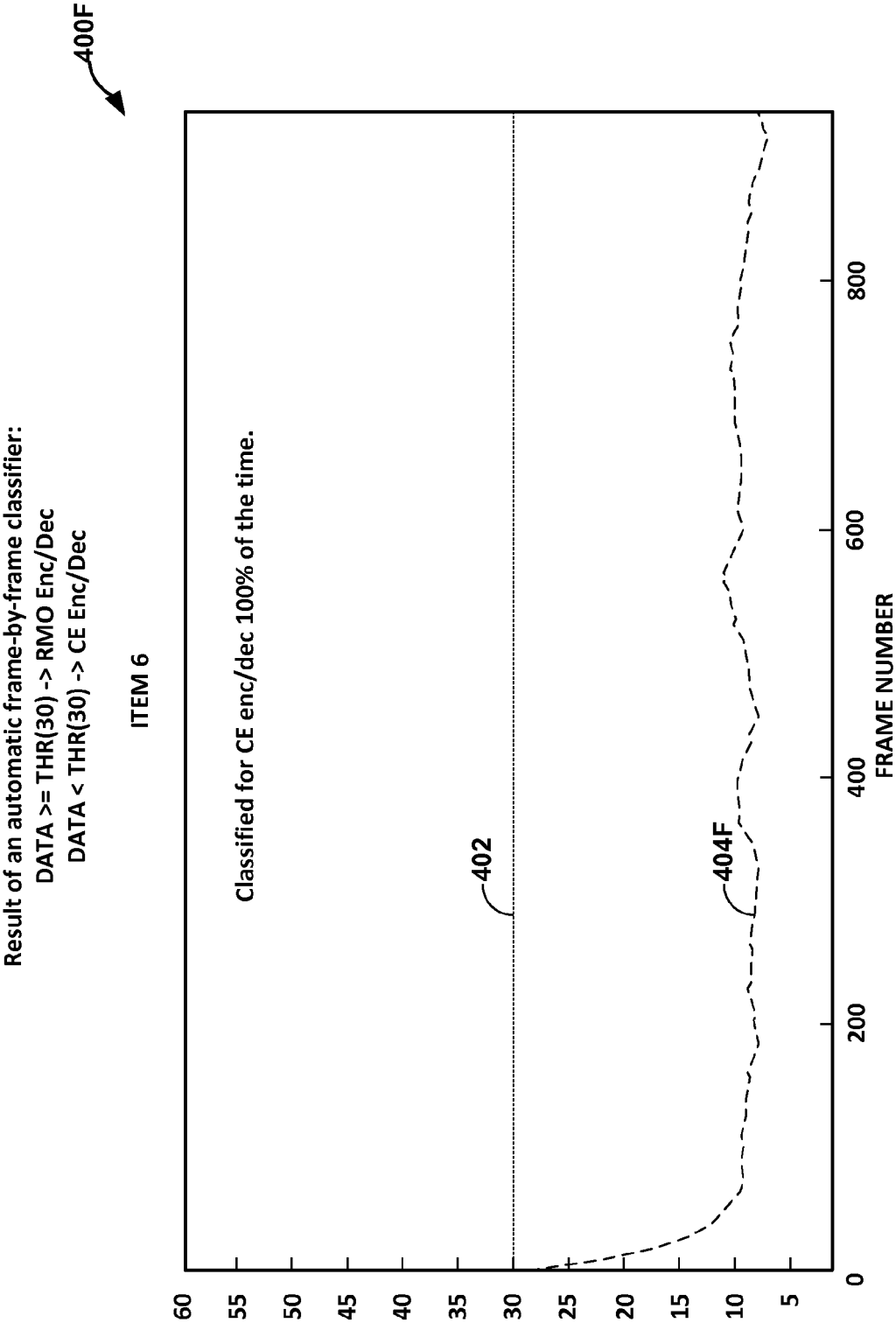


FIG. 31F

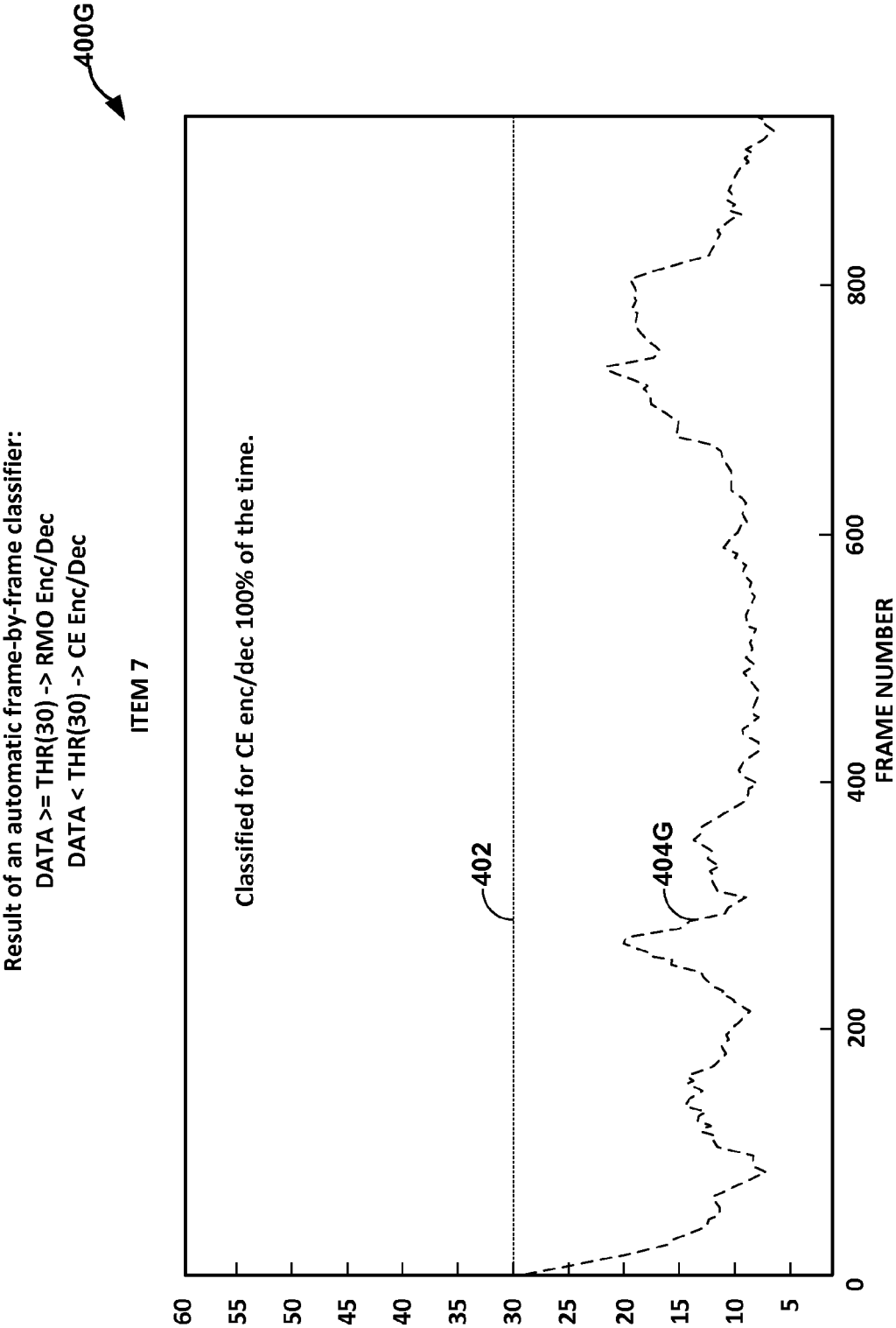


FIG. 31G

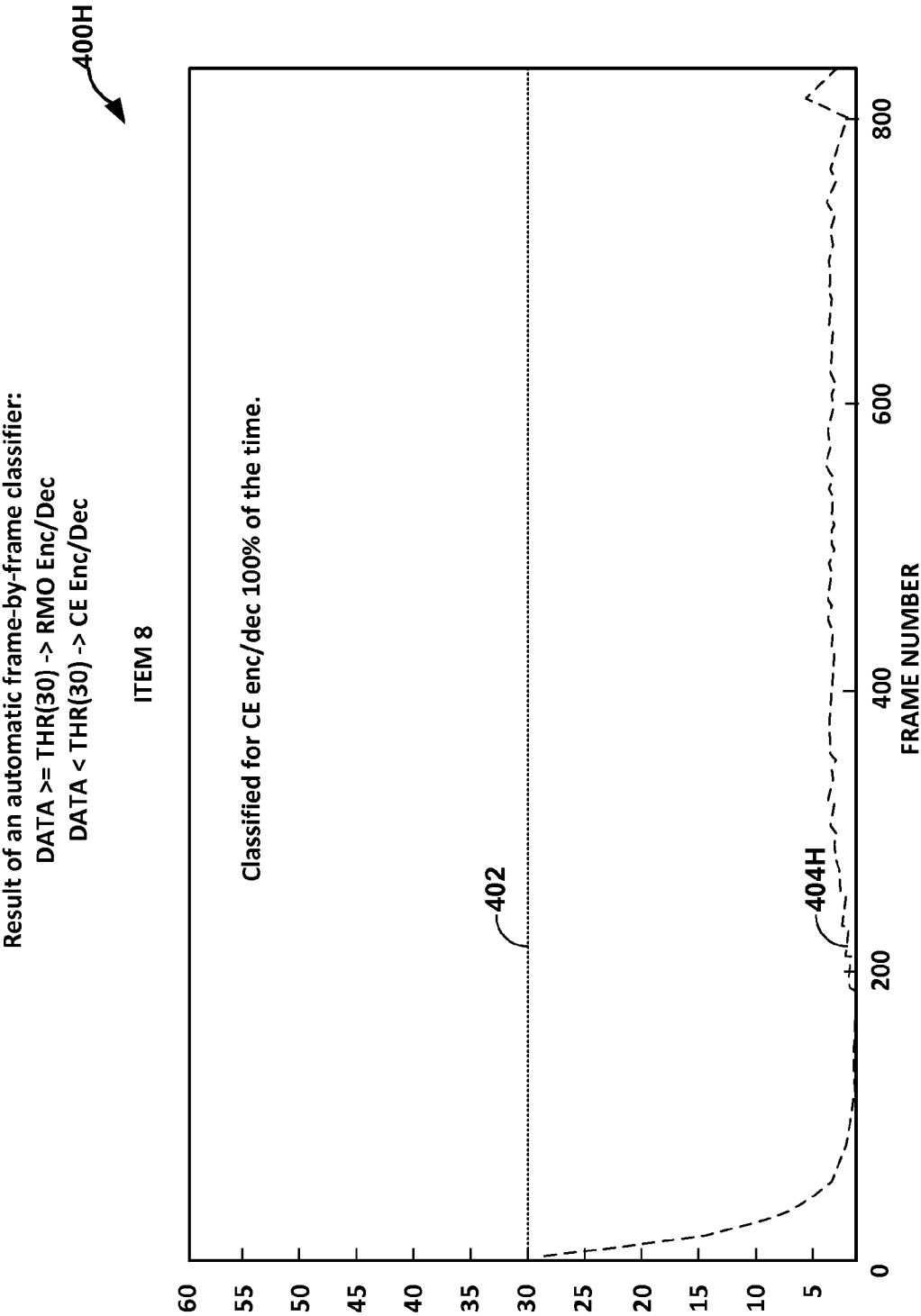


FIG. 31H

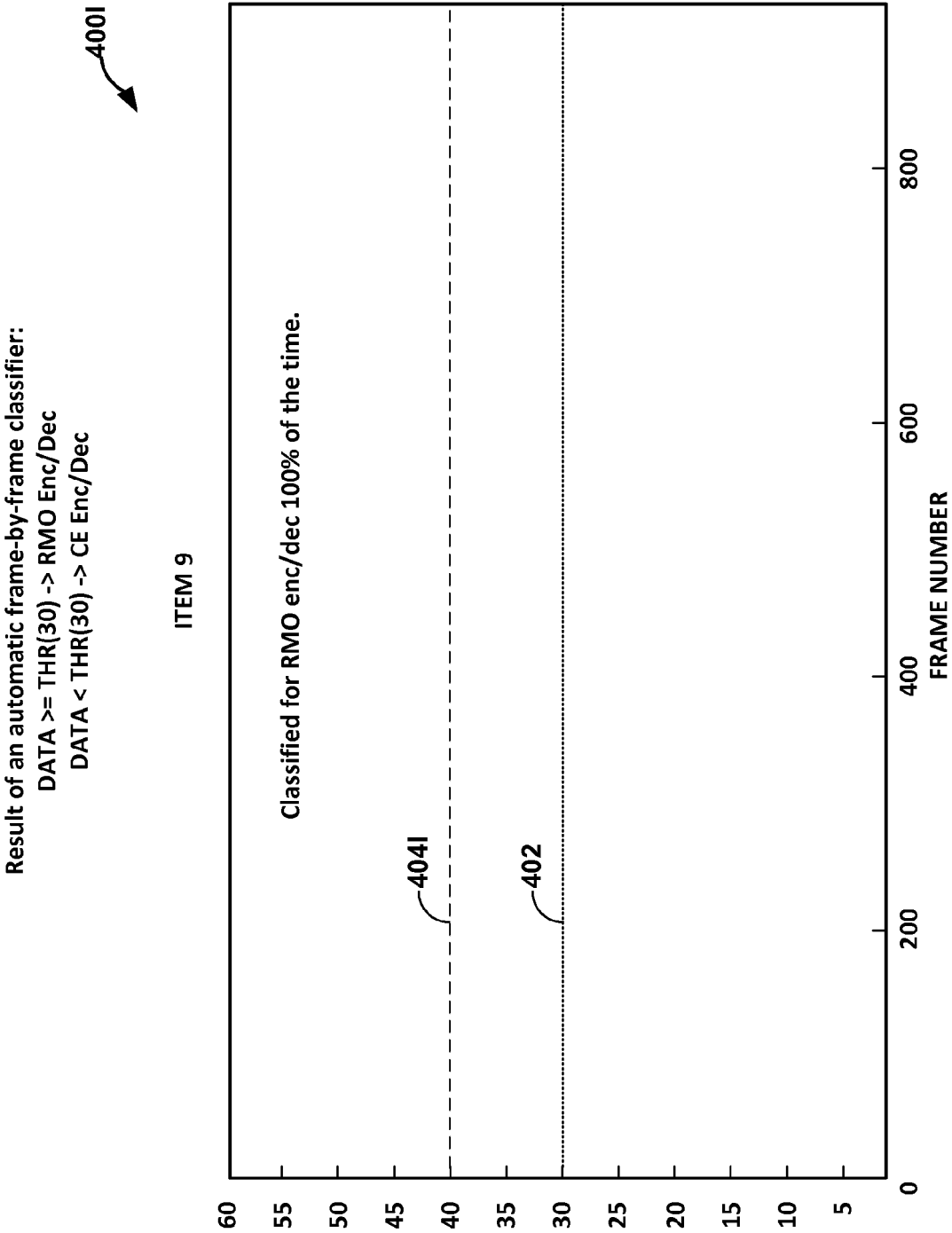


FIG. 31I

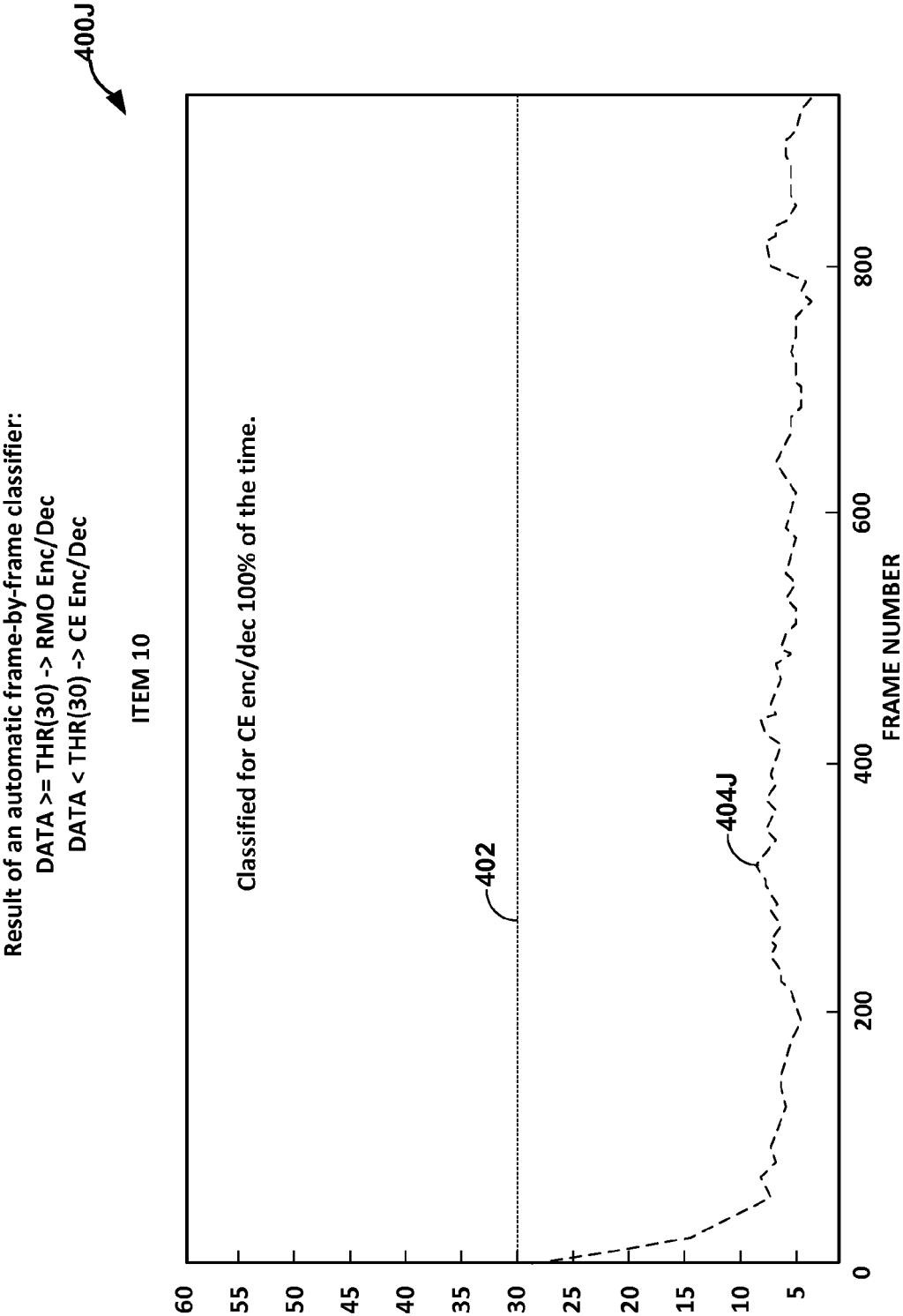


FIG. 31J

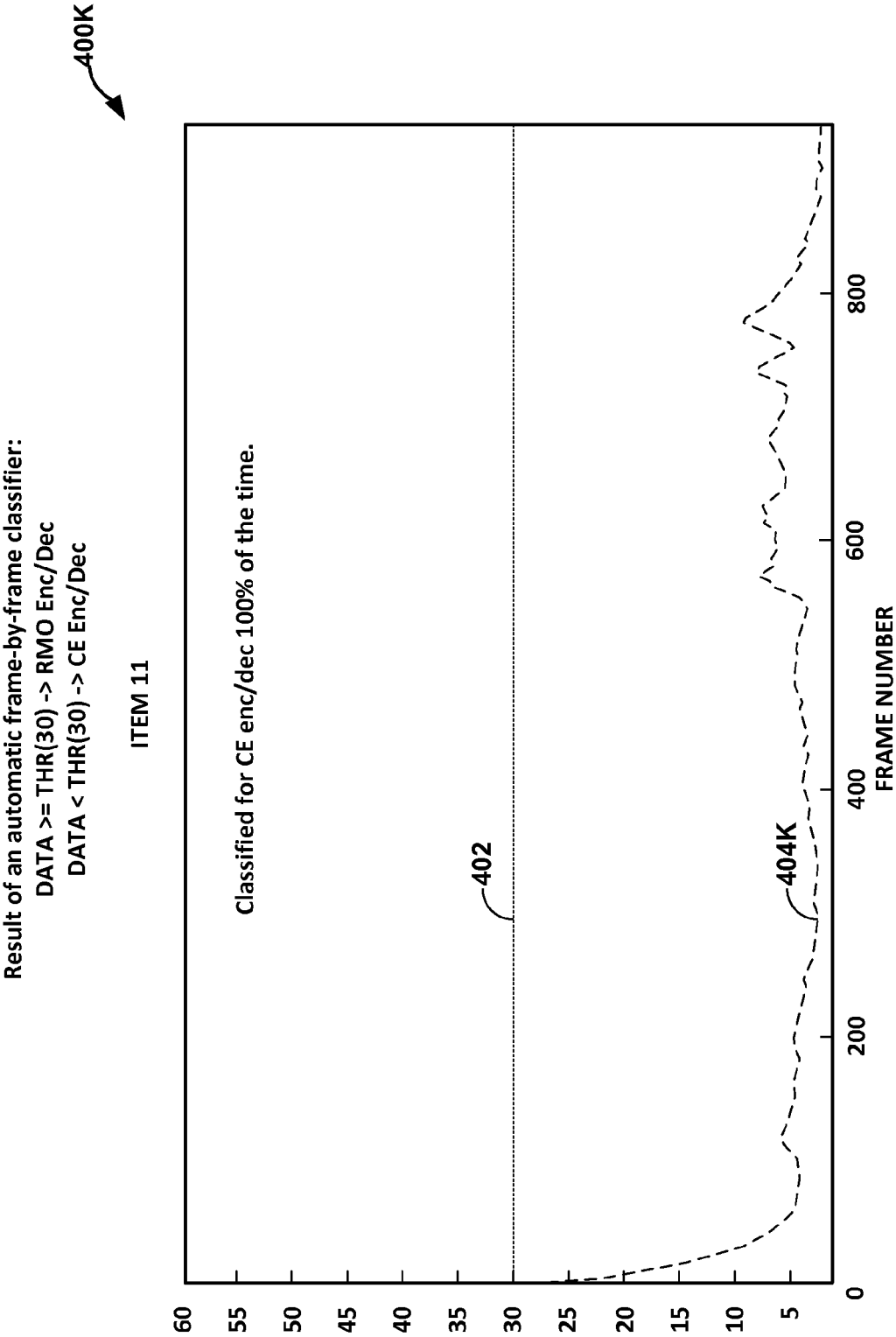


FIG. 31K

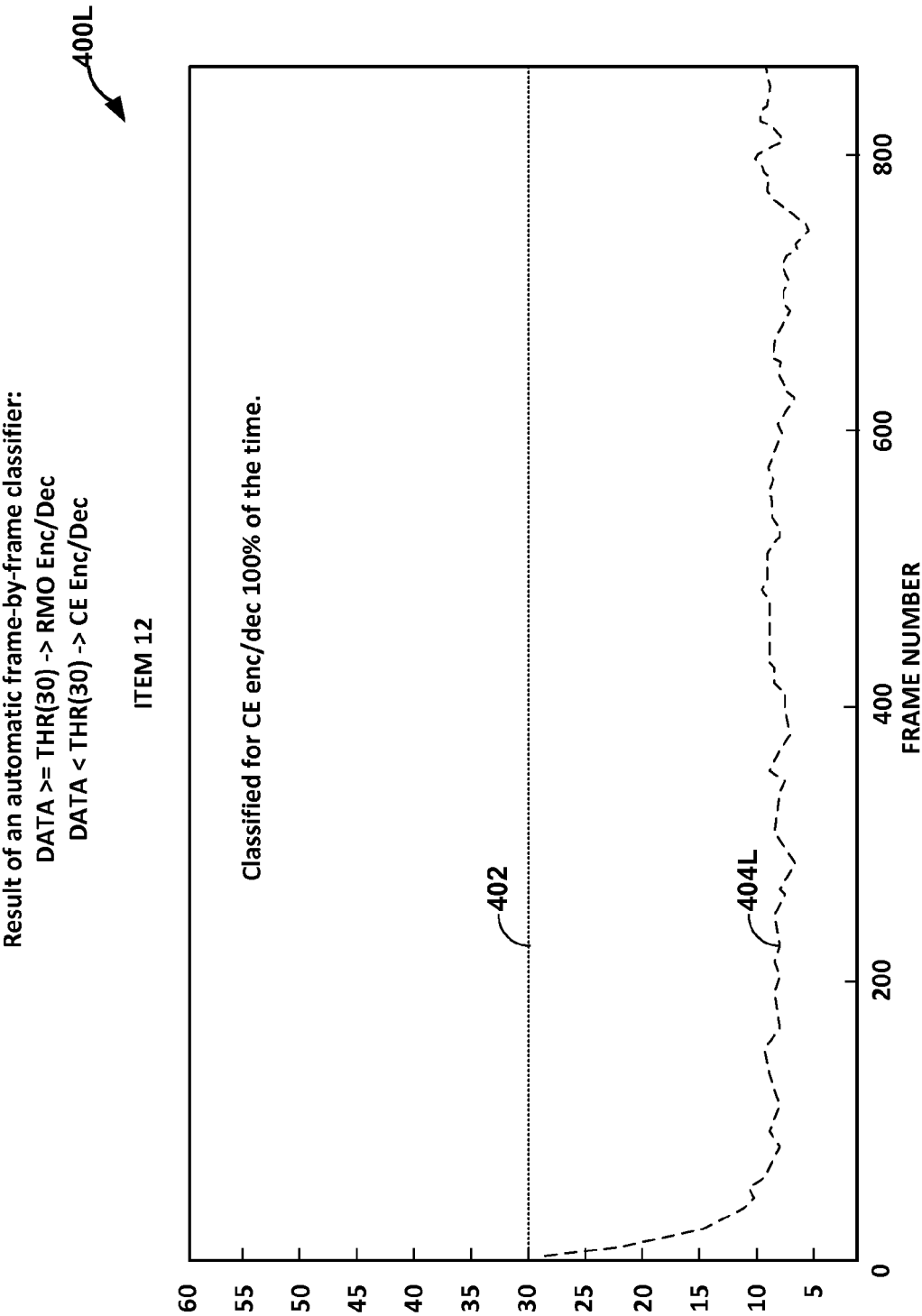


FIG. 31L

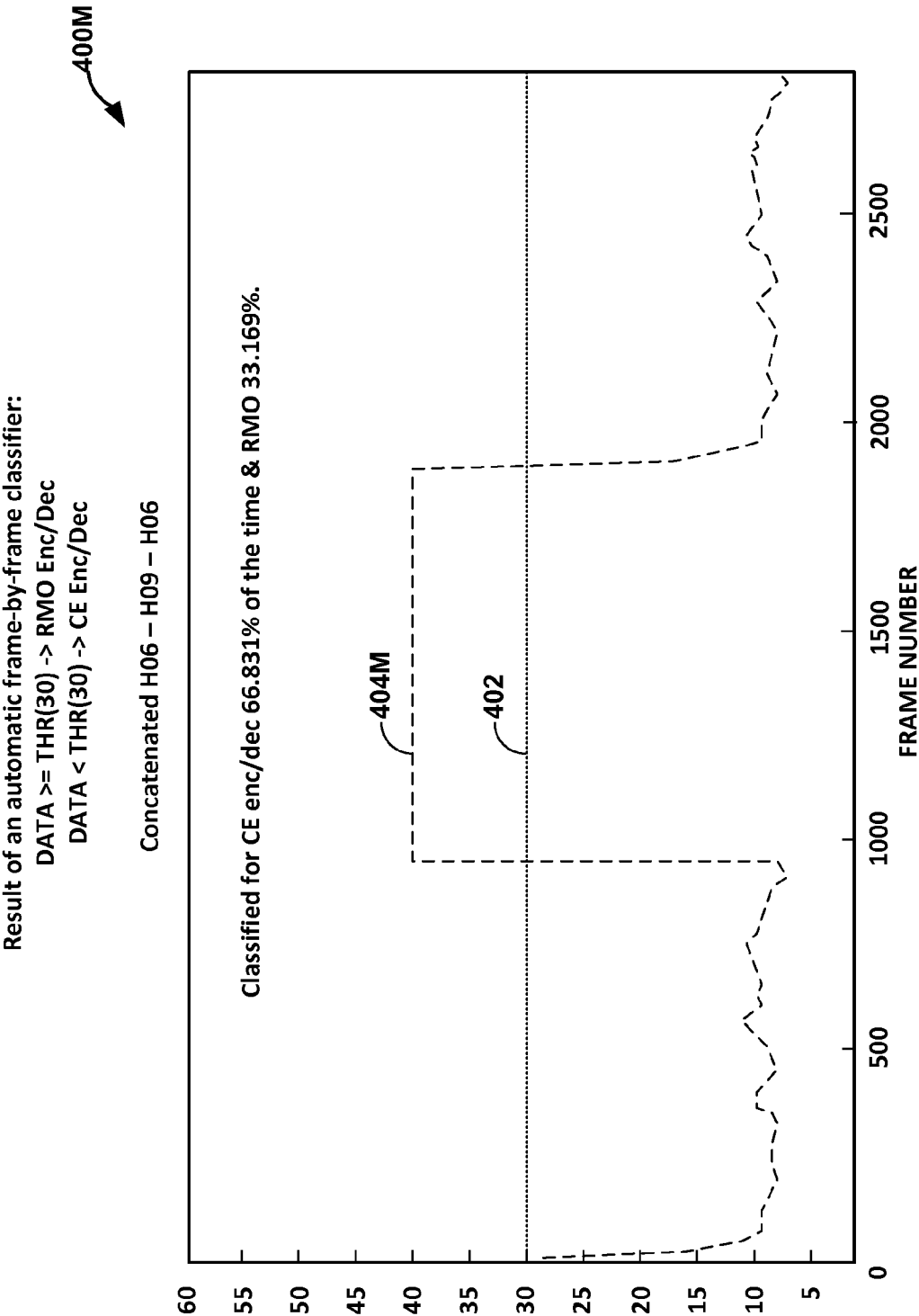


FIG. 31M

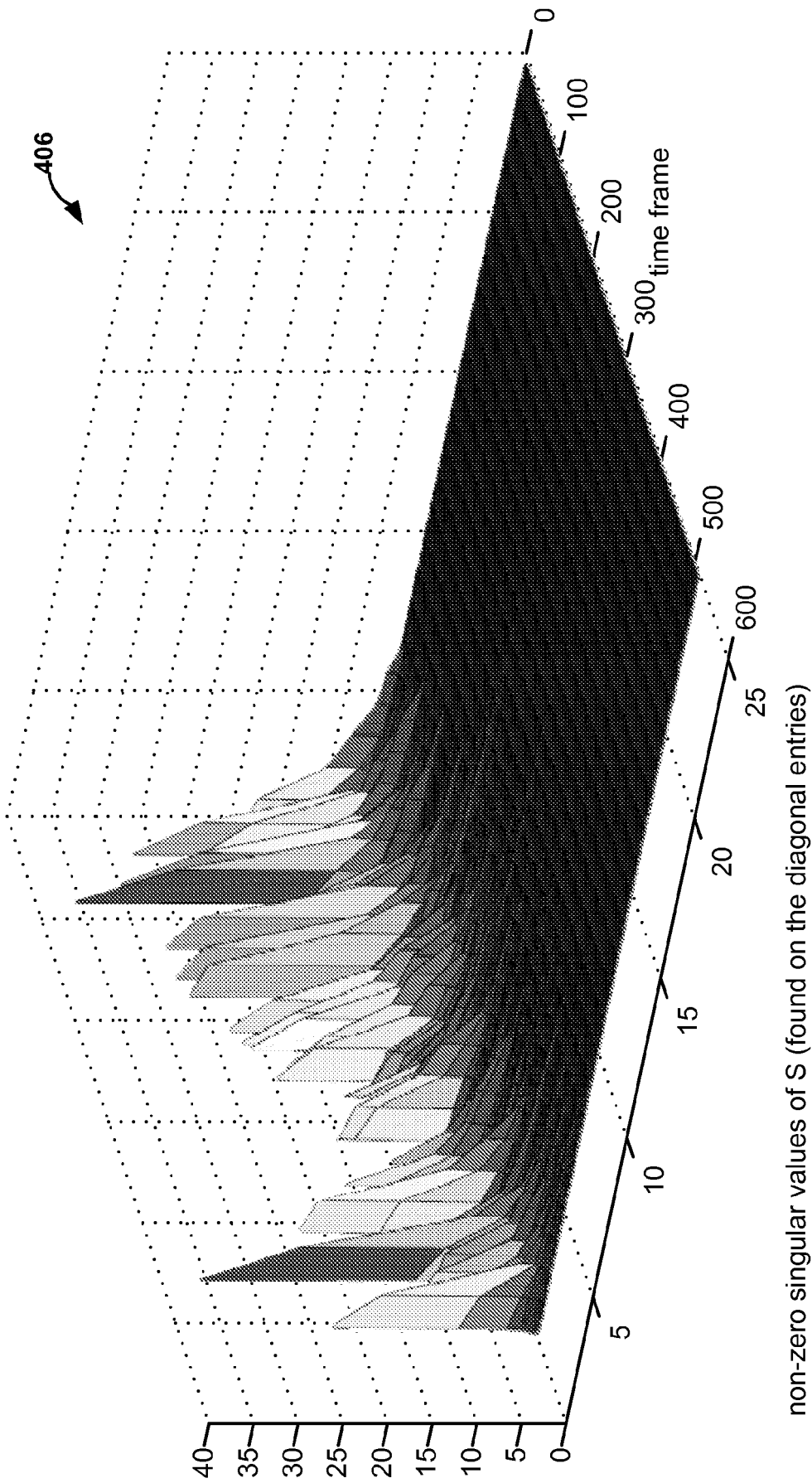
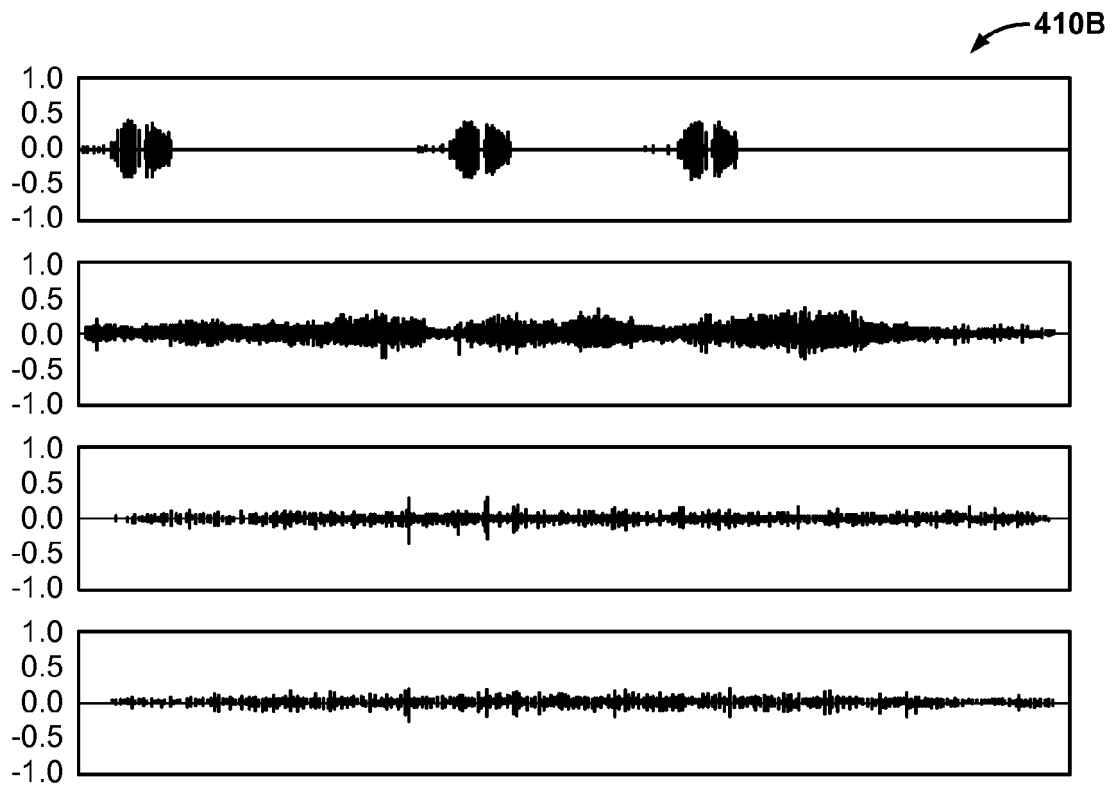
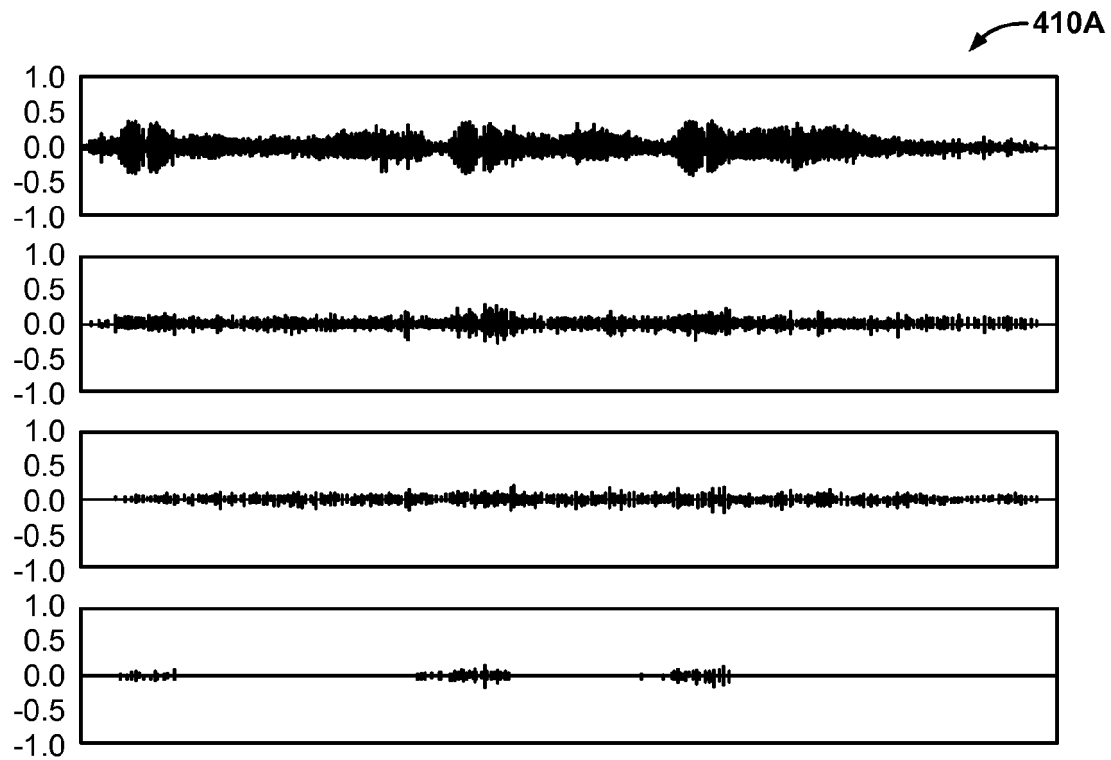


FIG. 32



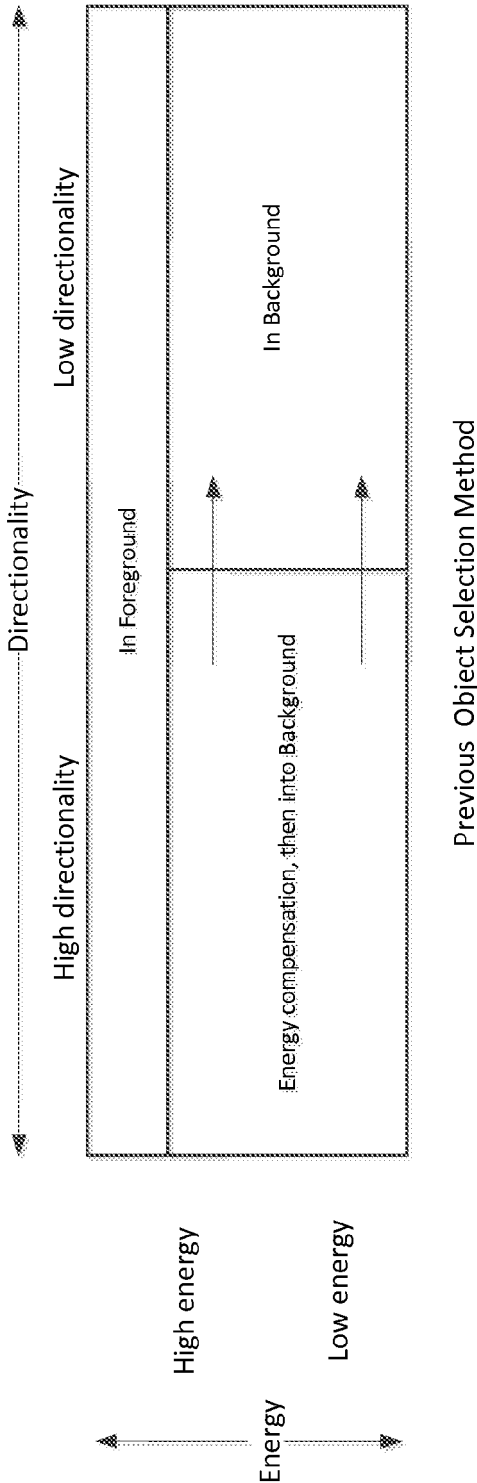


FIG. 34

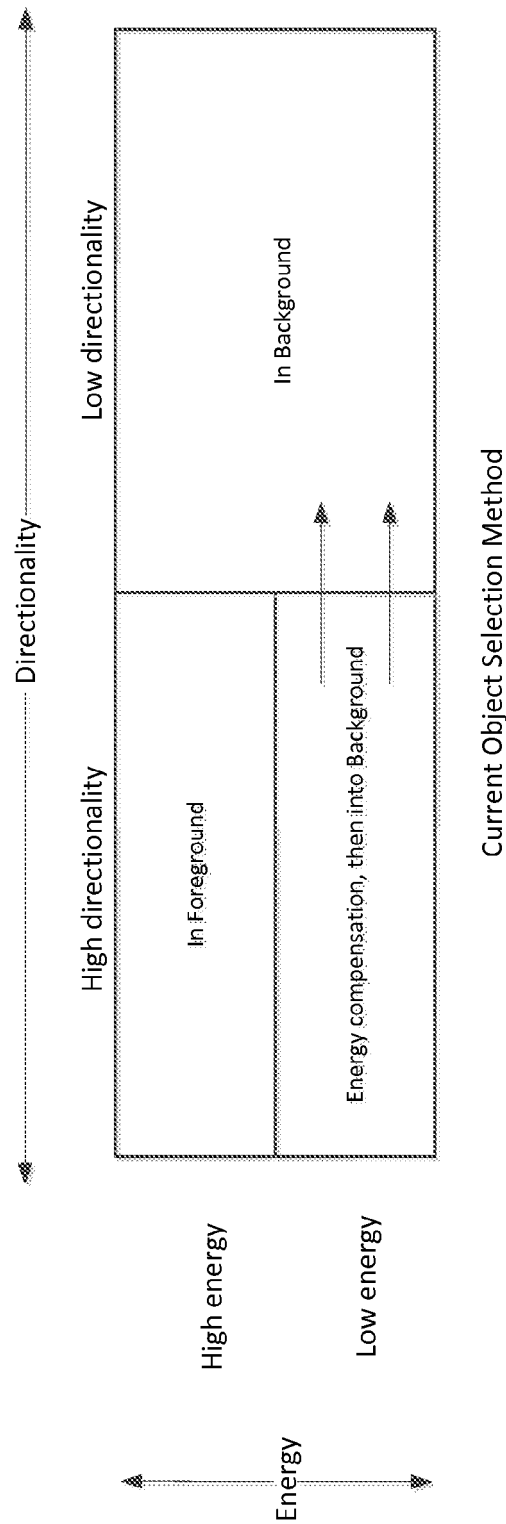


FIG. 35

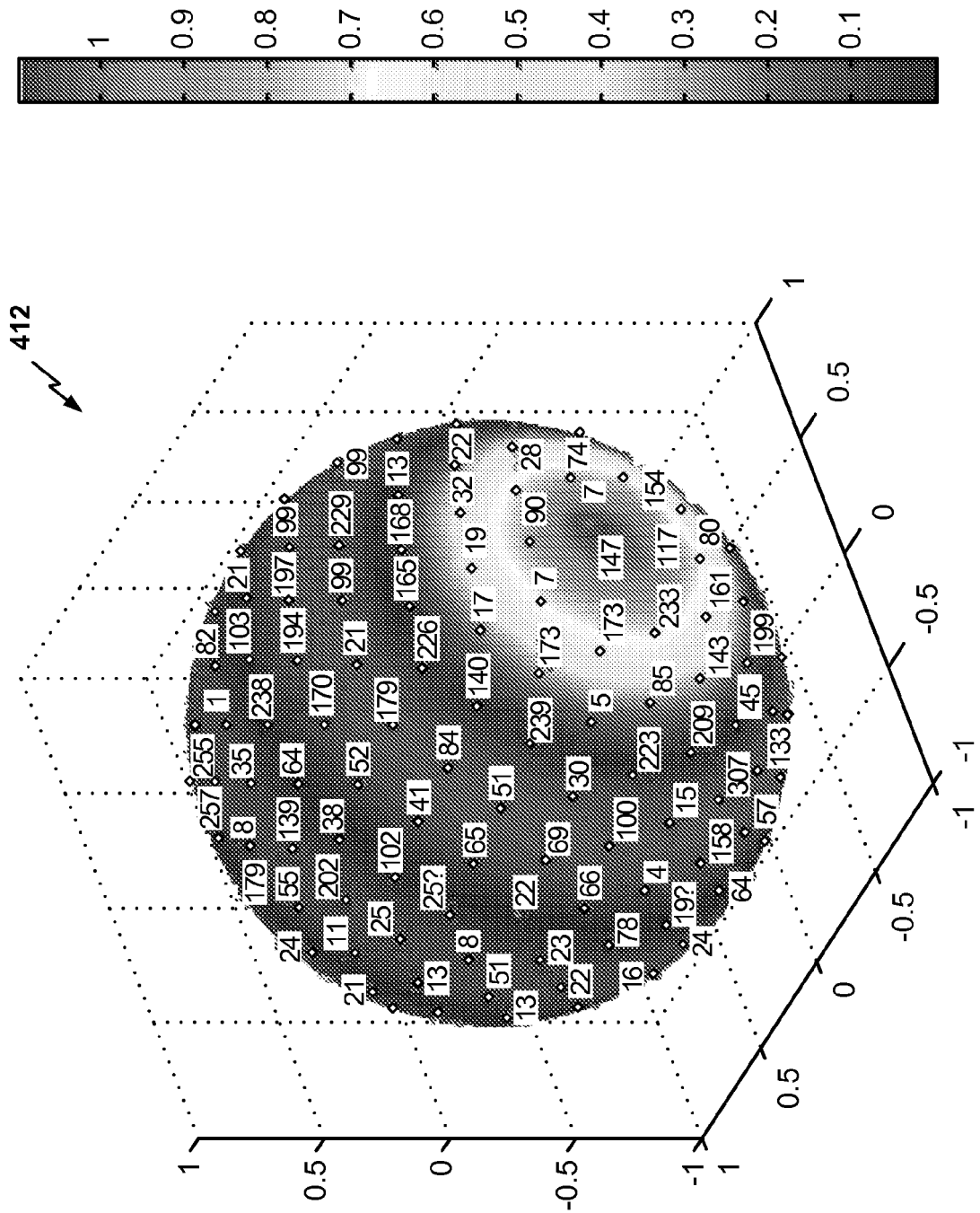


FIG. 36A

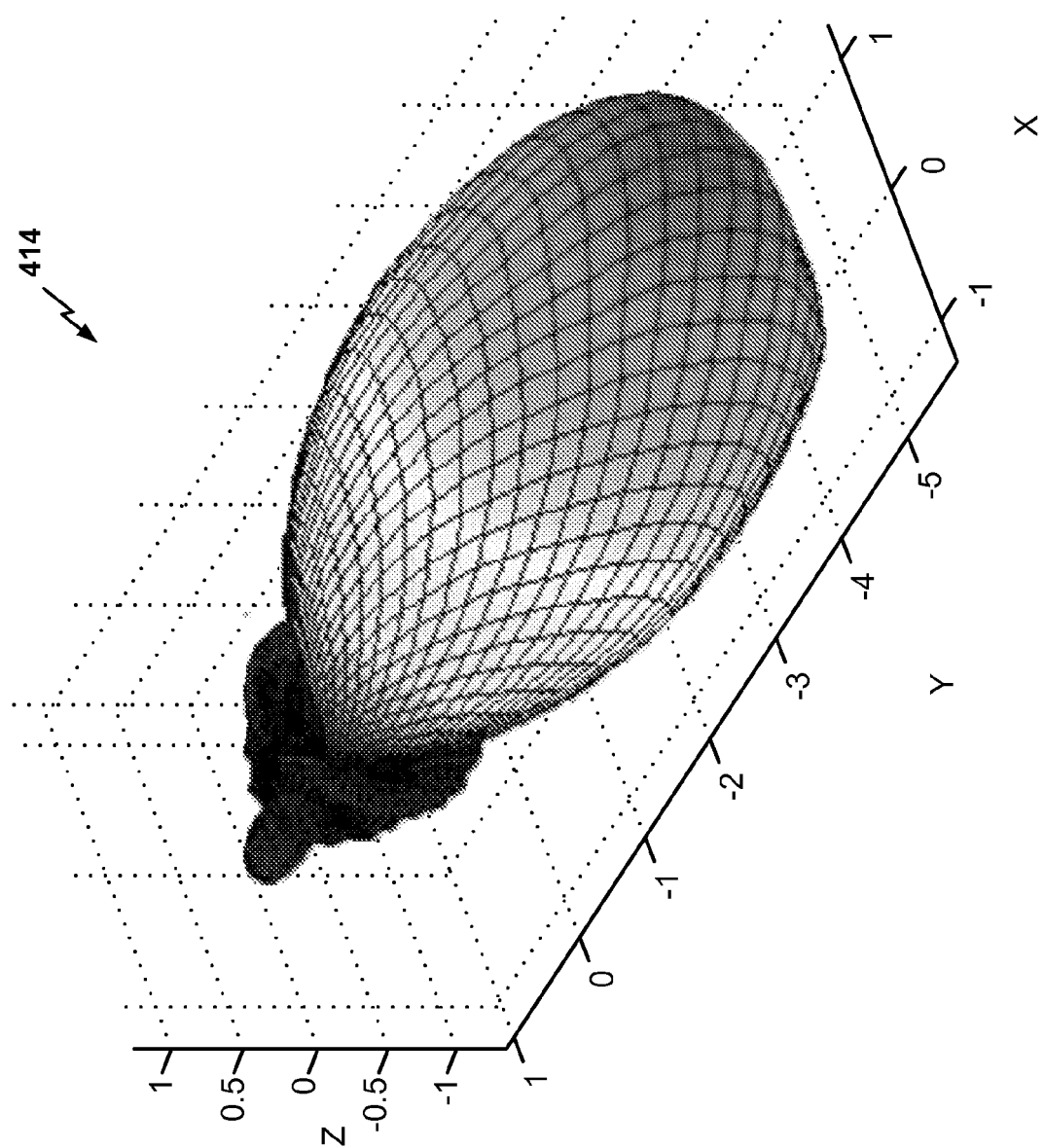


FIG. 36B

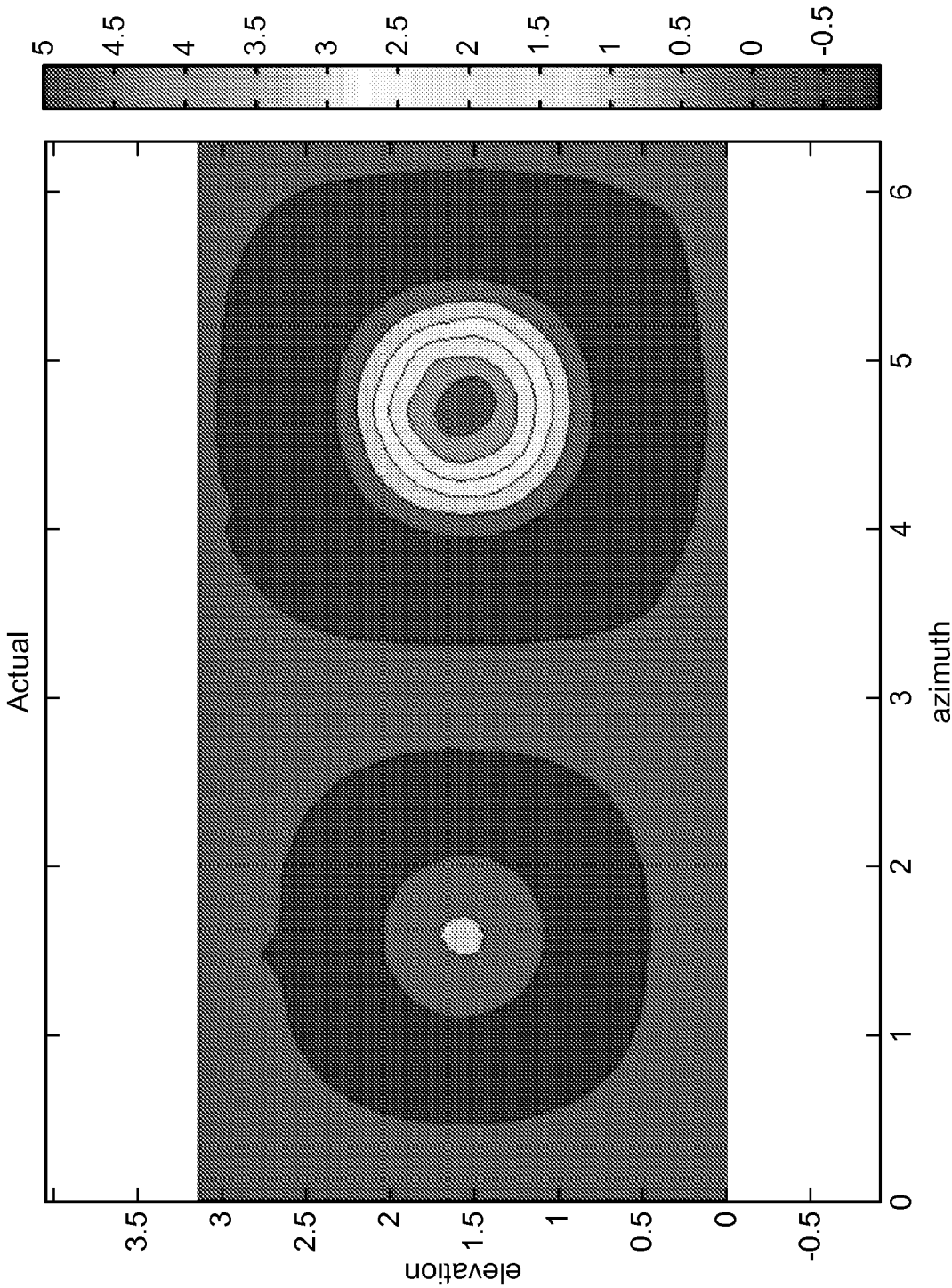


FIG. 36C

Bee sound comes from azimuth=0° and elevation=45°.

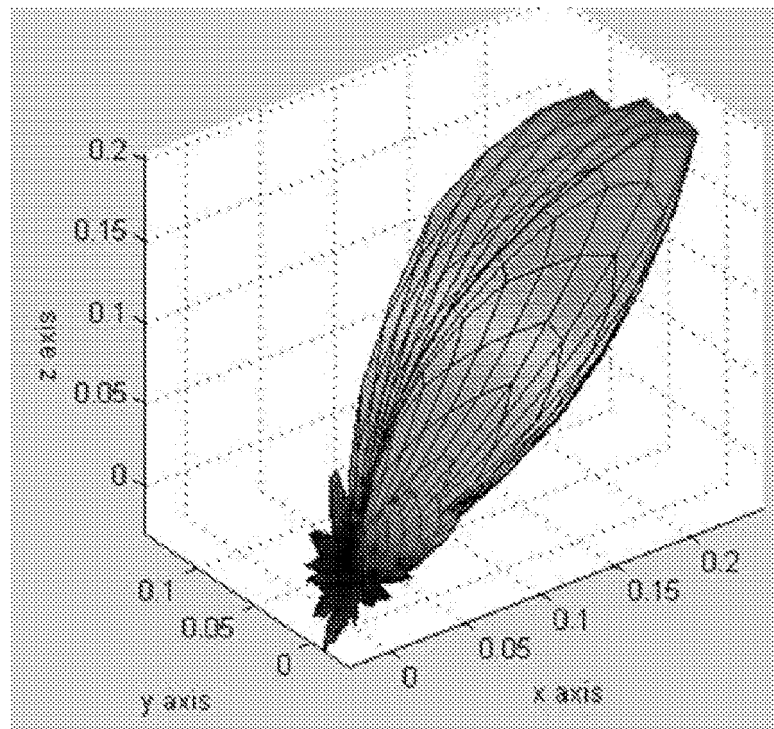


FIG. 36D

Helicopter sound comes from the sky.

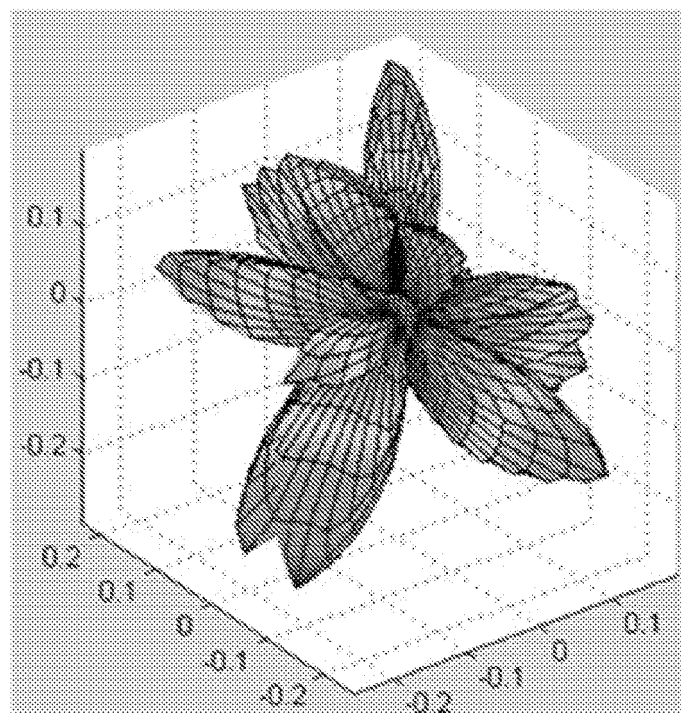


FIG. 36E

Modern electronic music comes from two different directions.

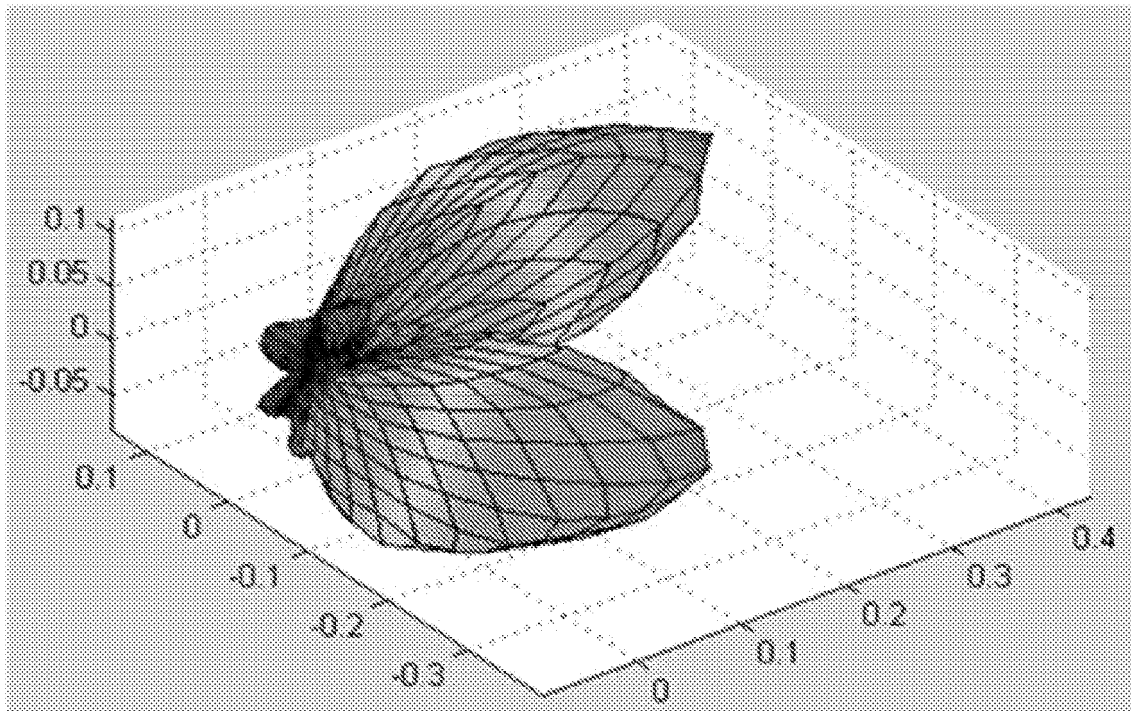


FIG. 36F

People are shouting in a stadium.

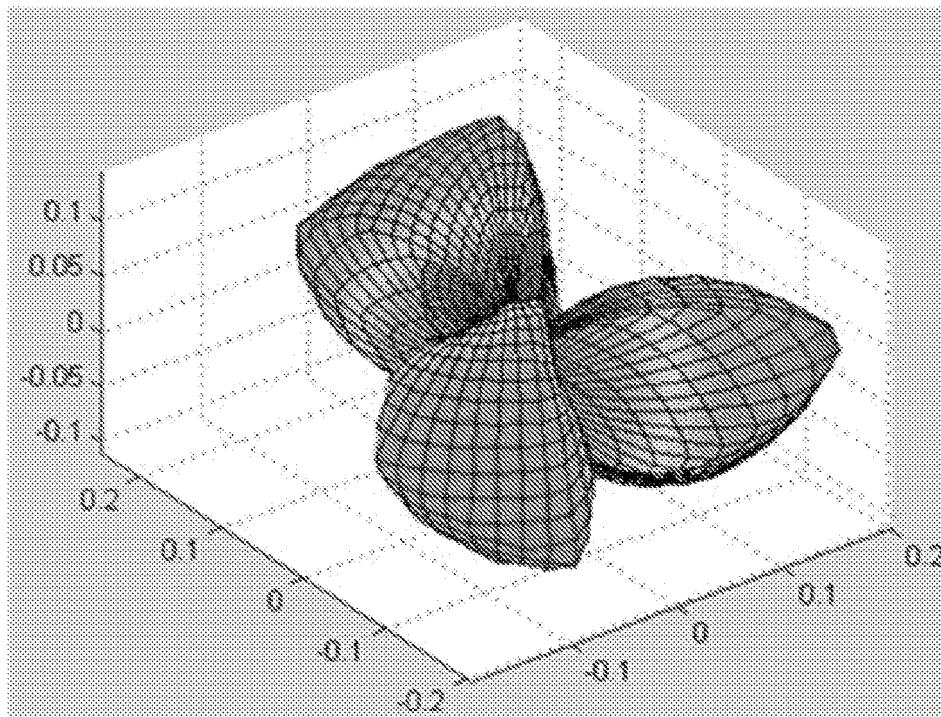


FIG. 36G

$$V_x = \frac{d_2}{d_1 + d_2} V_1 + \frac{d_1}{d_1 + d_2} V_2$$

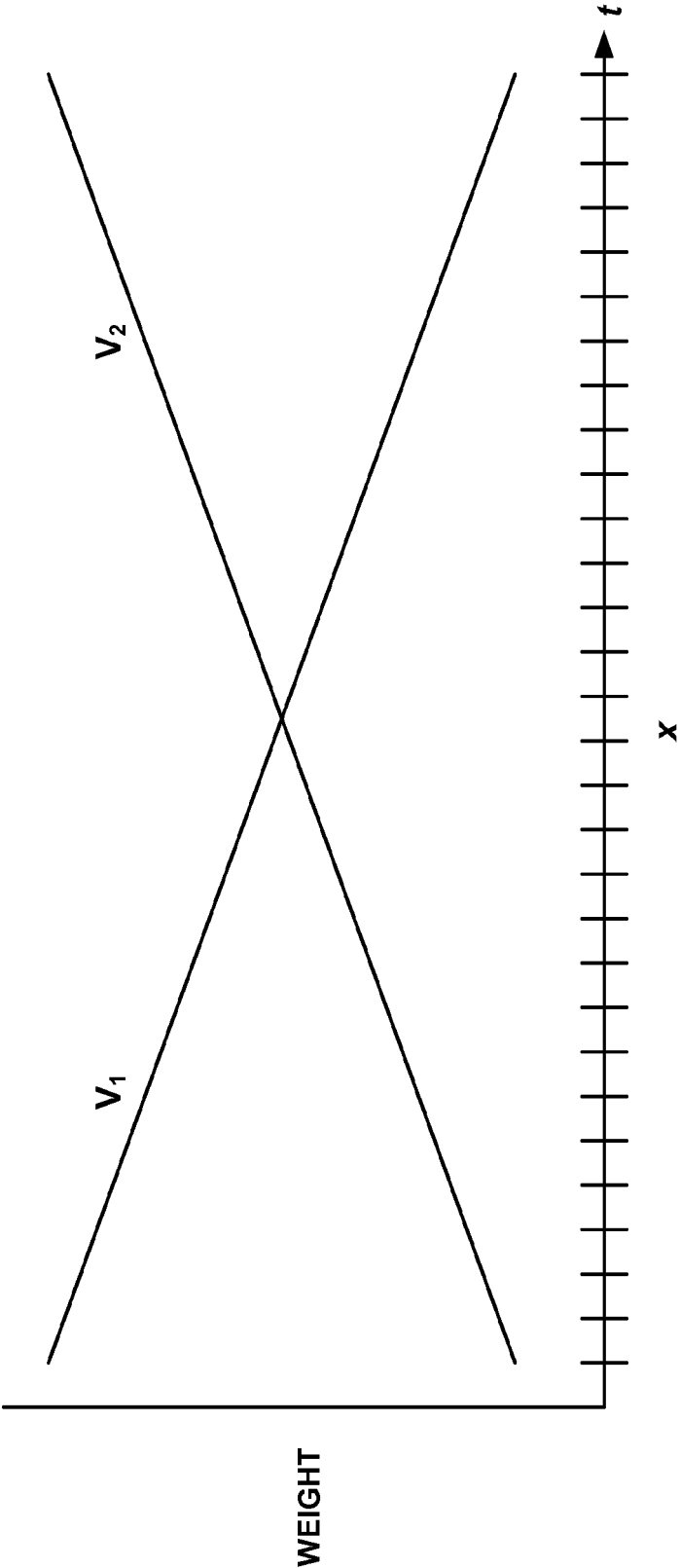


FIG. 37

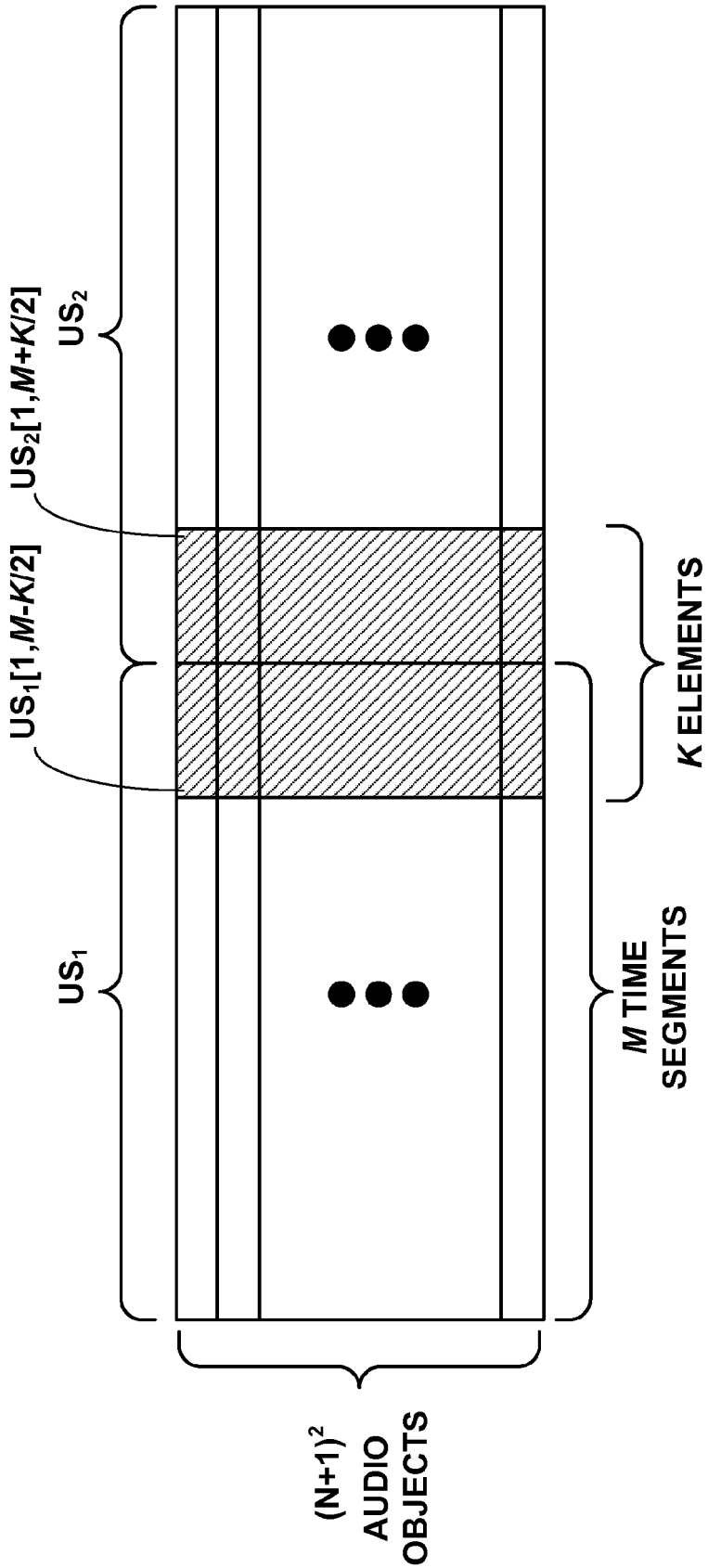


FIG. 38

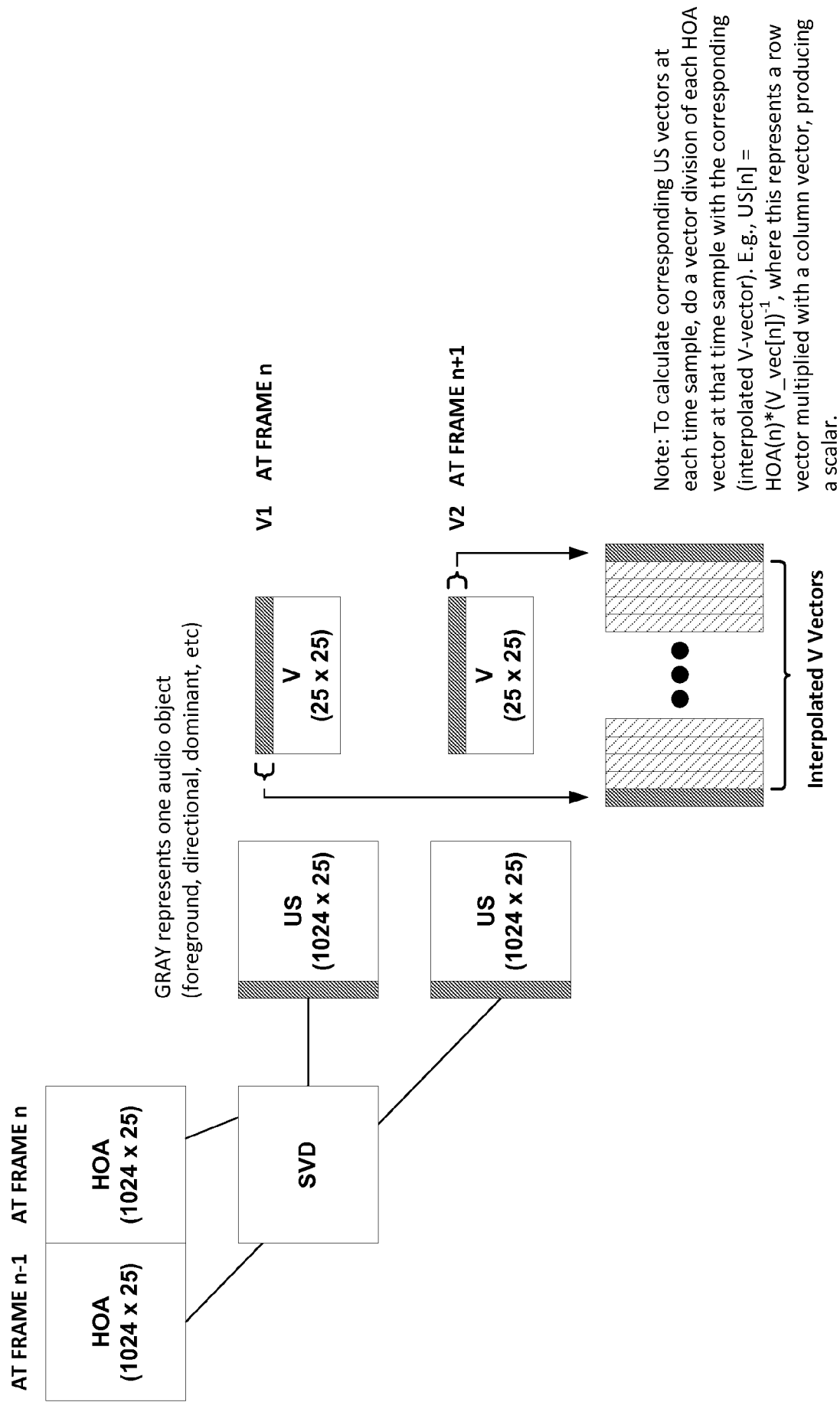


FIG. 39

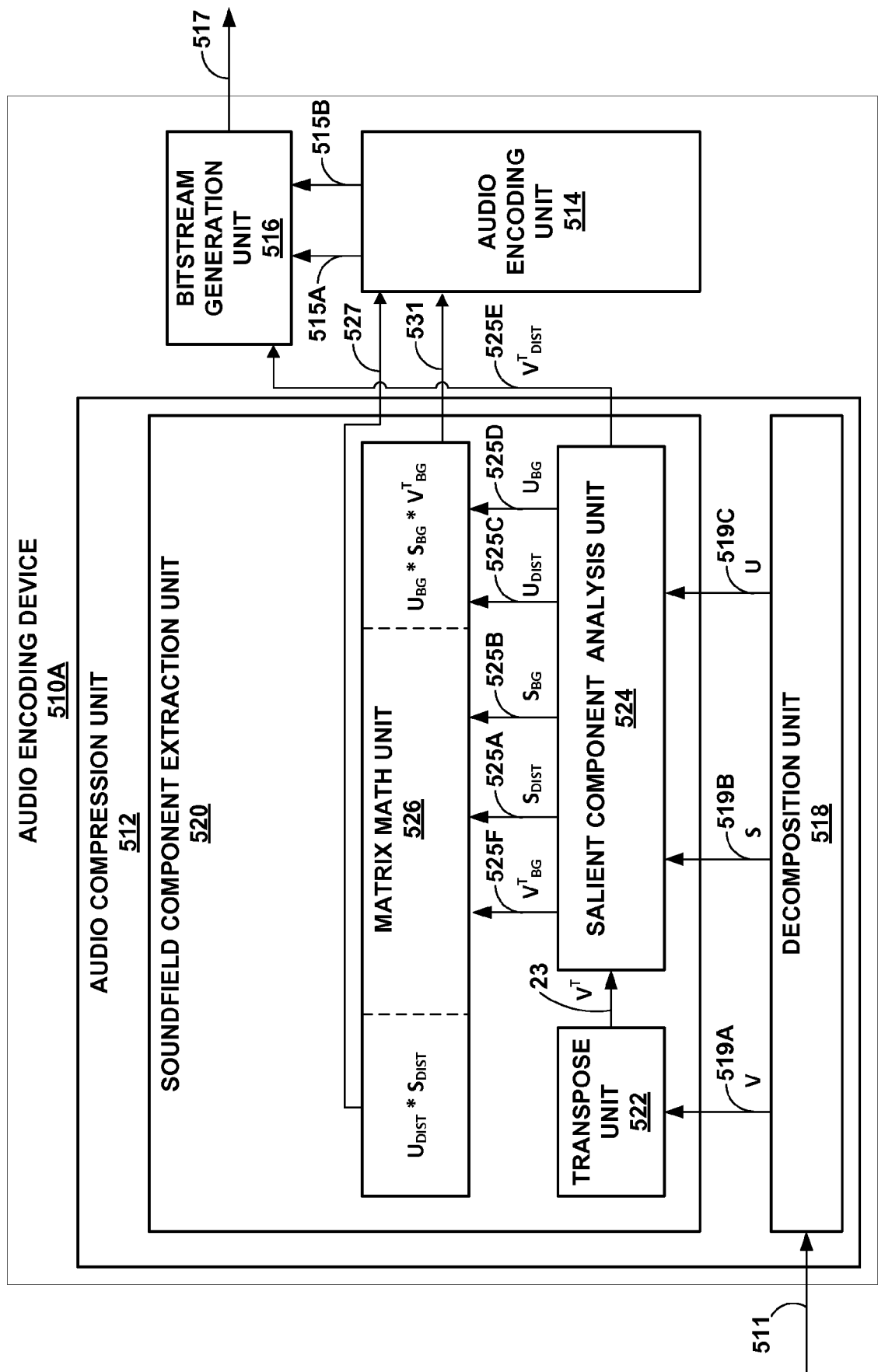


FIG. 40A

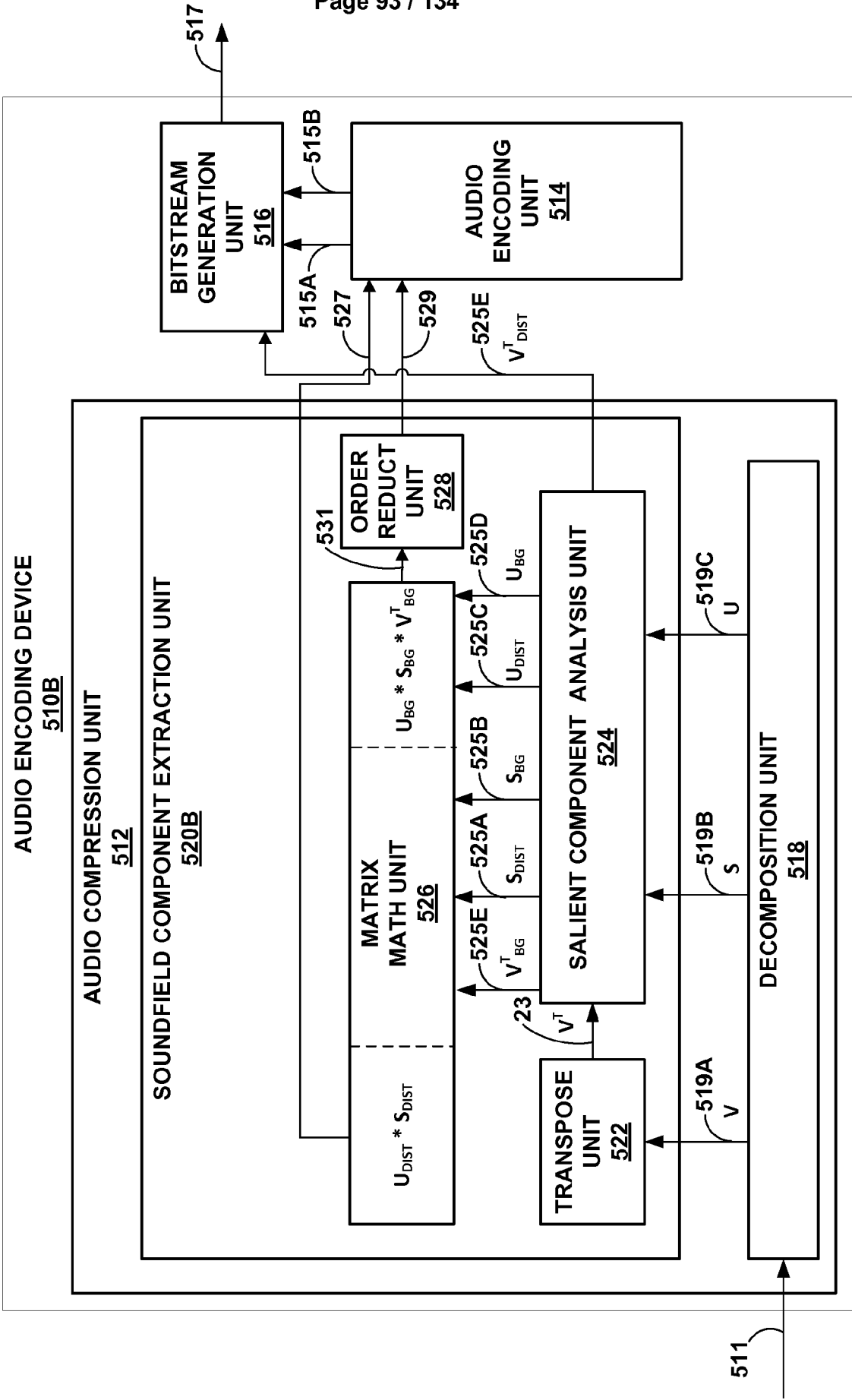


FIG. 40B

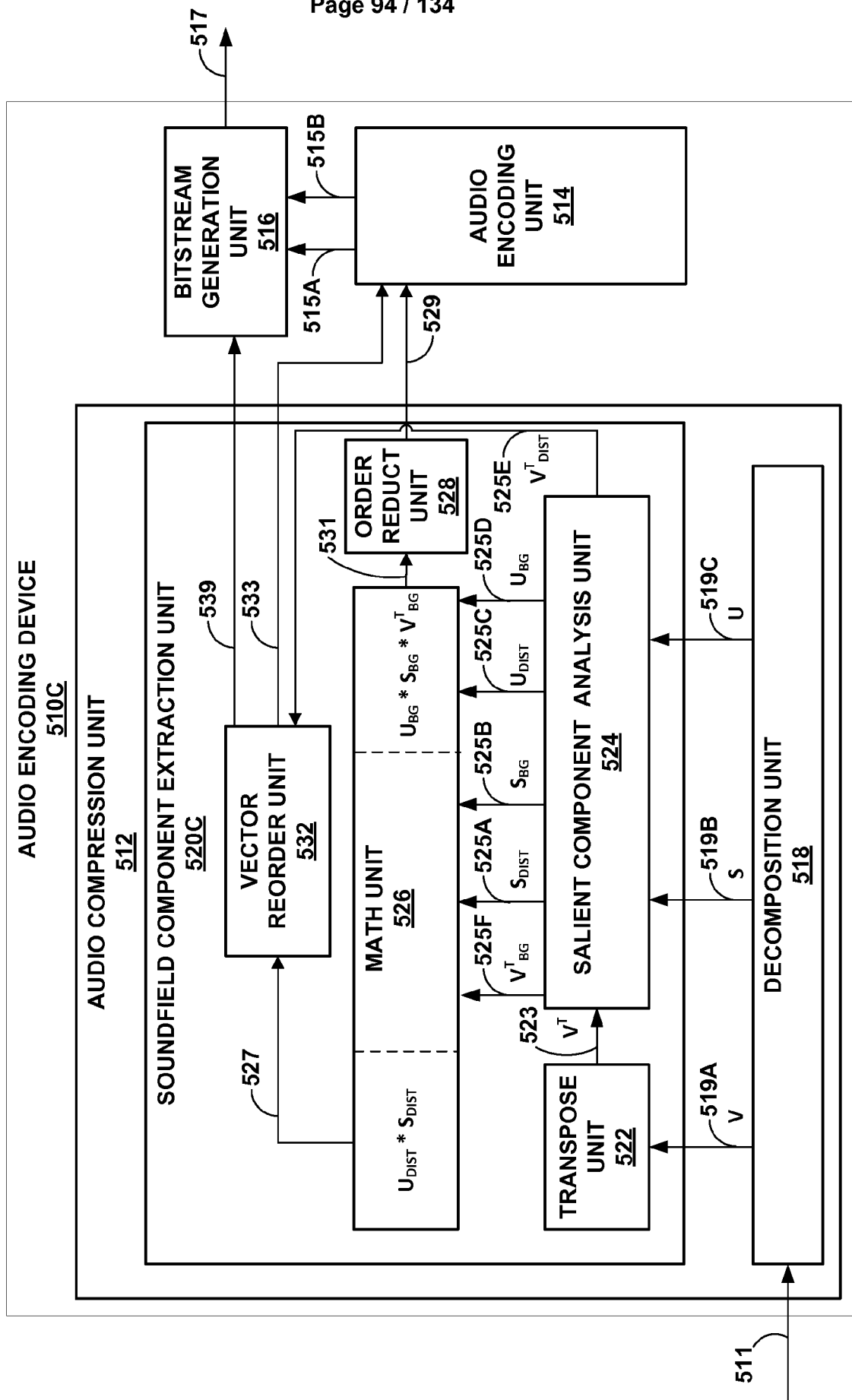


FIG. 40C

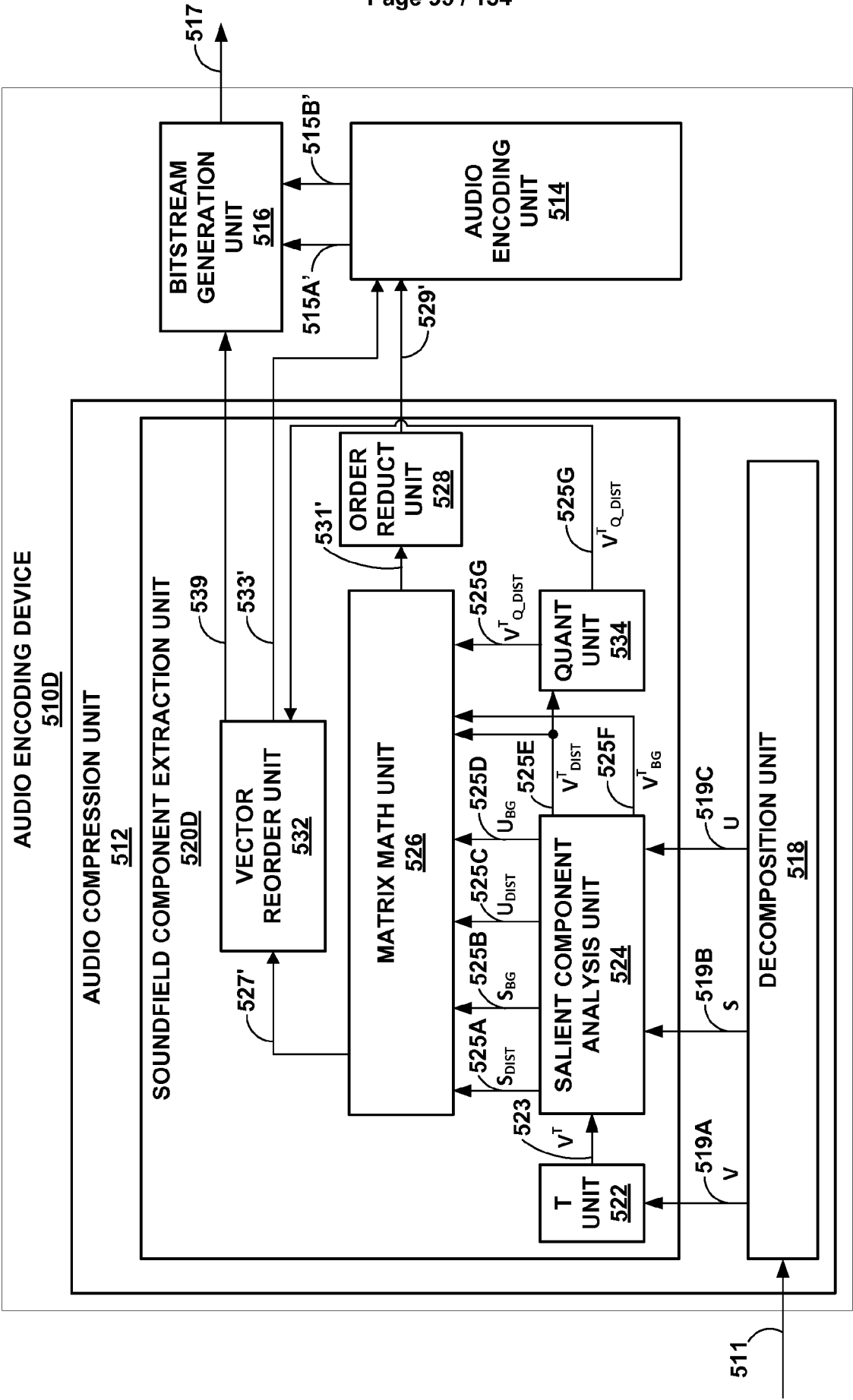


FIG. 40D

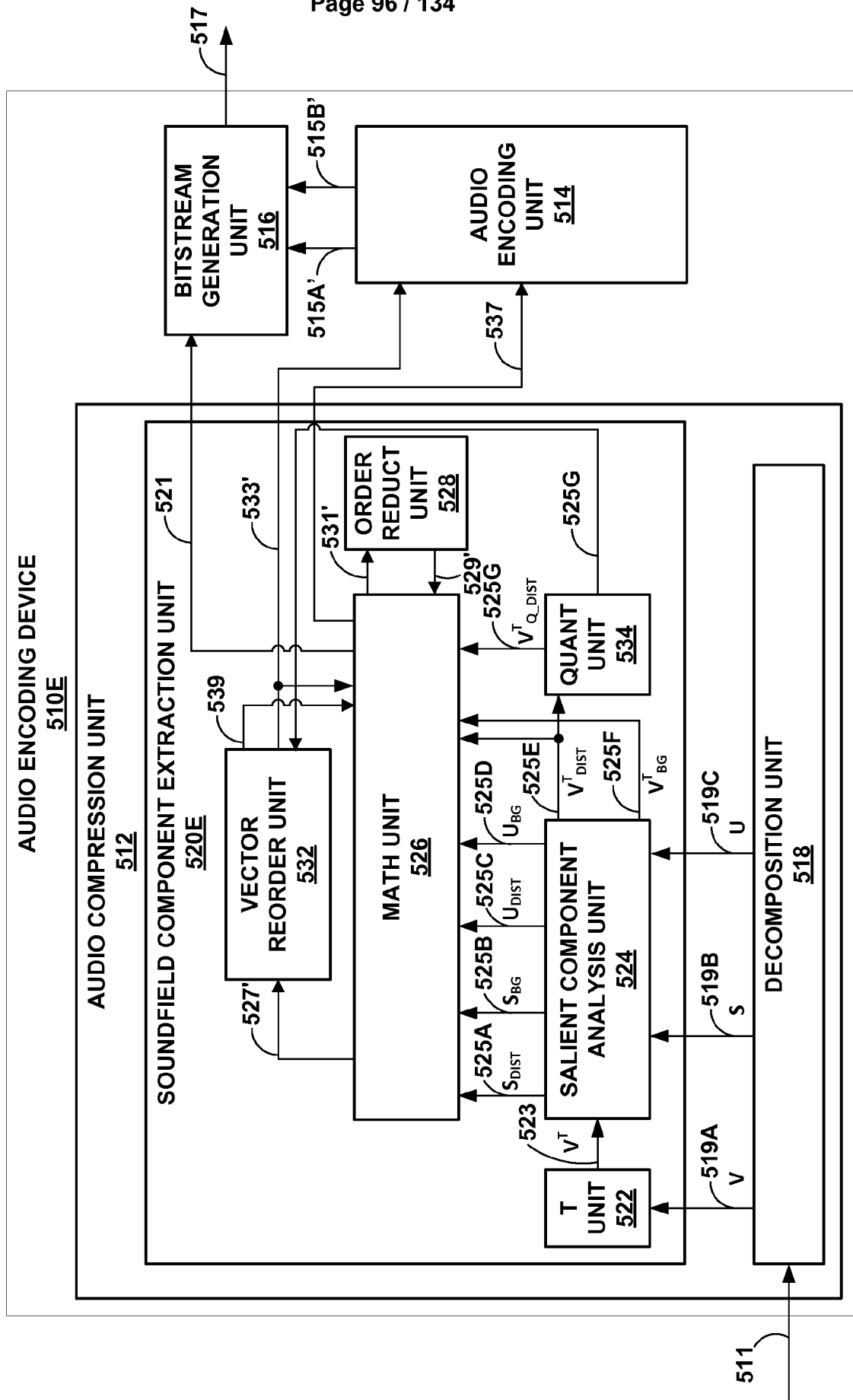


FIG. 40E

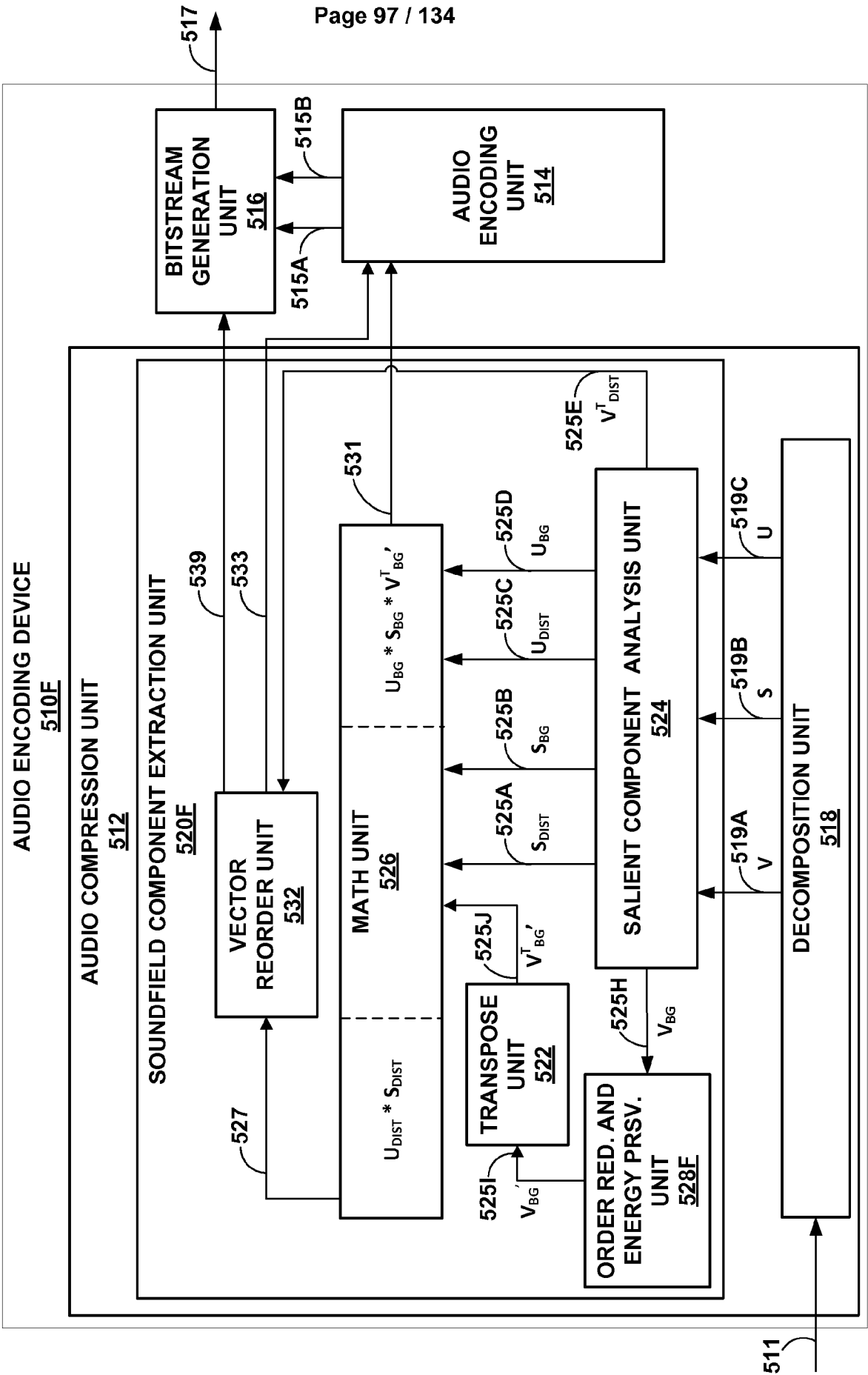


FIG. 40F

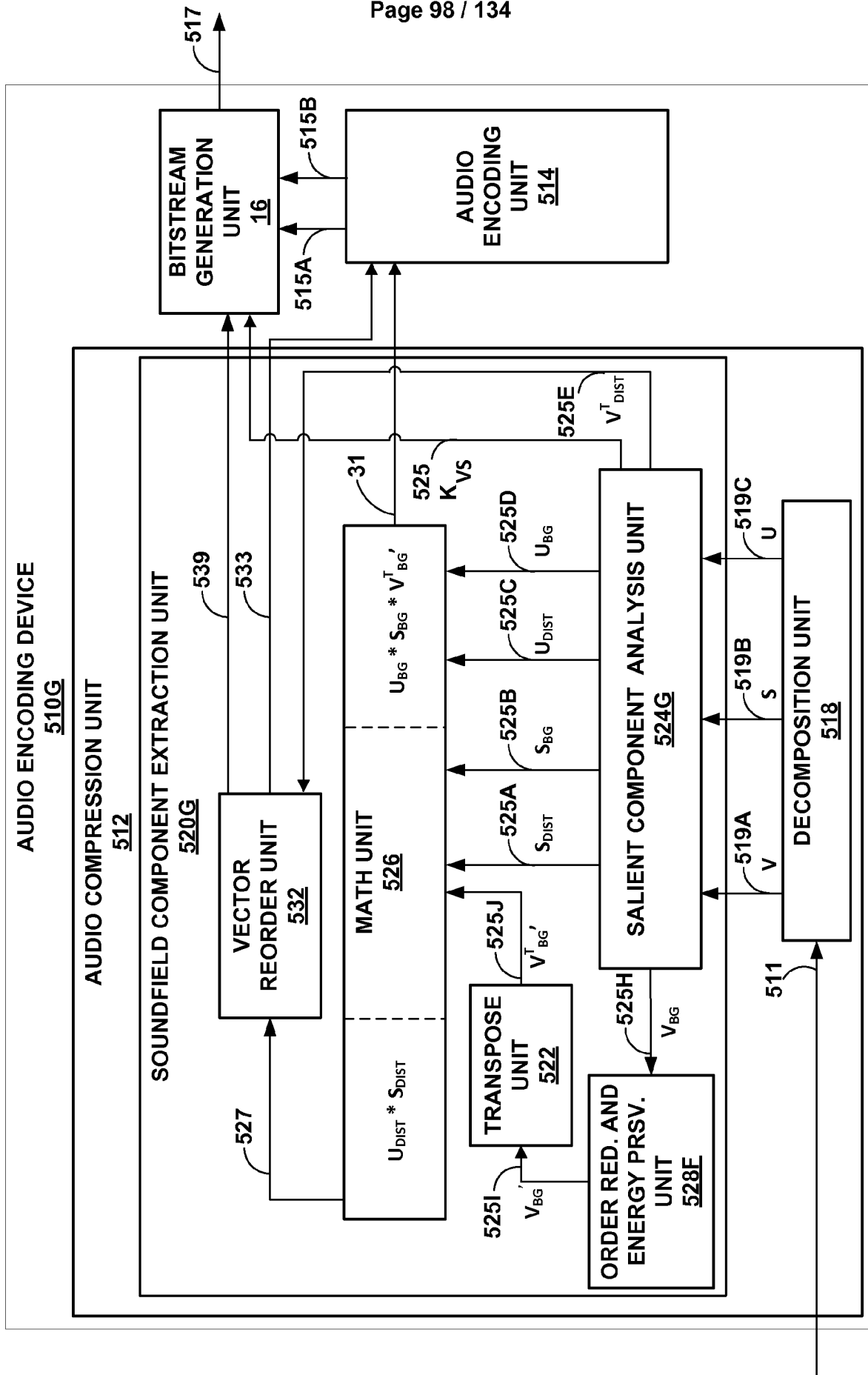
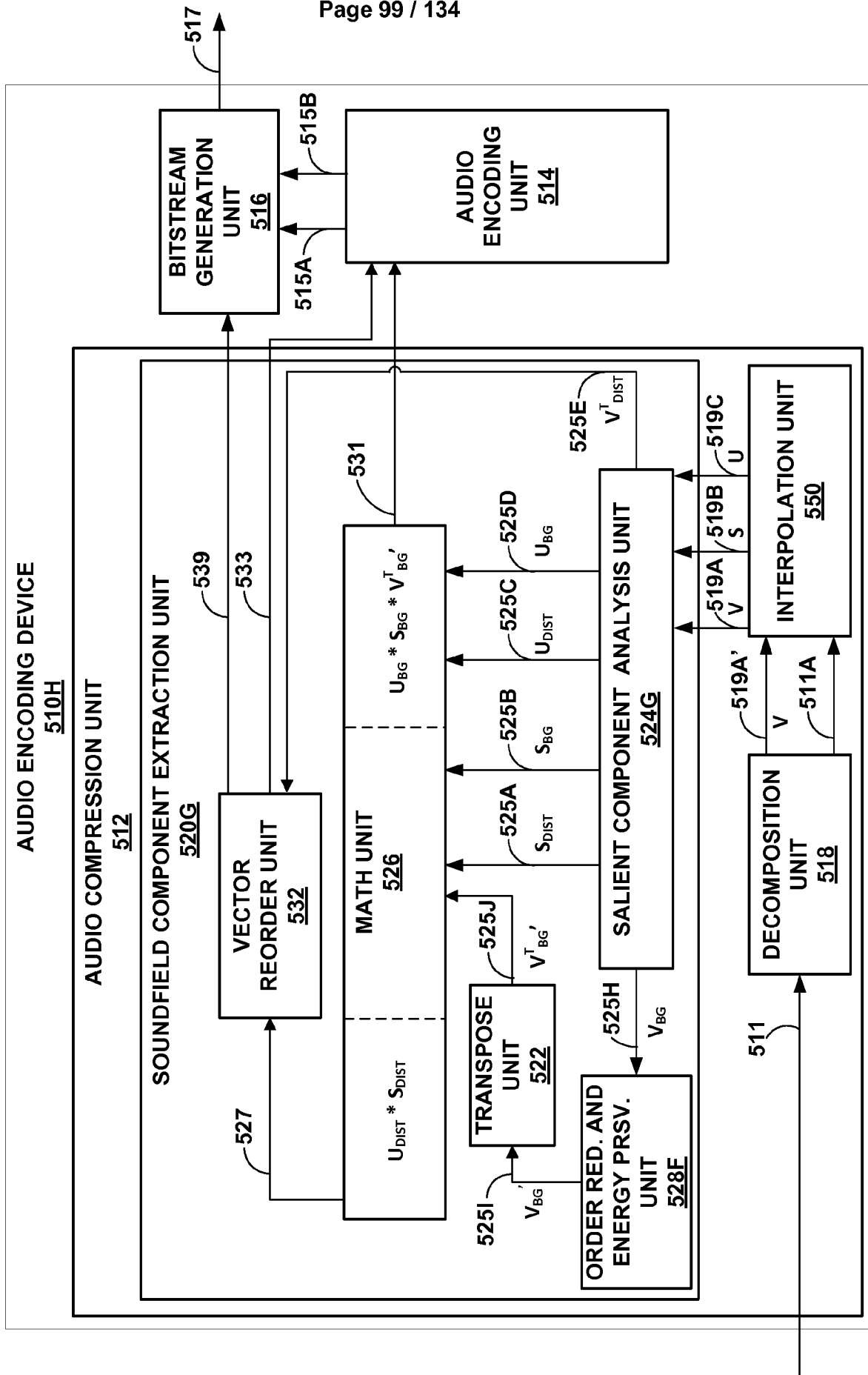


FIG. 40G



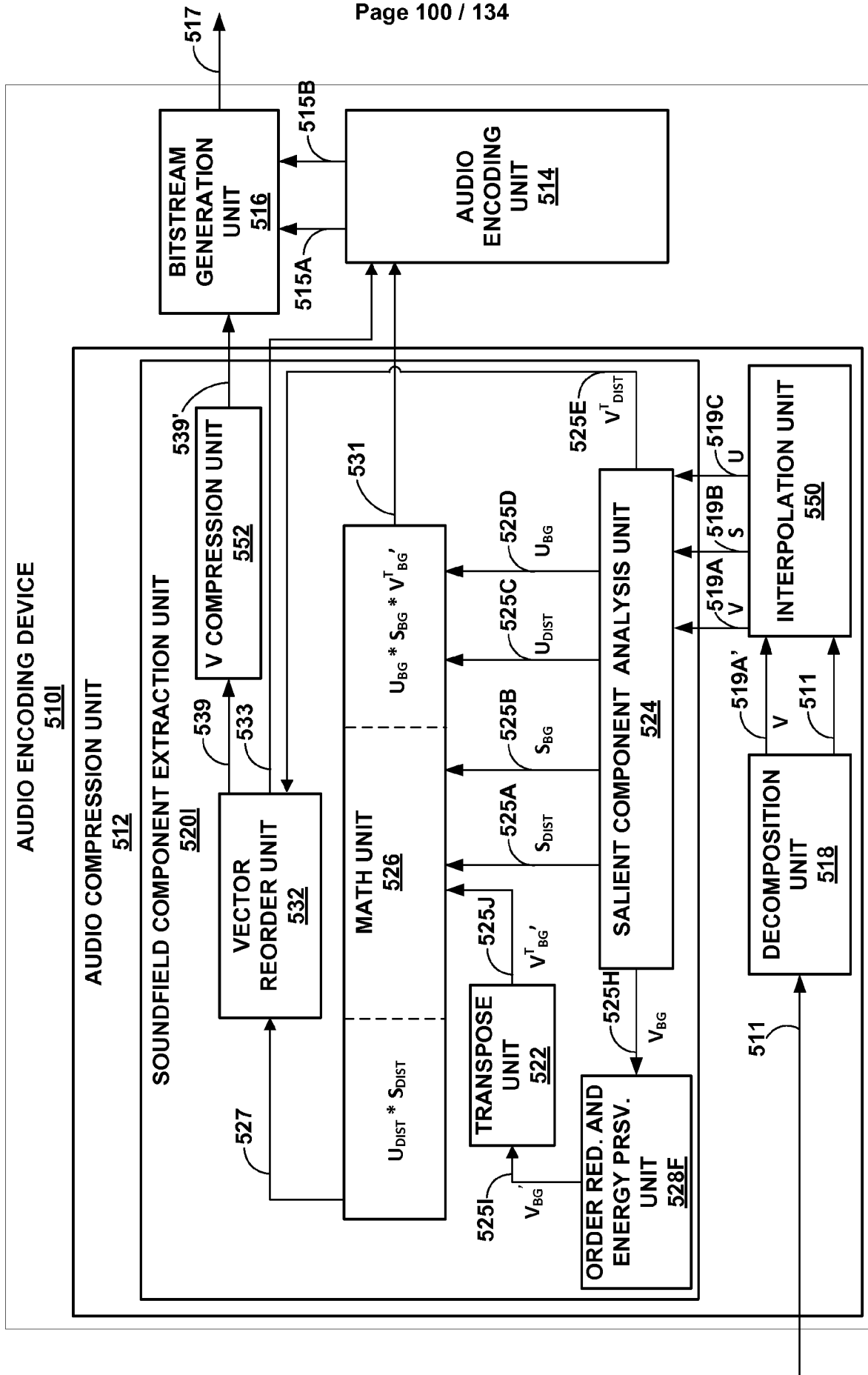


FIG. 40I

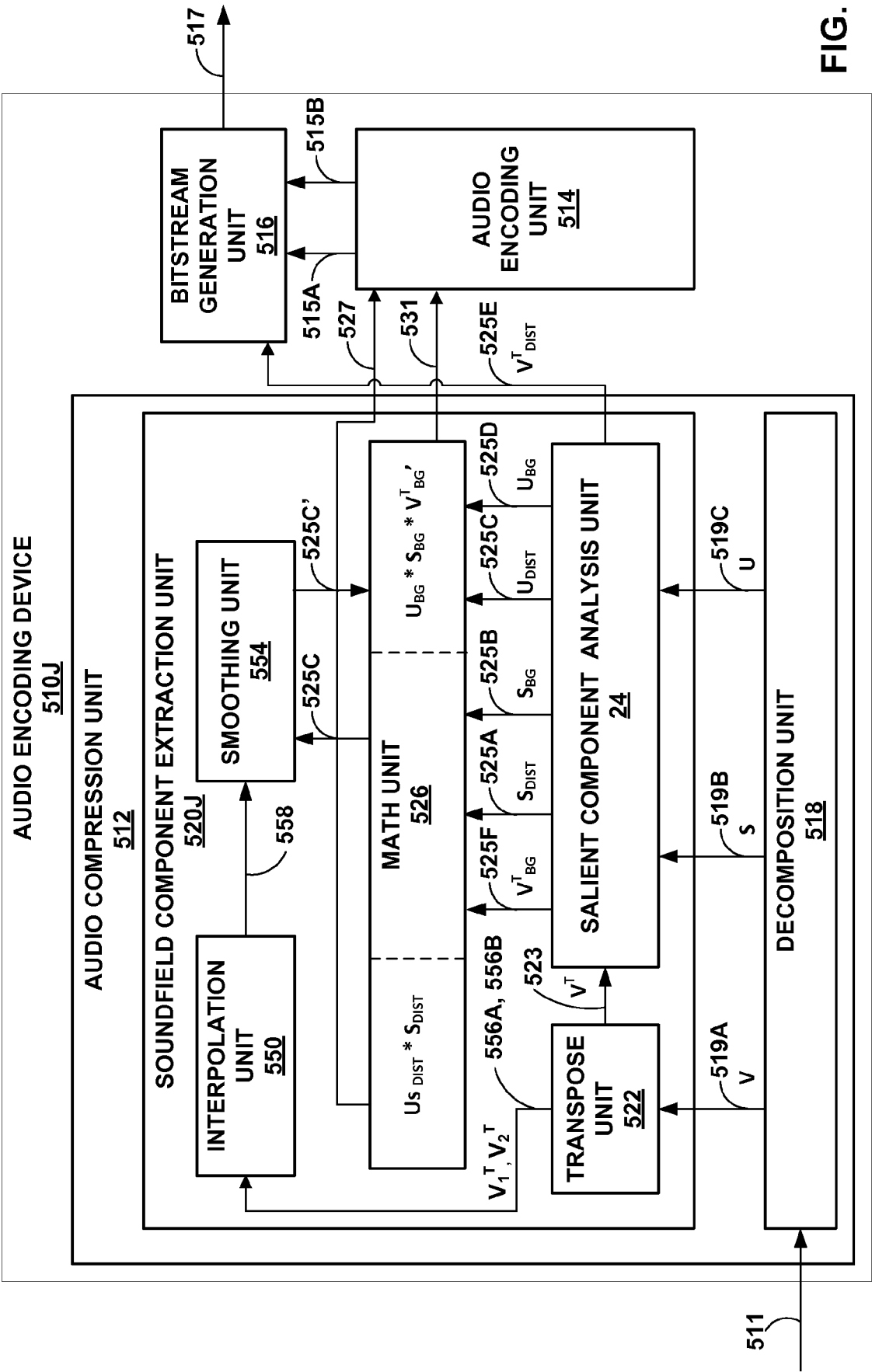


FIG. 40J

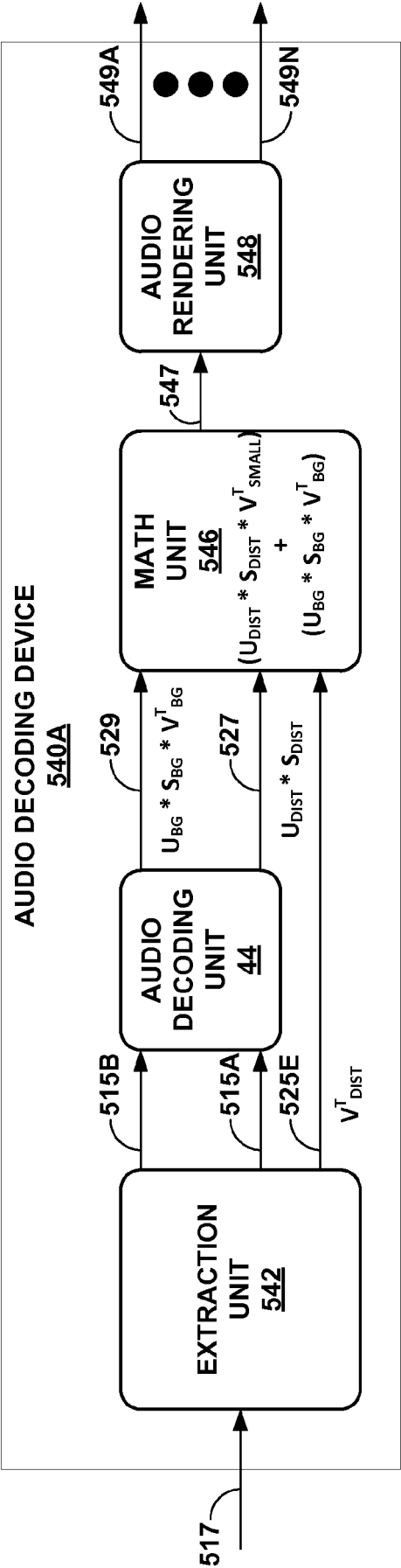


FIG. 41A

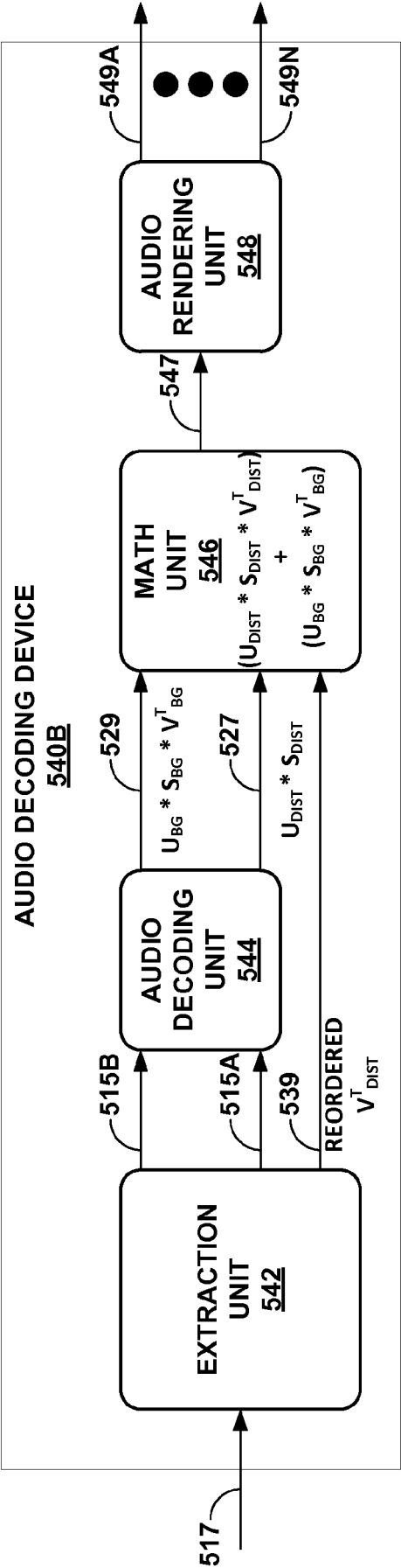


FIG. 41B

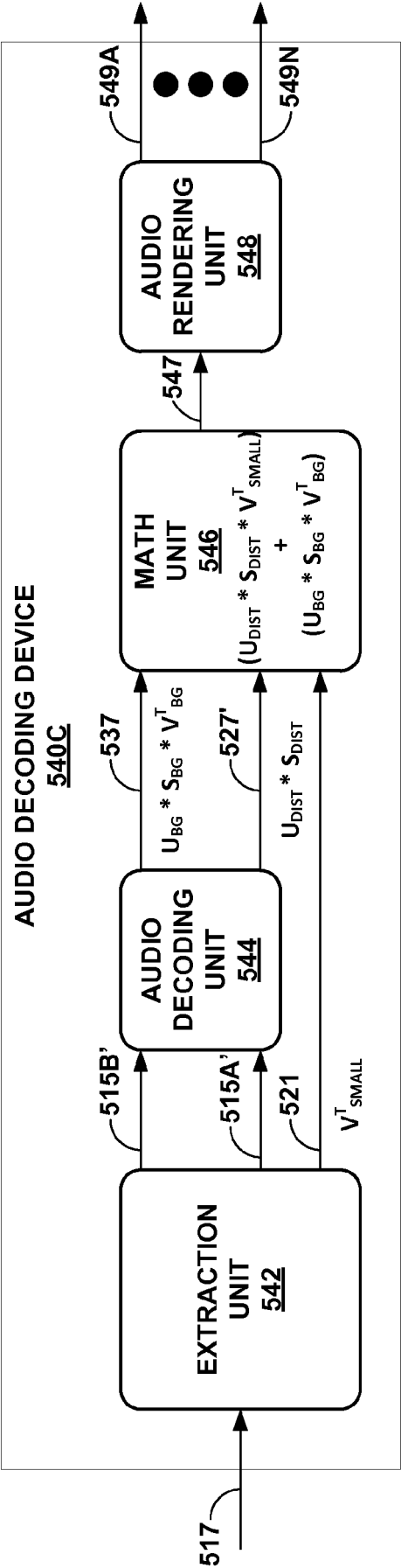


FIG. 41C

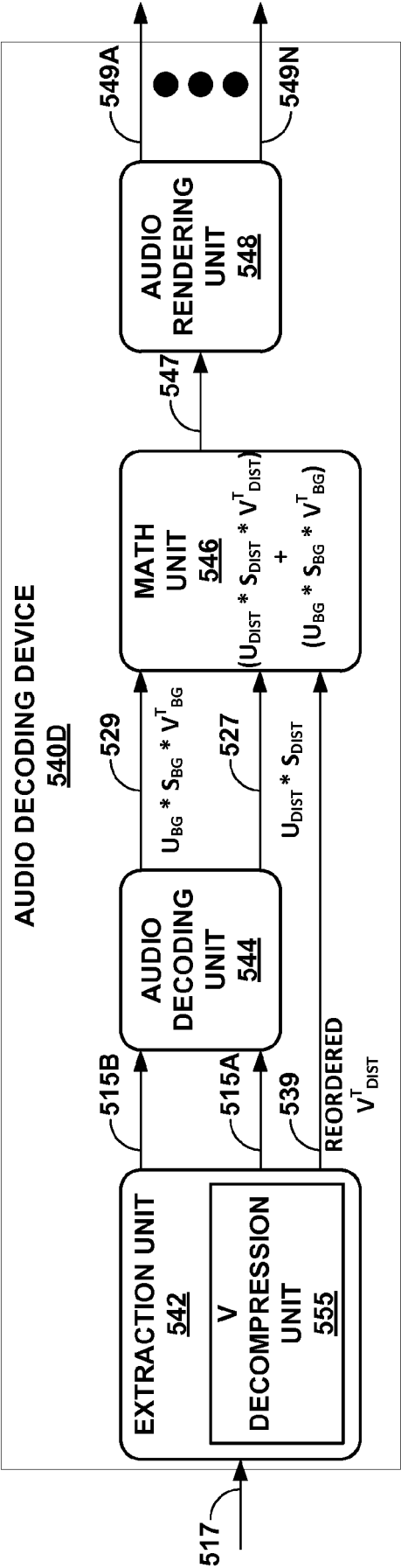


FIG. 41D

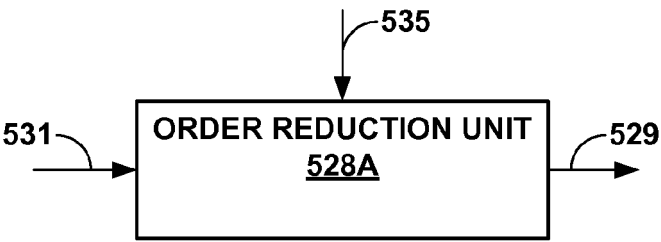


FIG. 42A

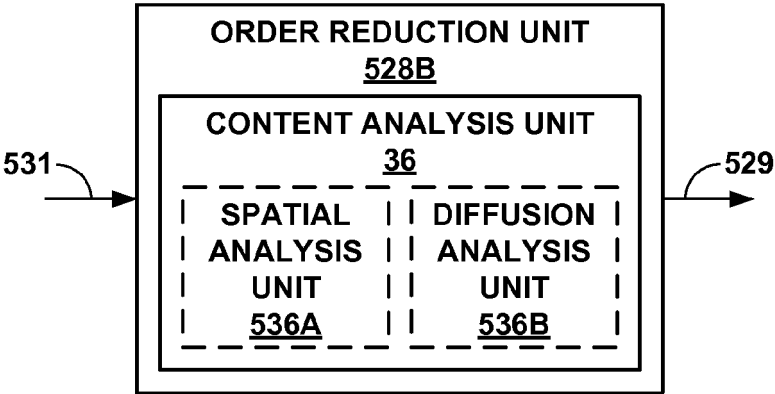


FIG. 42B

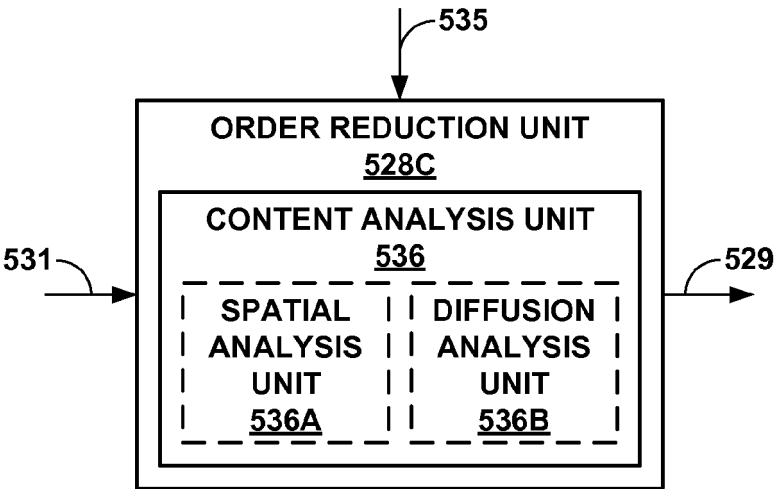


FIG. 42C

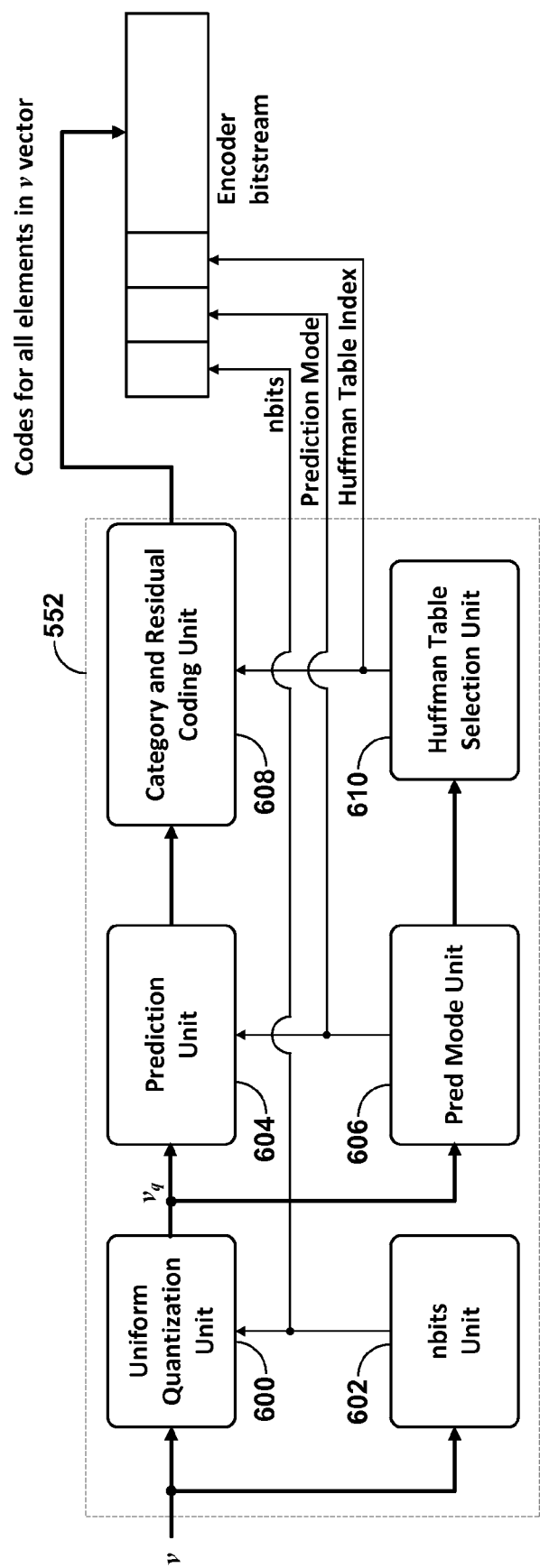


FIG. 43

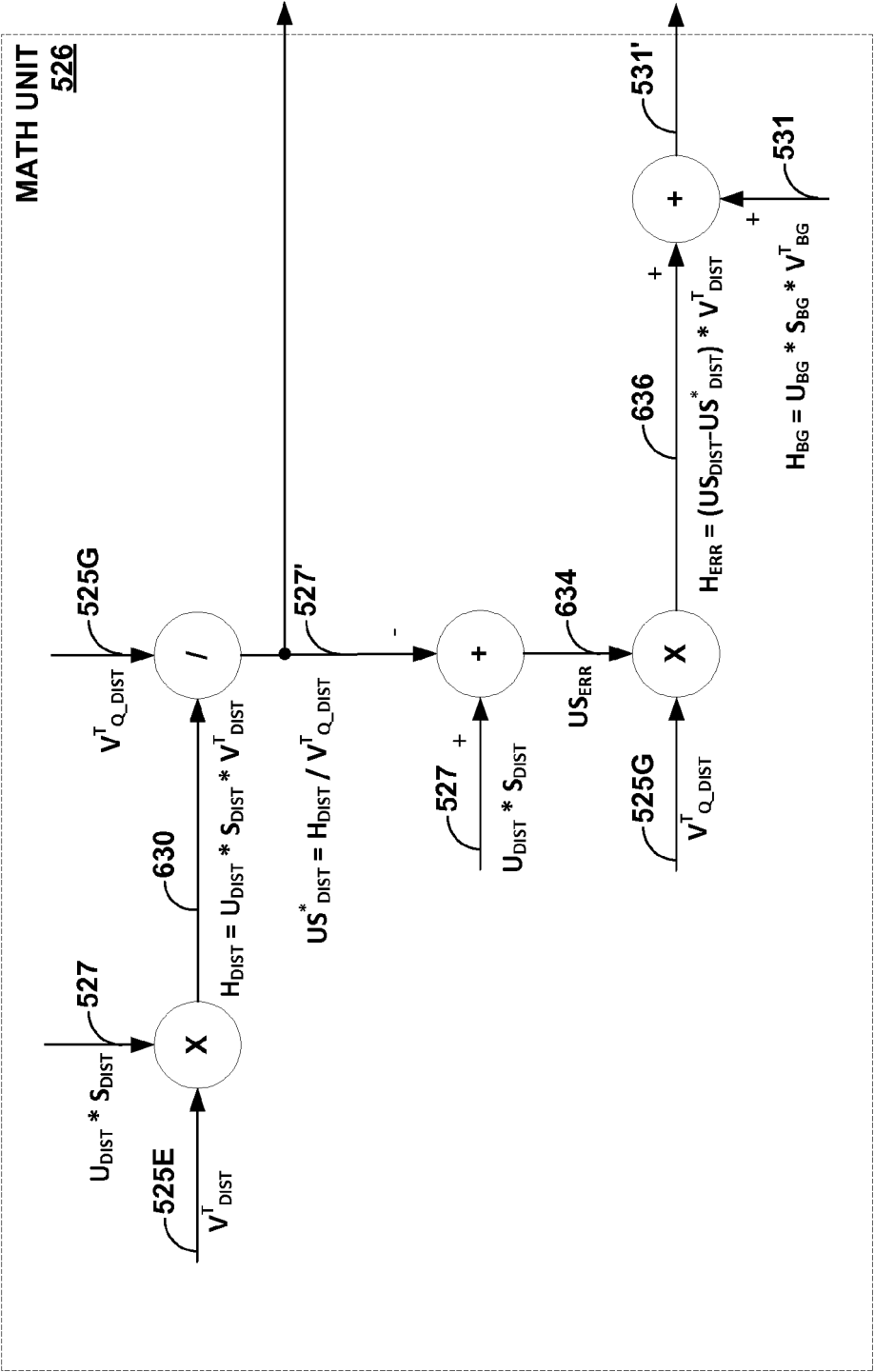
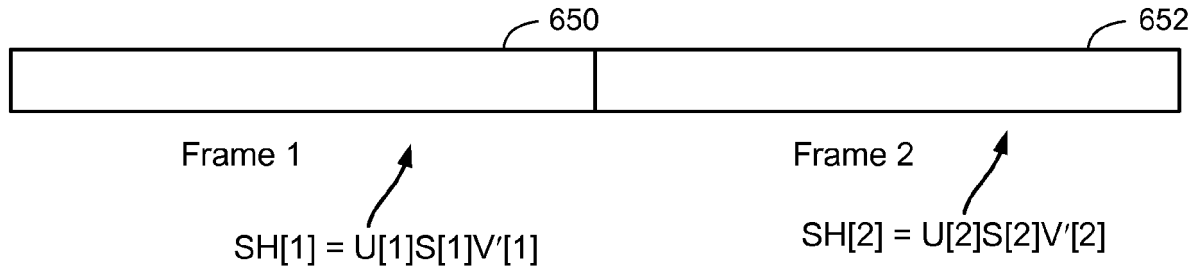
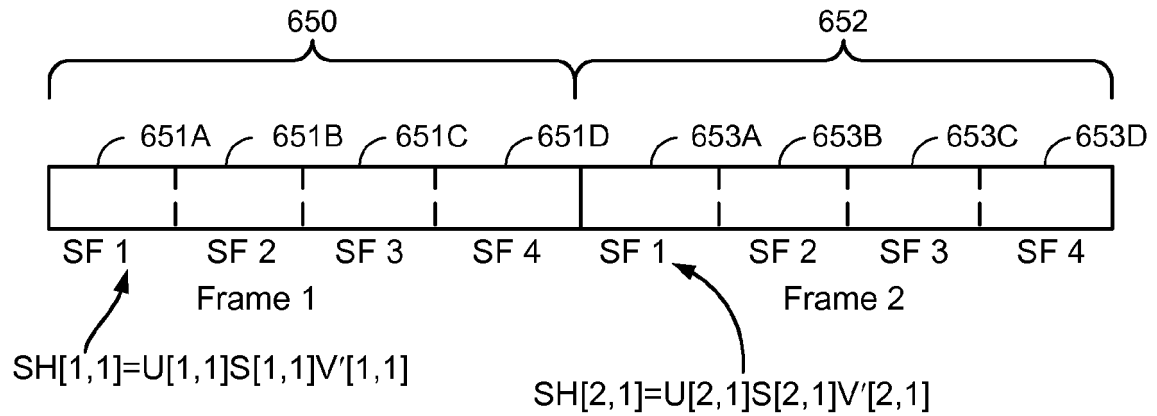


FIG. 44

**FIG. 45A**

$$\begin{aligned}
 V'[1,2] &= \text{interpolation}(V'[1,1], V'[2,1]) \rightarrow U[1,2]S[1,2] = SH[1,2](V'[1,2]) - 1 \\
 V'[1,3] &= \text{interpolation}(V'[1,1], V'[2,1]) \rightarrow U[1,3]S[1,3] = SH[1,3](V'[1,3]) - 1 \\
 V'[1,4] &= \text{interpolation}(V'[1,1], V'[2,1]) \rightarrow U[1,3]S[1,3] = SH[1,3](V'[1,3]) - 1
 \end{aligned}$$

FIG. 45B

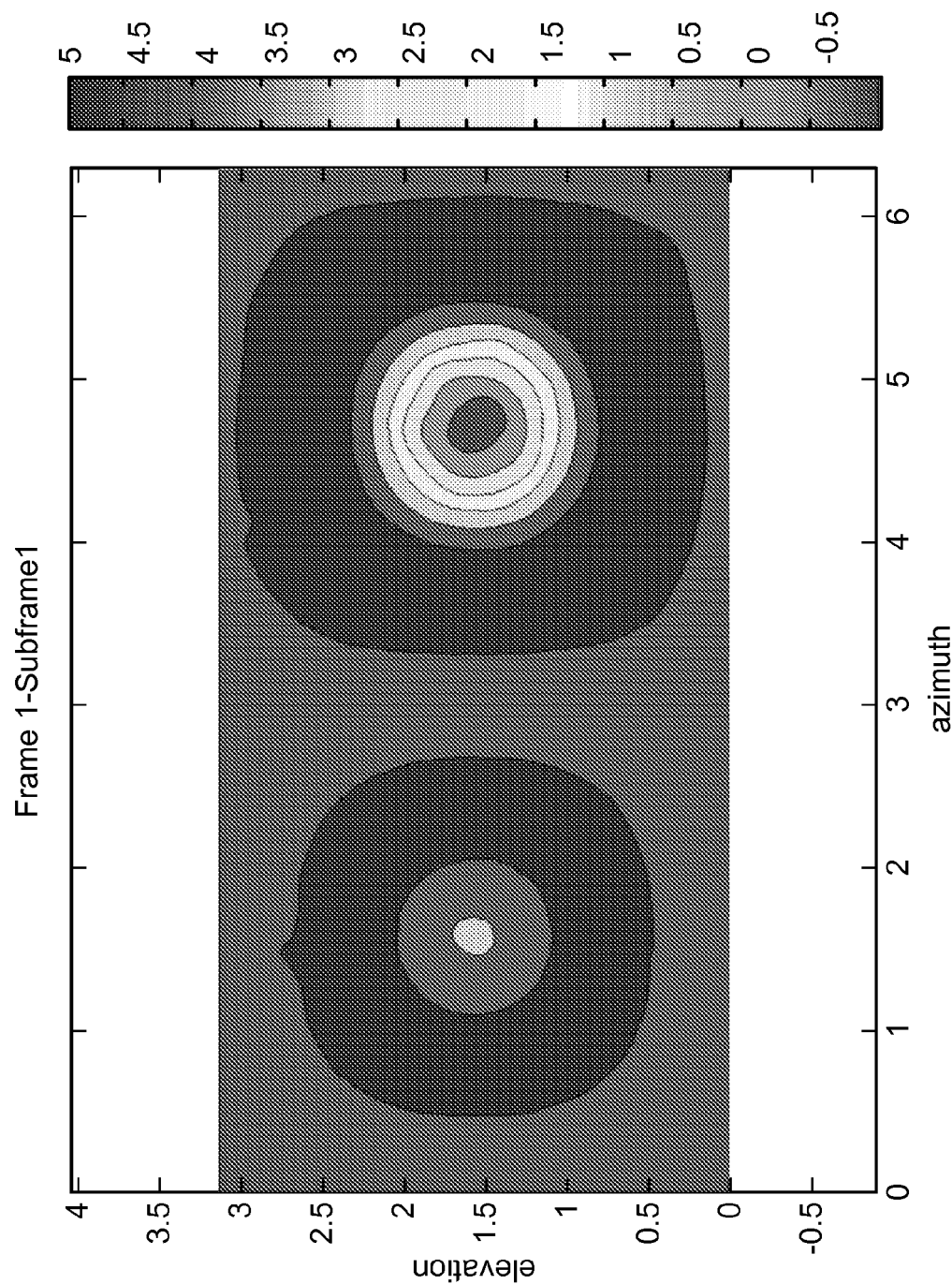


FIG. 46A

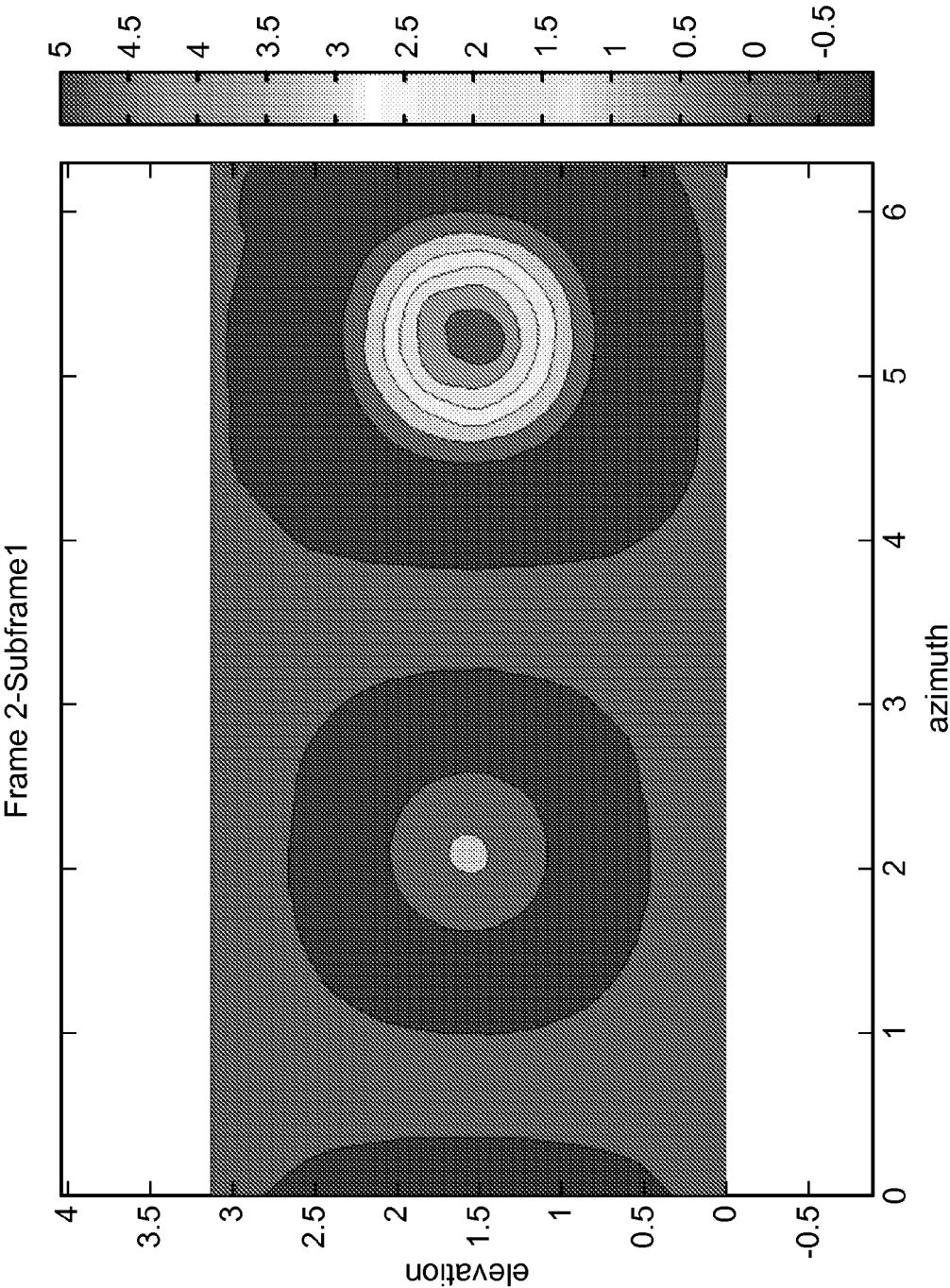


FIG. 46B

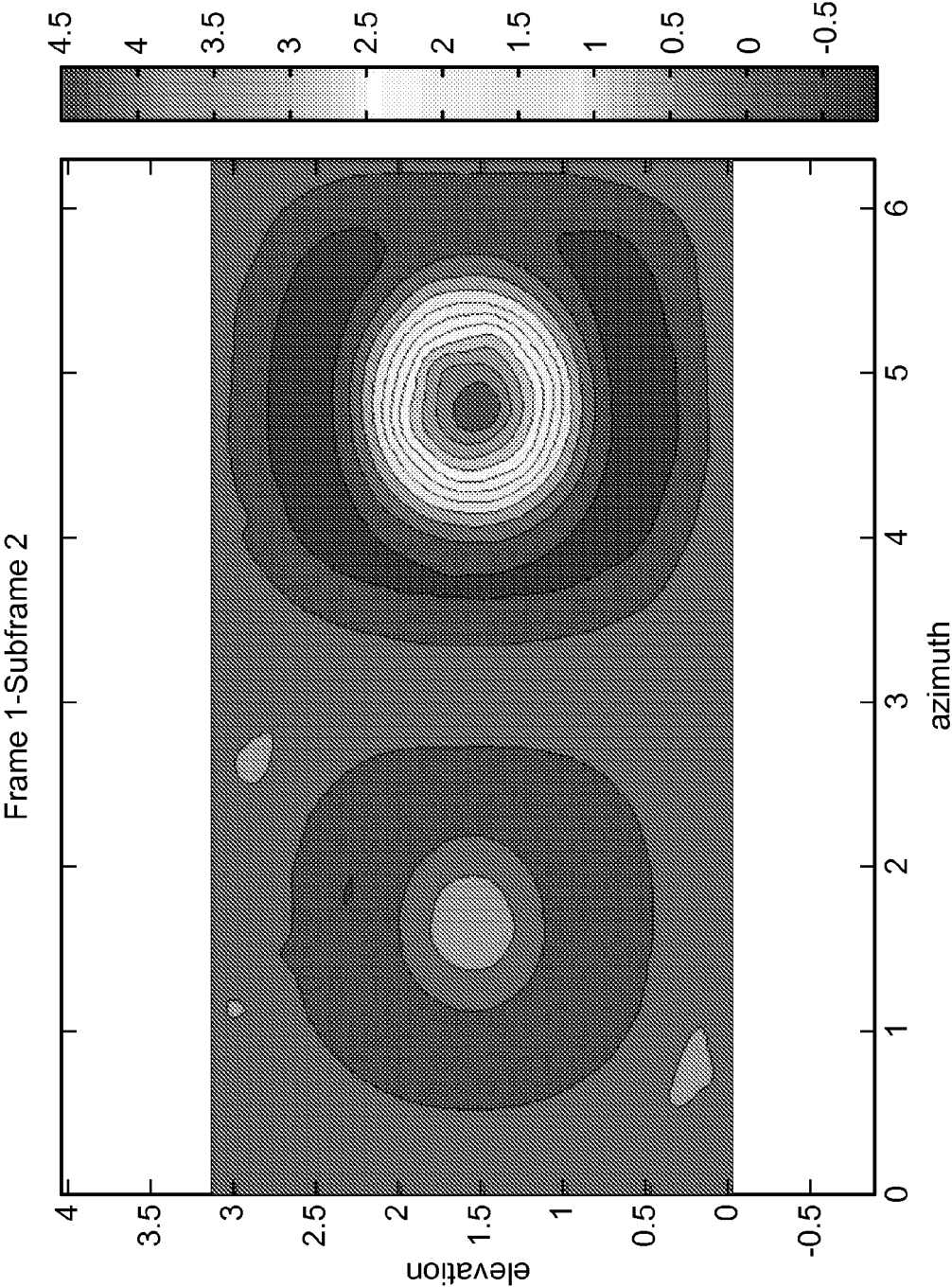


FIG. 46C

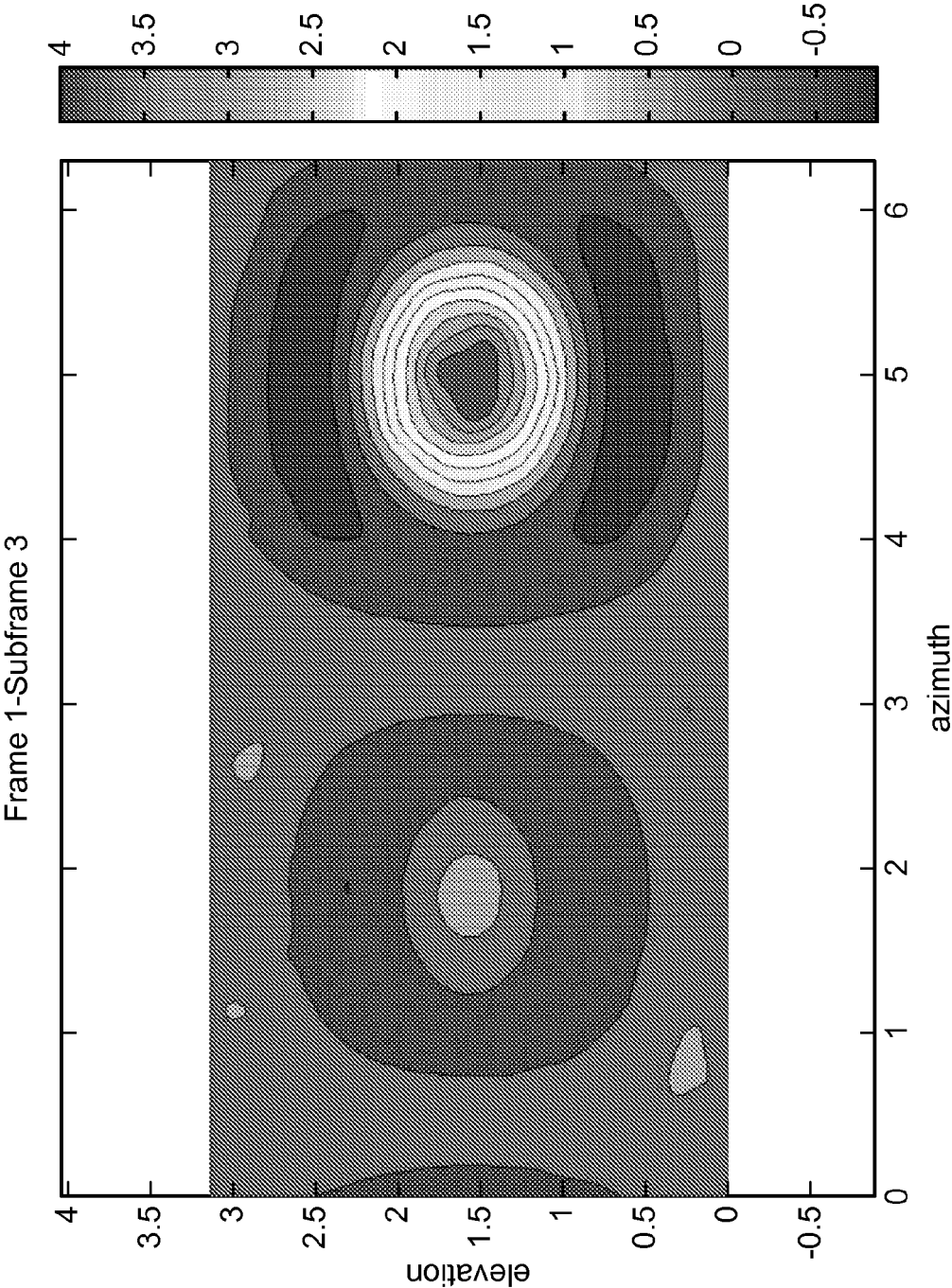


FIG. 46D

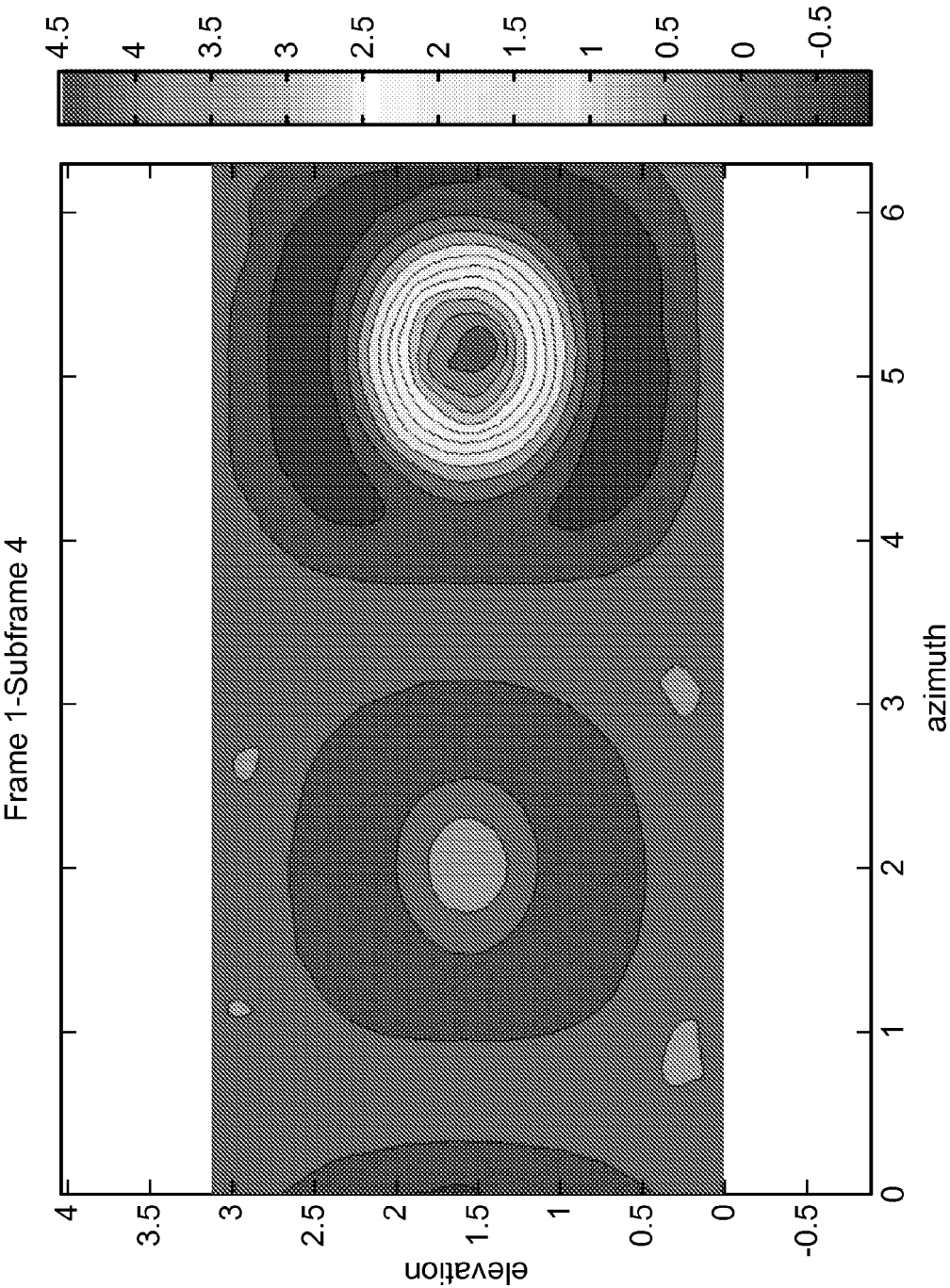


FIG. 46E

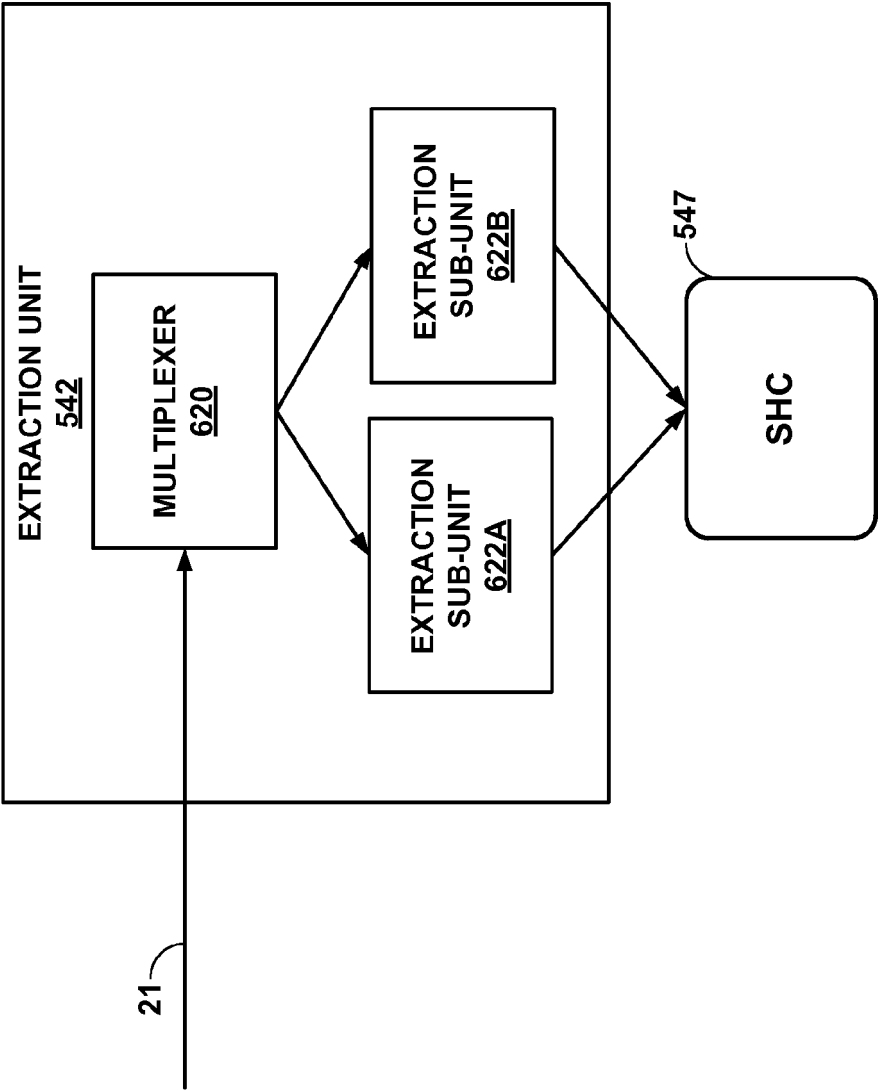
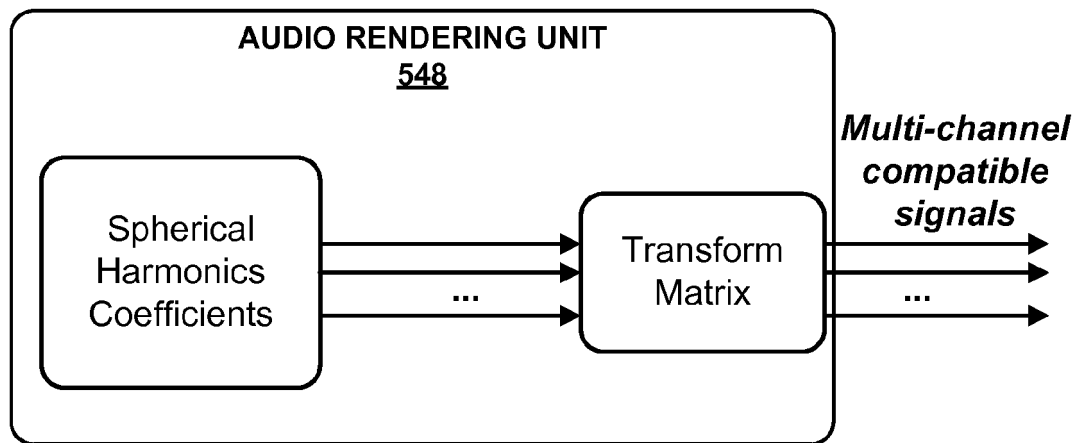


FIG. 47

**FIG. 48**

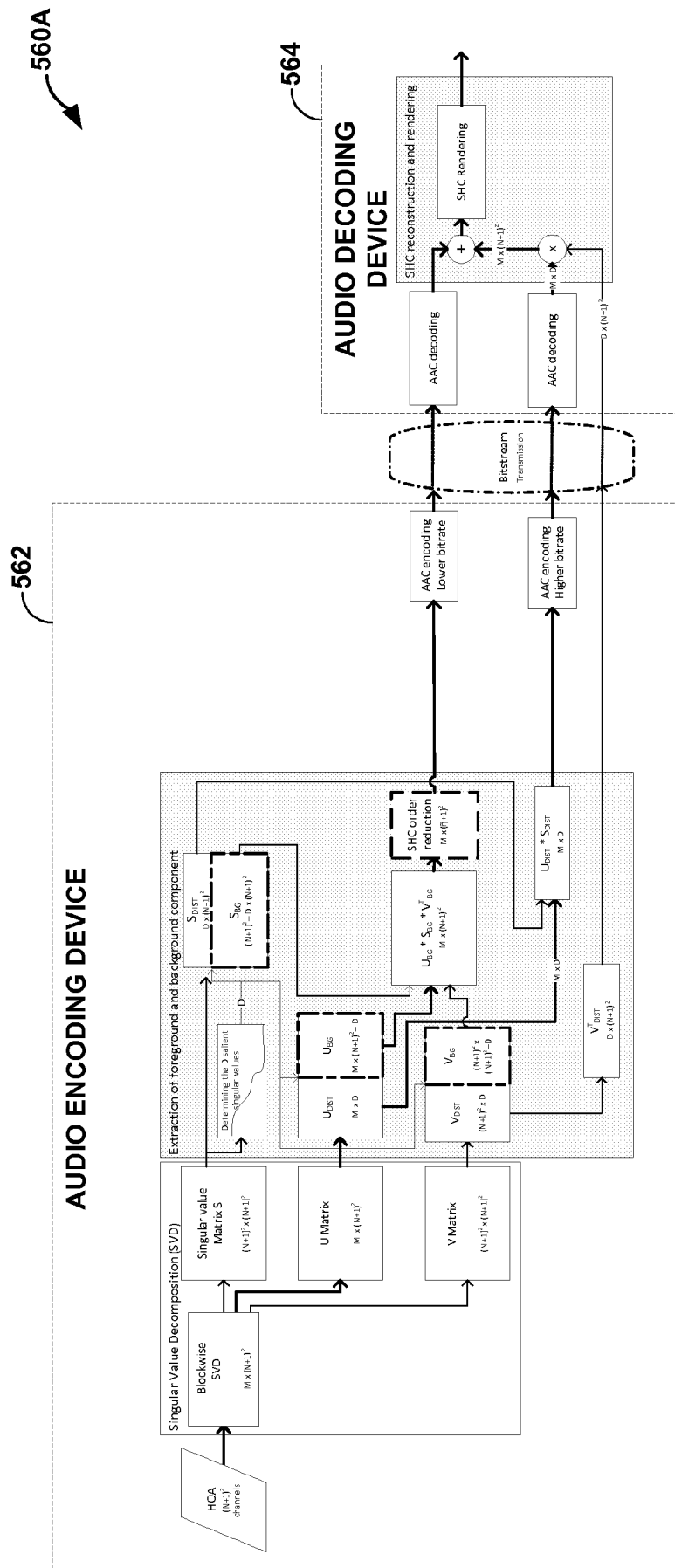


FIG. 49A

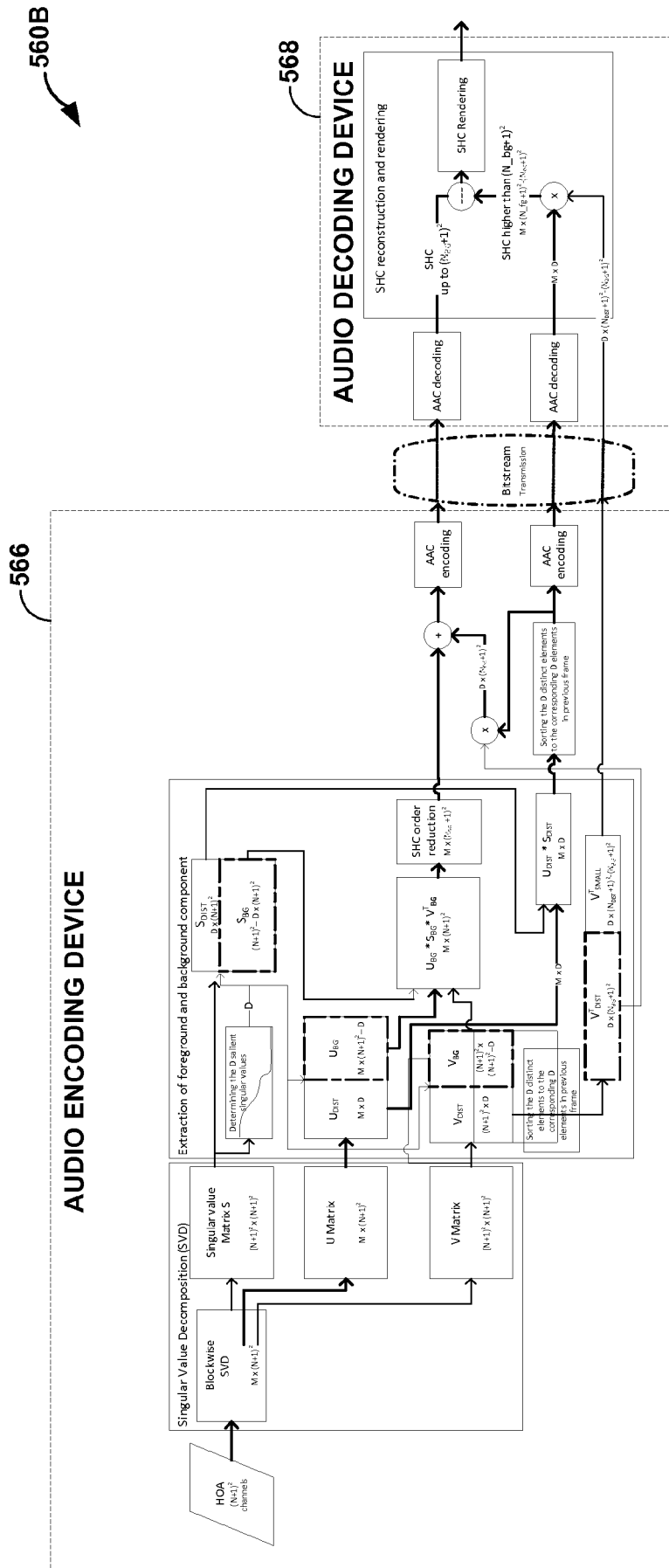


FIG. 49B

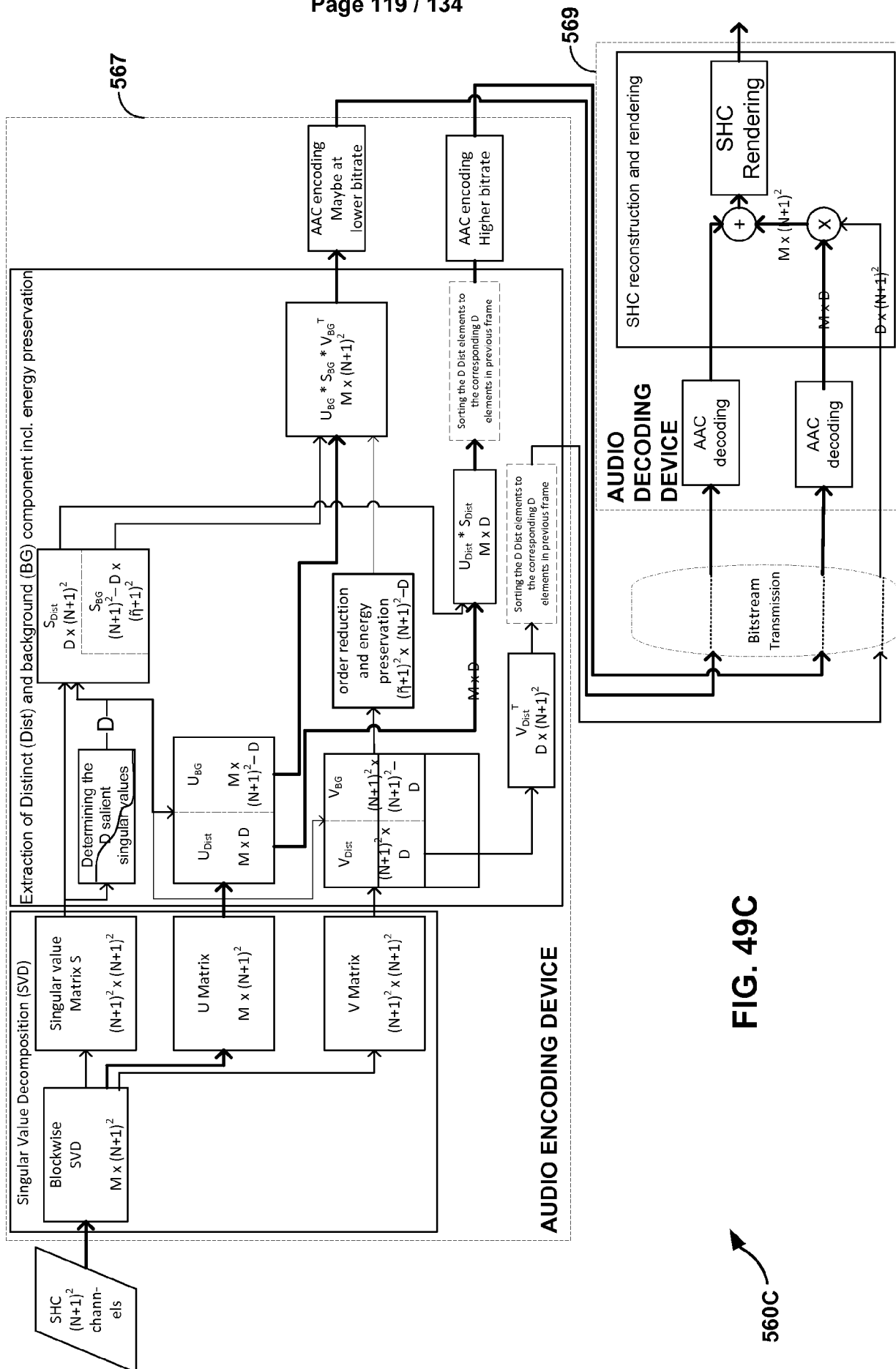


FIG. 49C

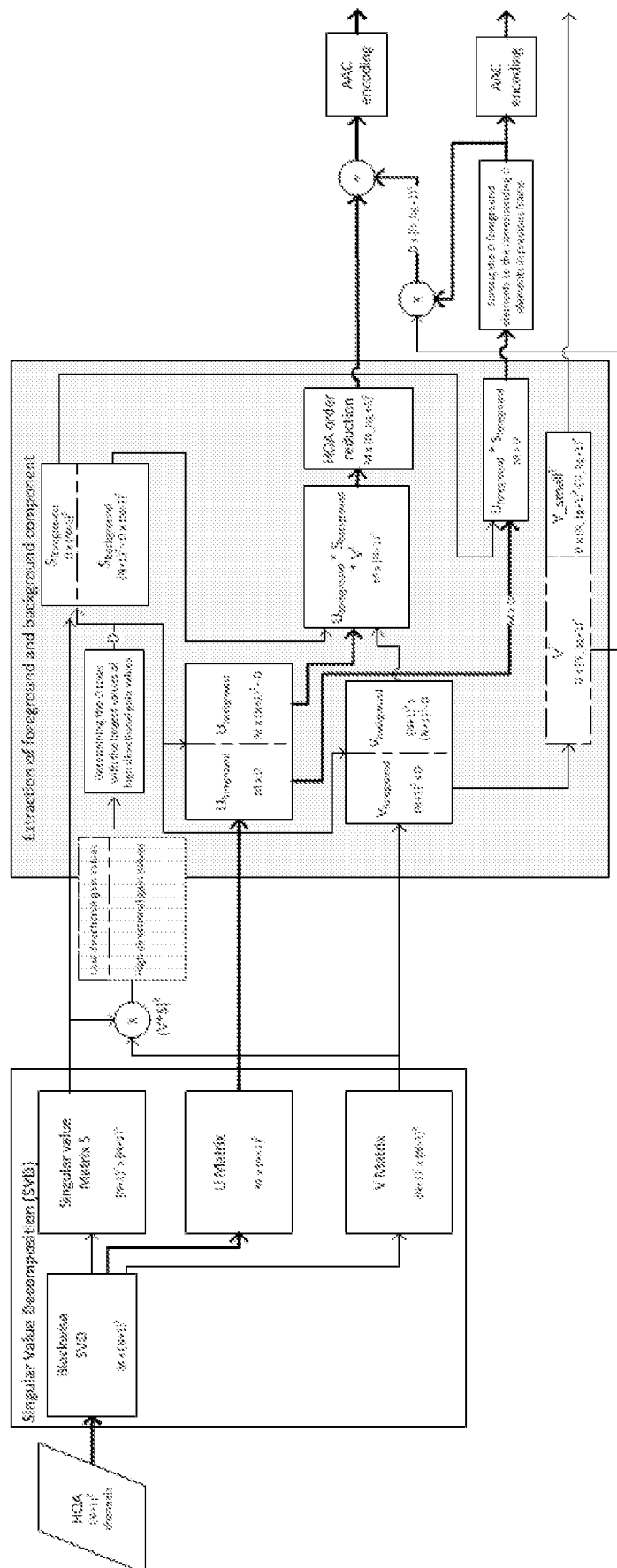


FIG. 49D(i)

567D

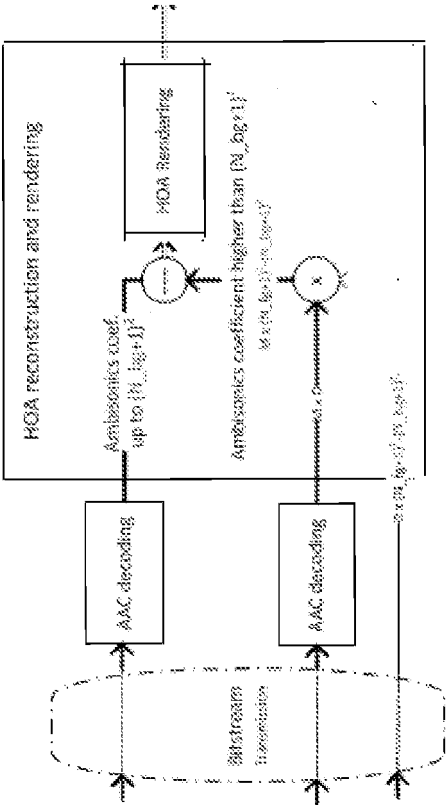


FIG. 49D(ii)

569D

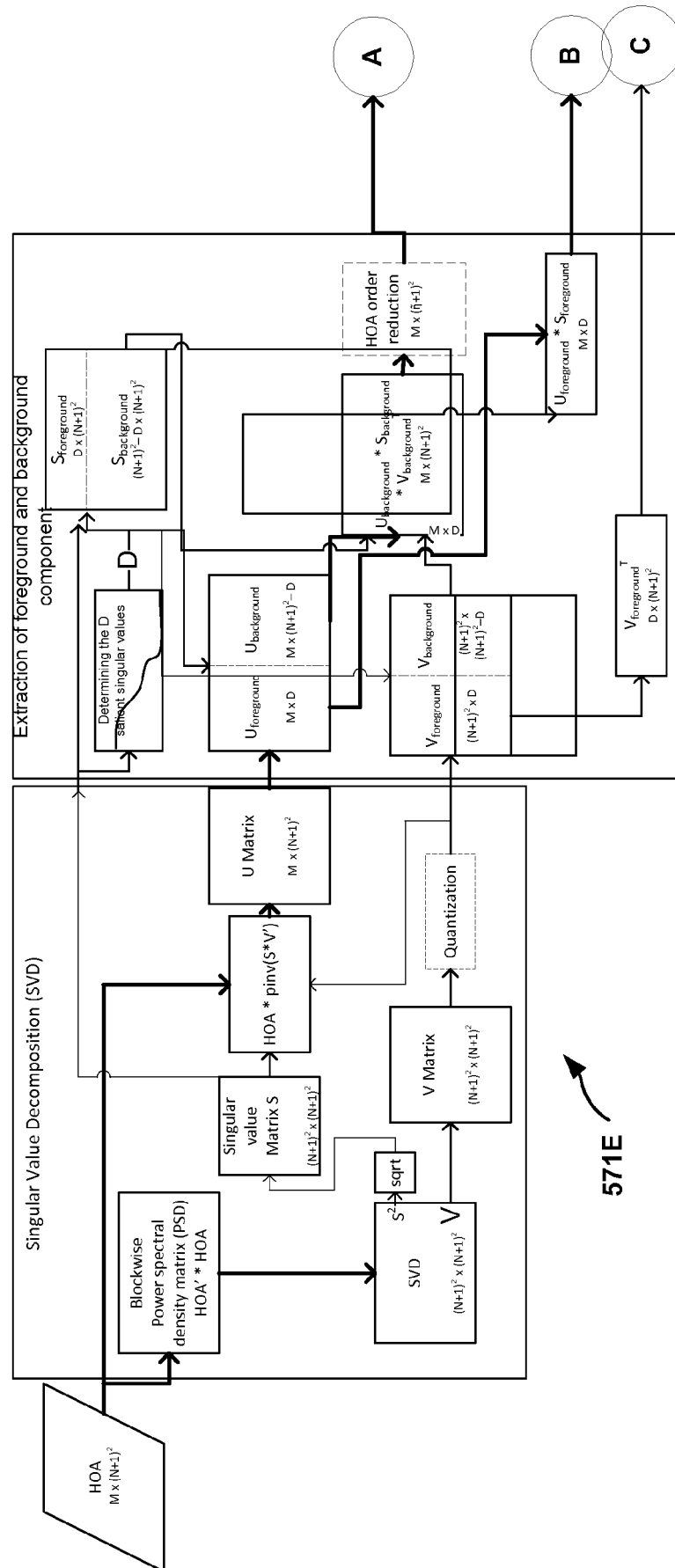


FIG. 49E(i)

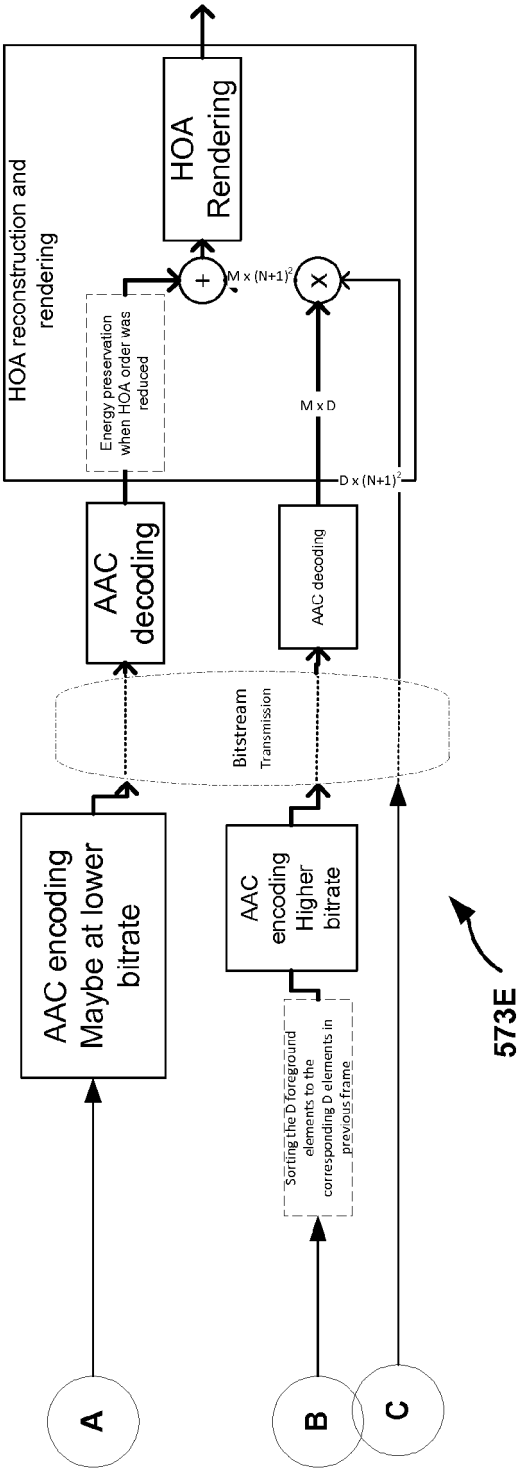


FIG. 49E(ii)

1. Reducing the HOA Order of the background content to $\tilde{n}$ ($\tilde{n} < N$)
approach

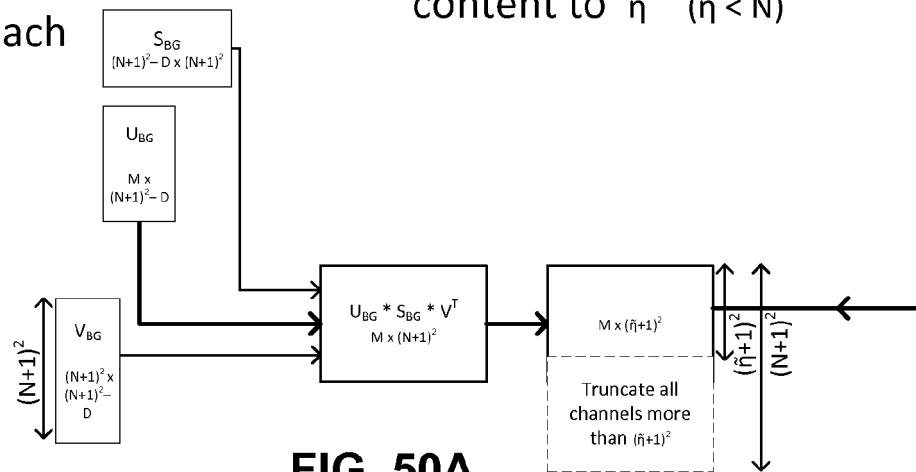


FIG. 50A

2. approach

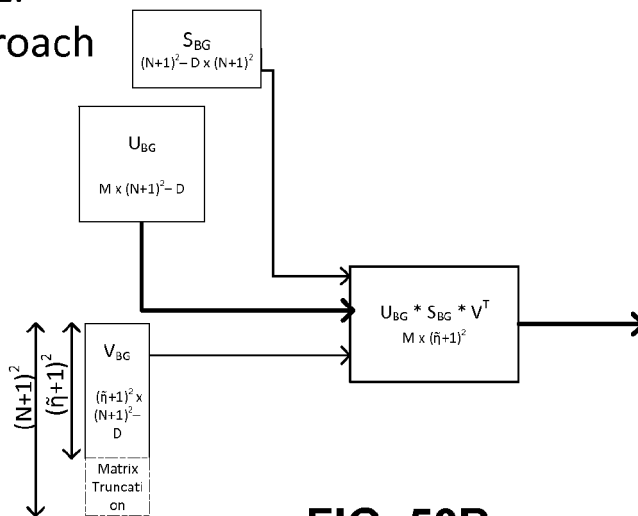
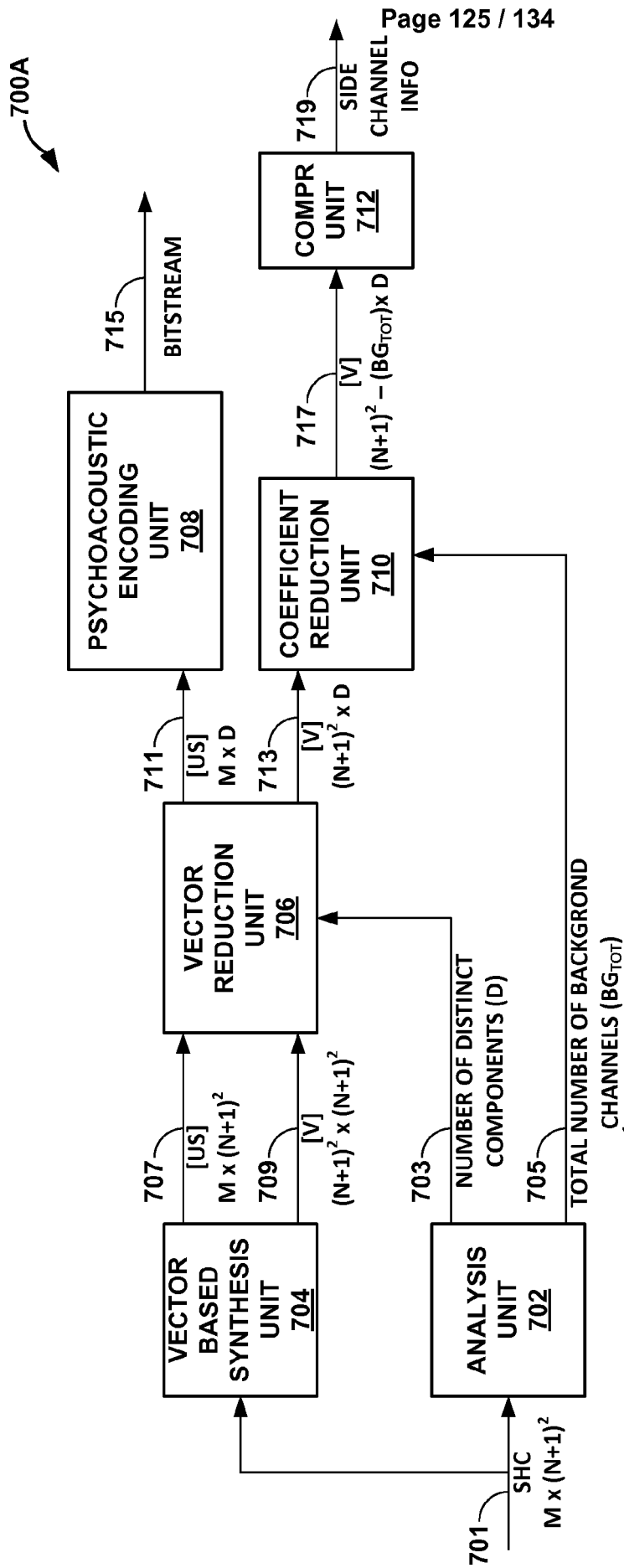


FIG. 50B



$BG_{TOT} = (N_{BG} + 1)^2 + TotalOfAddAmbHOAChan,$
 where the $TotalOfAddAmbHOAChan$ is selected
 from the set of $[(N_{BG} + 1)^2 + 1, (N+1)^2]$

FIG. 51

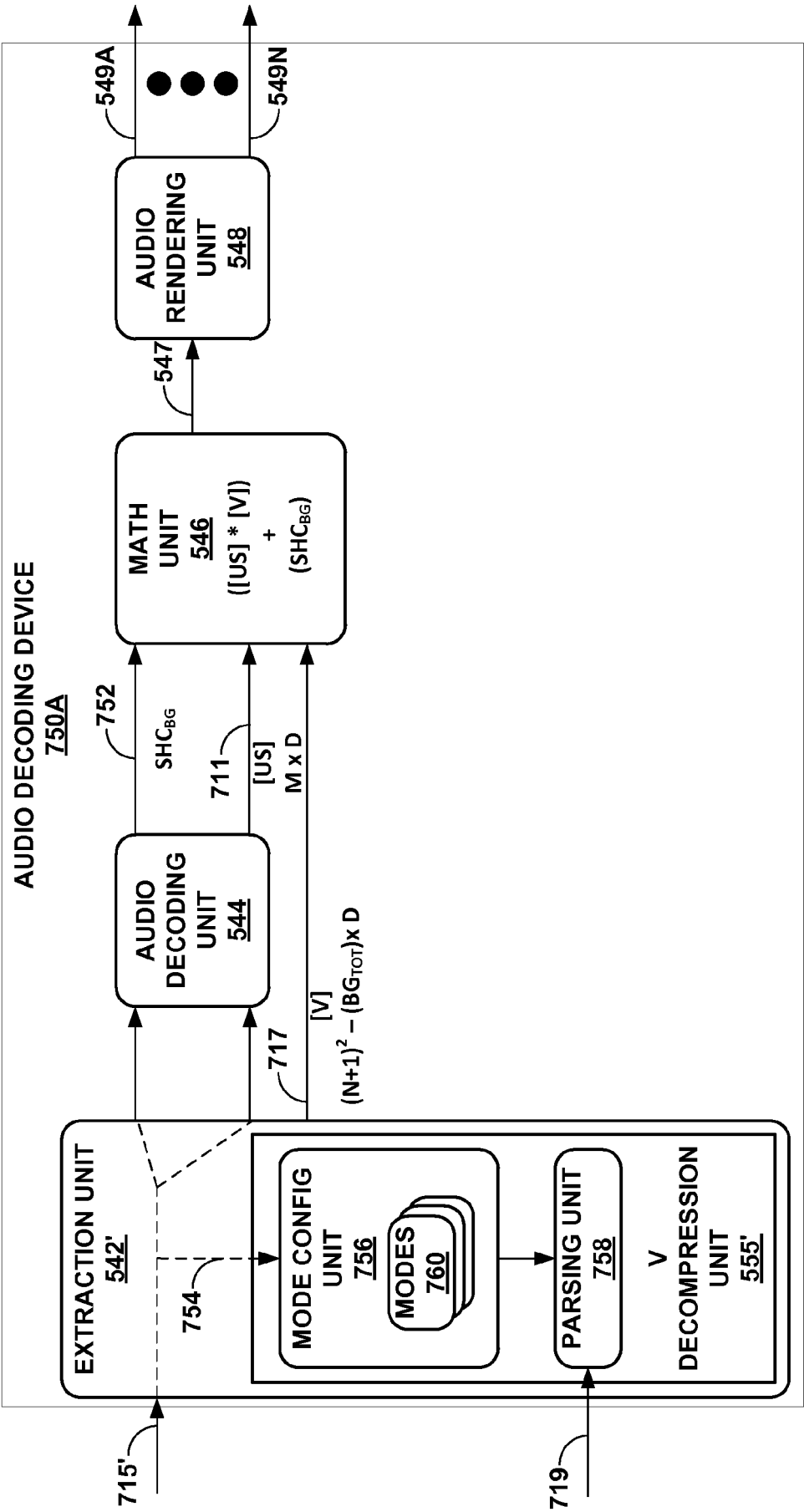


FIG. 52

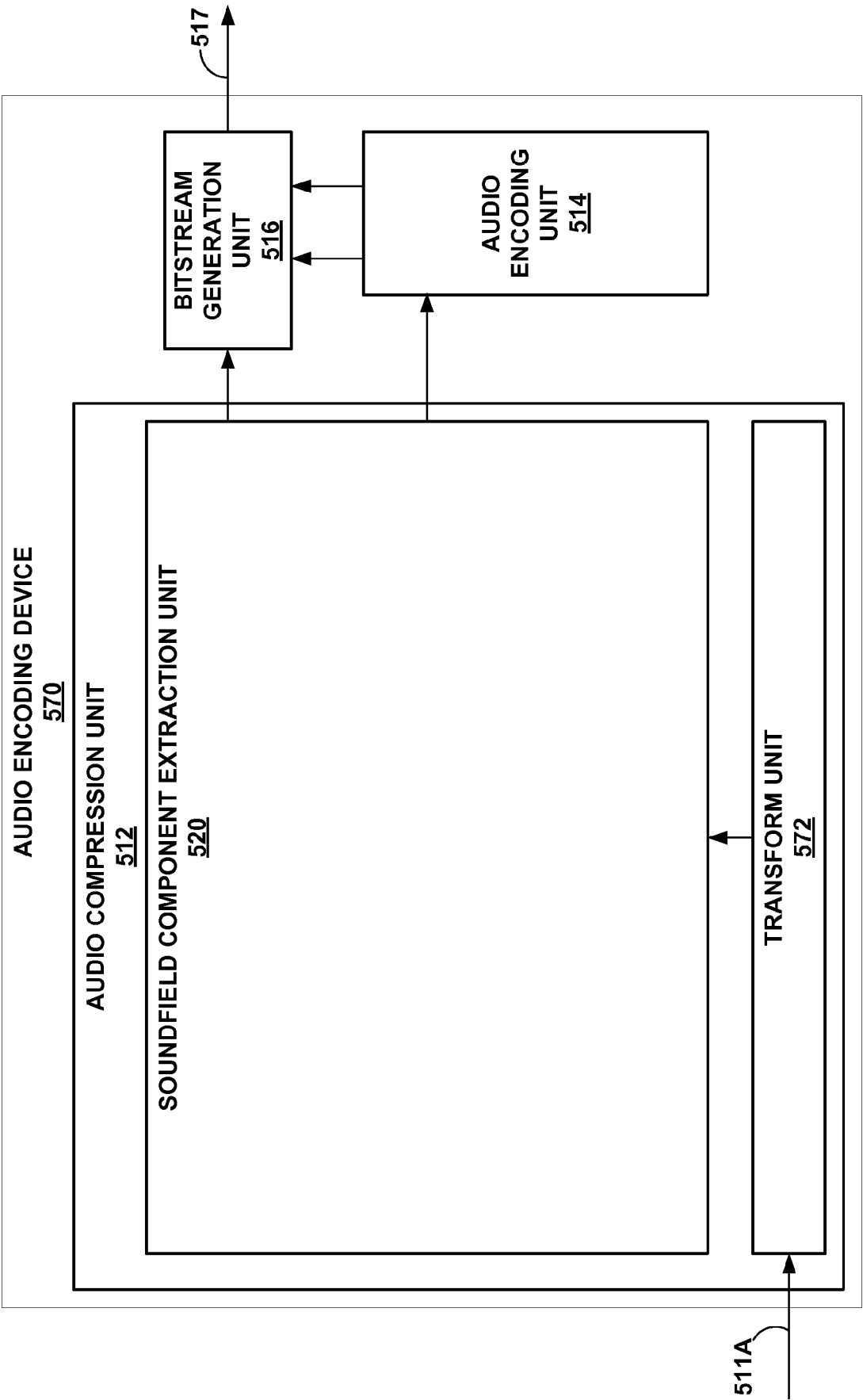


FIG. 53

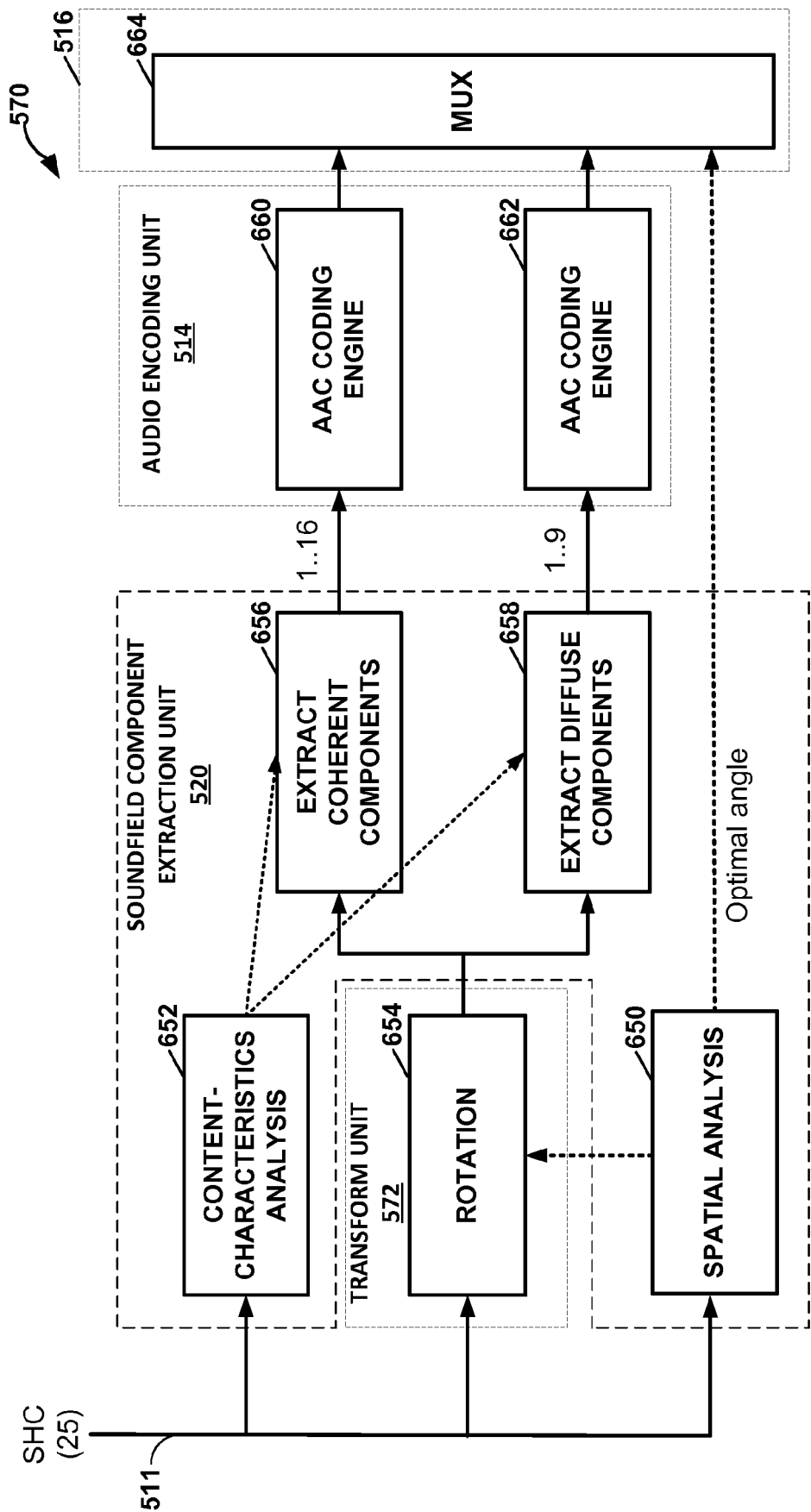


FIG. 54

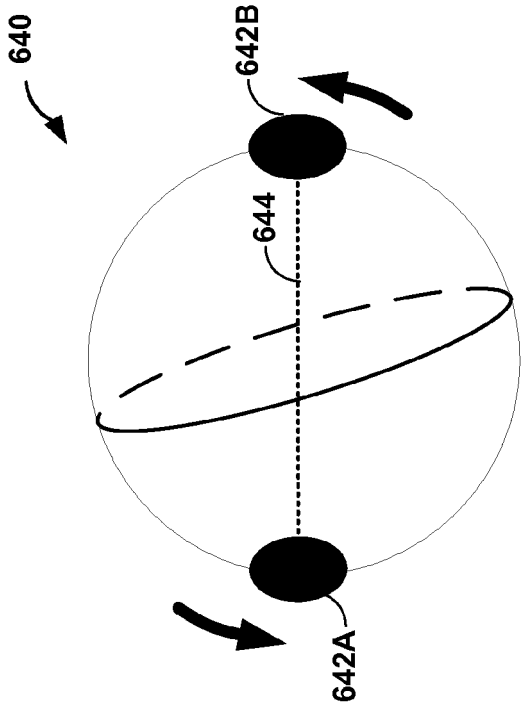


FIG. 55B

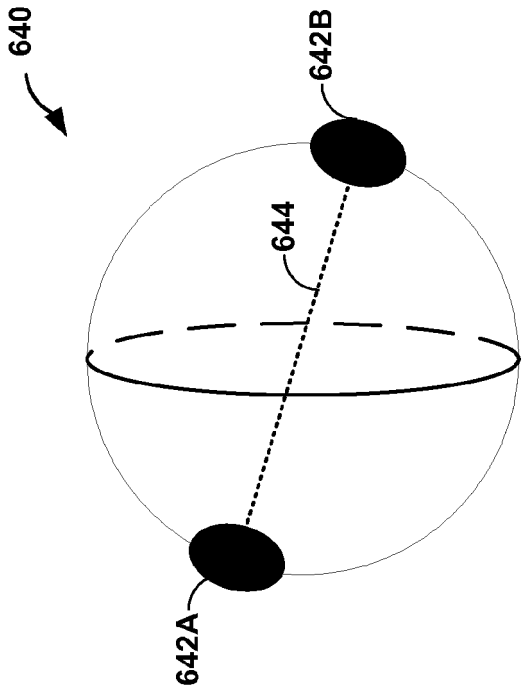


FIG. 55A

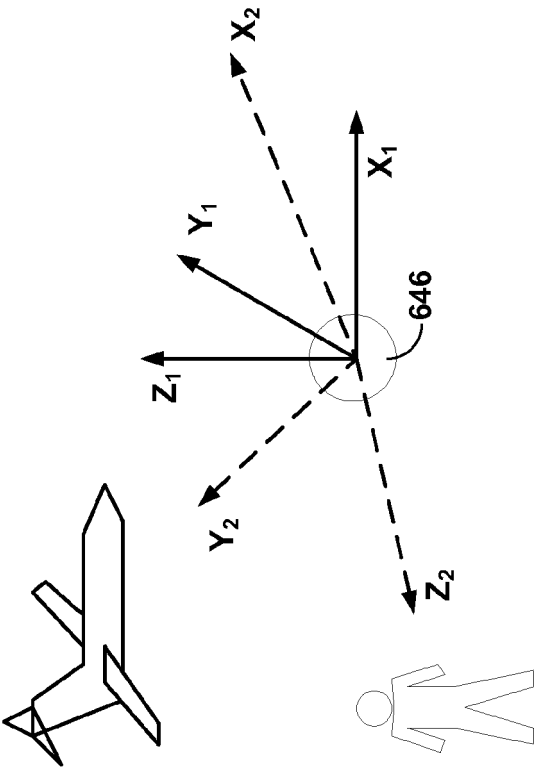


FIG. 56

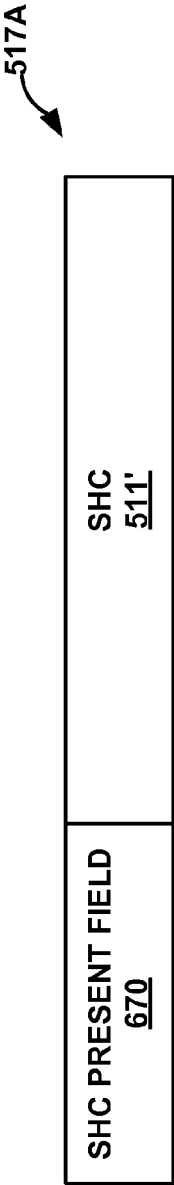


FIG. 57A

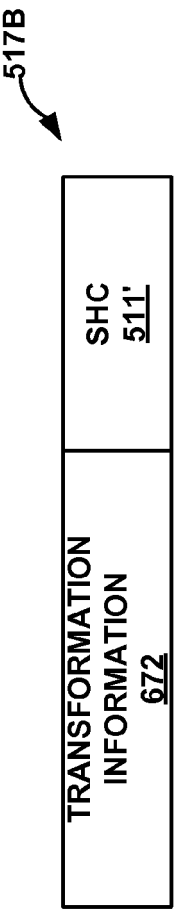


FIG. 57B

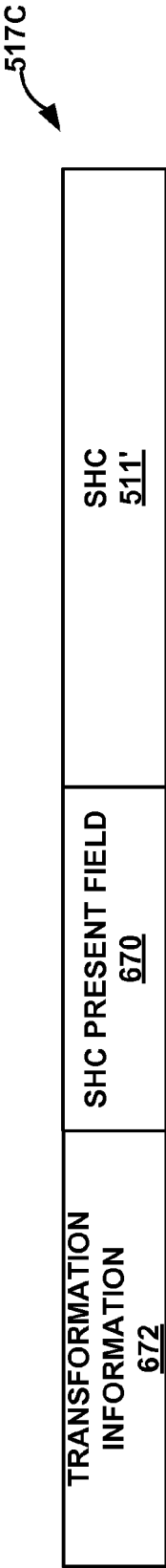


FIG. 57C

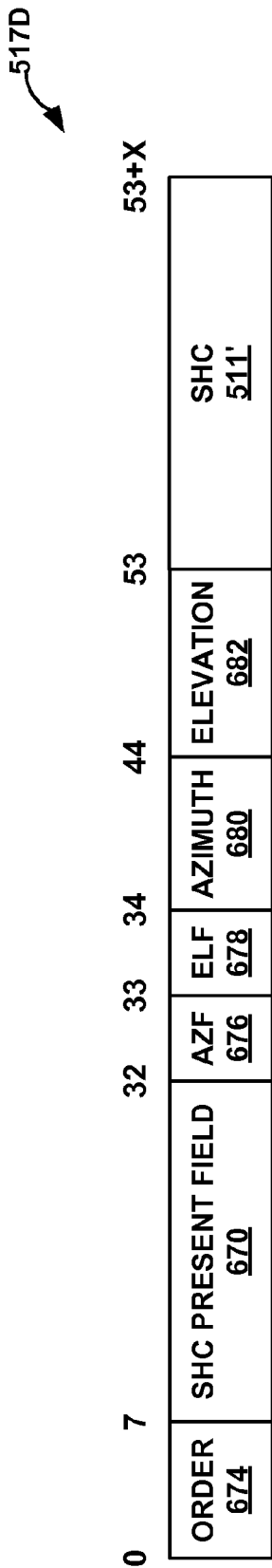


FIG. 57D

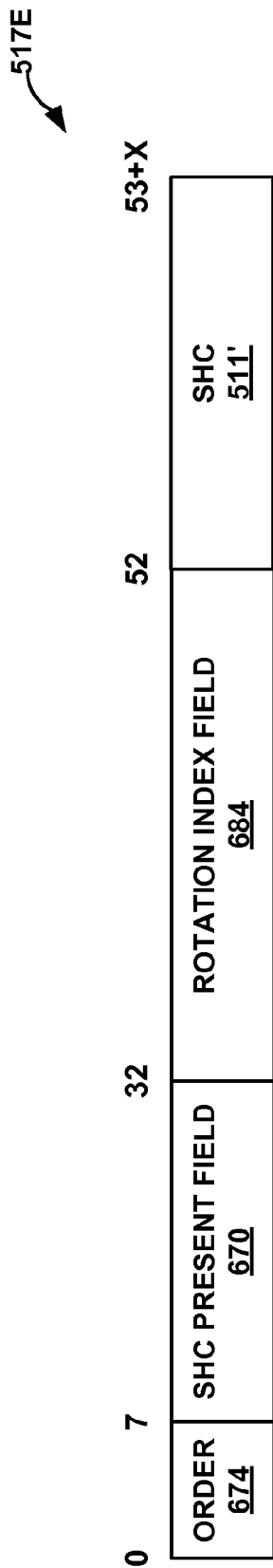


FIG. 57E

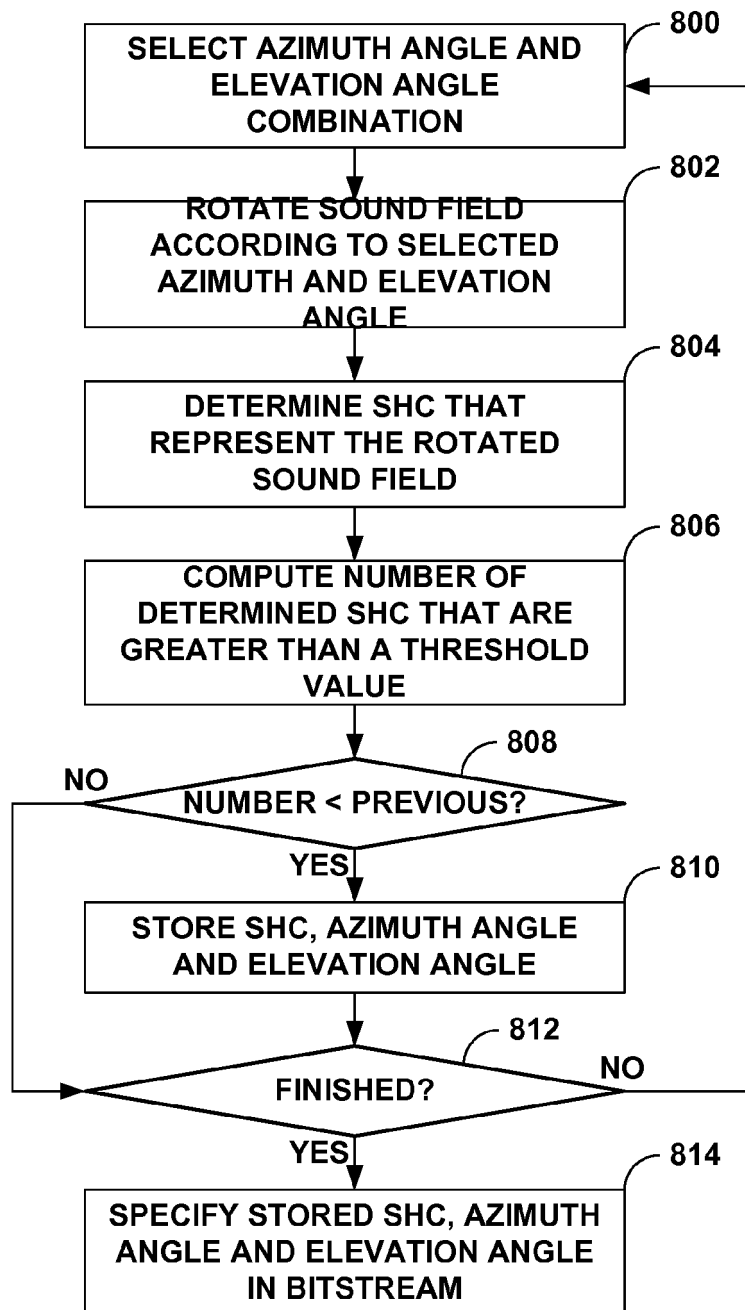


FIG. 58

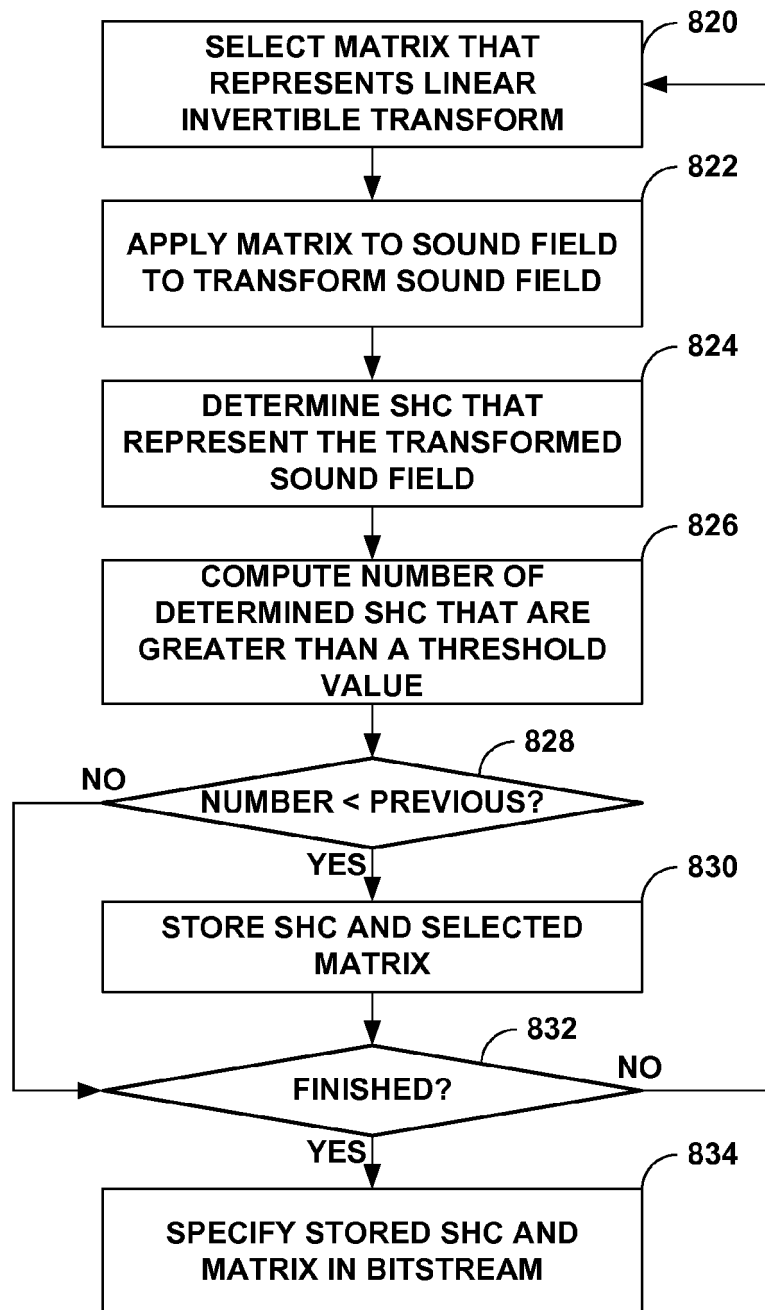


FIG. 59