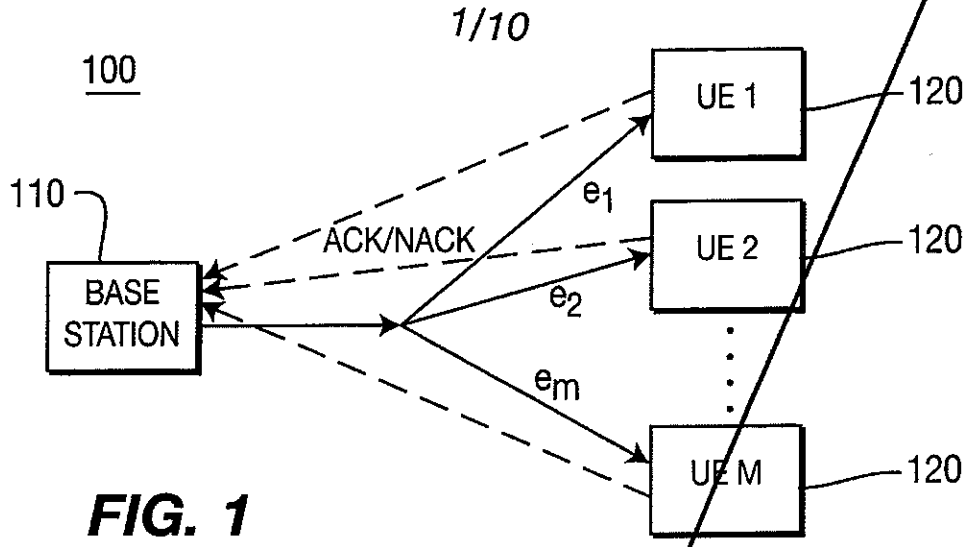

100
110
BASE STATION
ACK/NACK
e_1
e_2
e_m
UE 1
UE 2
UE M
120
120
120

FIG. 1

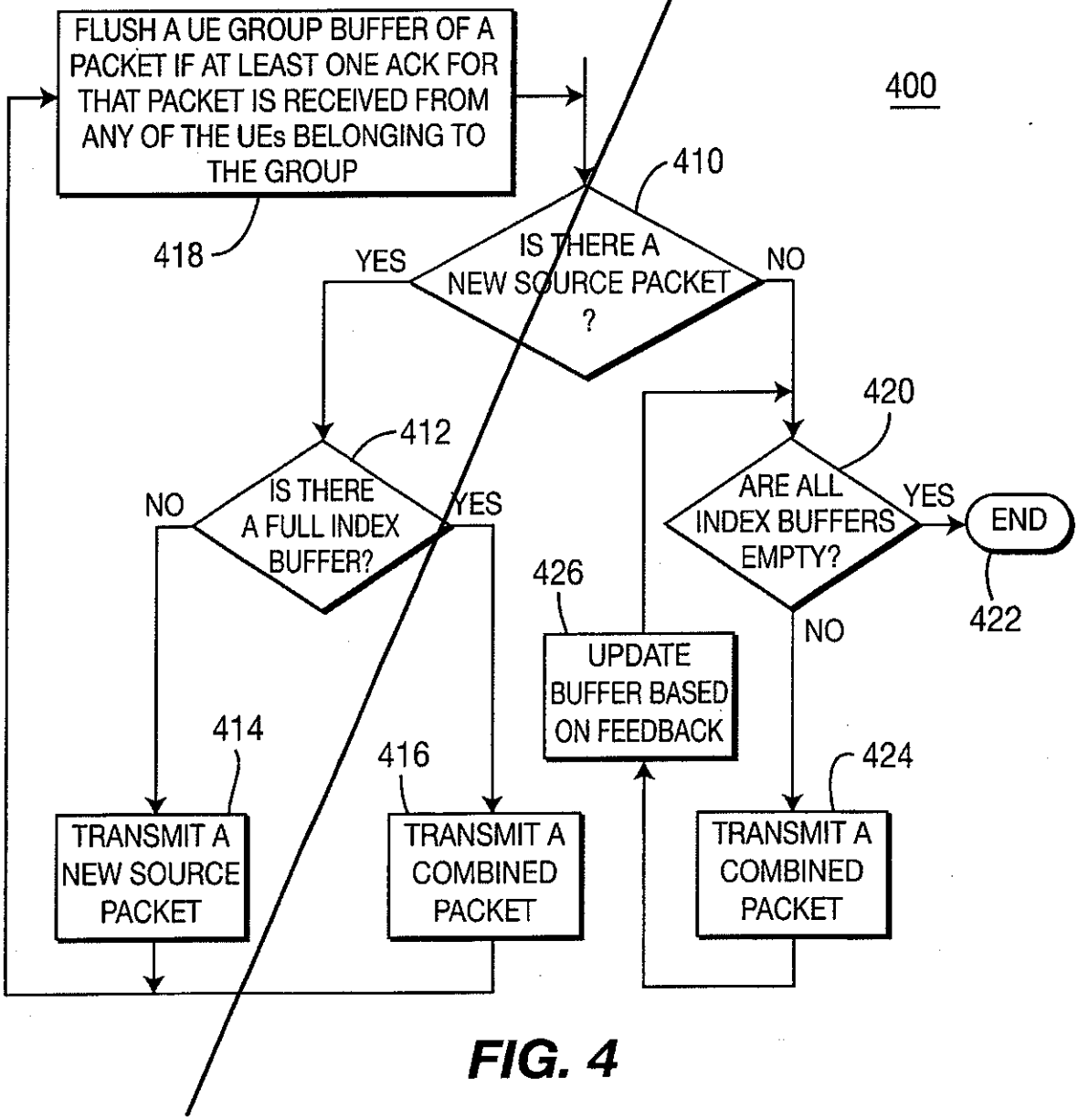

400
FLUSH A UE GROUP BUFFER OF A PACKET IF AT LEAST ONE ACK FOR THAT PACKET IS RECEIVED FROM ANY OF THE UEs BELONGING TO THE GROUP
418
410
IS THERE A NEW SOURCE PACKET ?
YES
NO
412
IS THERE A FULL INDEX BUFFER?
NO
YES
420
ARE ALL INDEX BUFFERS EMPTY?
YES
END
422
NO
426
UPDATE BUFFER BASED ON FEEDBACK
414
TRANSMIT A NEW SOURCE PACKET
416
TRANSMIT A COMBINED PACKET
424
TRANSMIT A COMBINED PACKET

FIG. 4

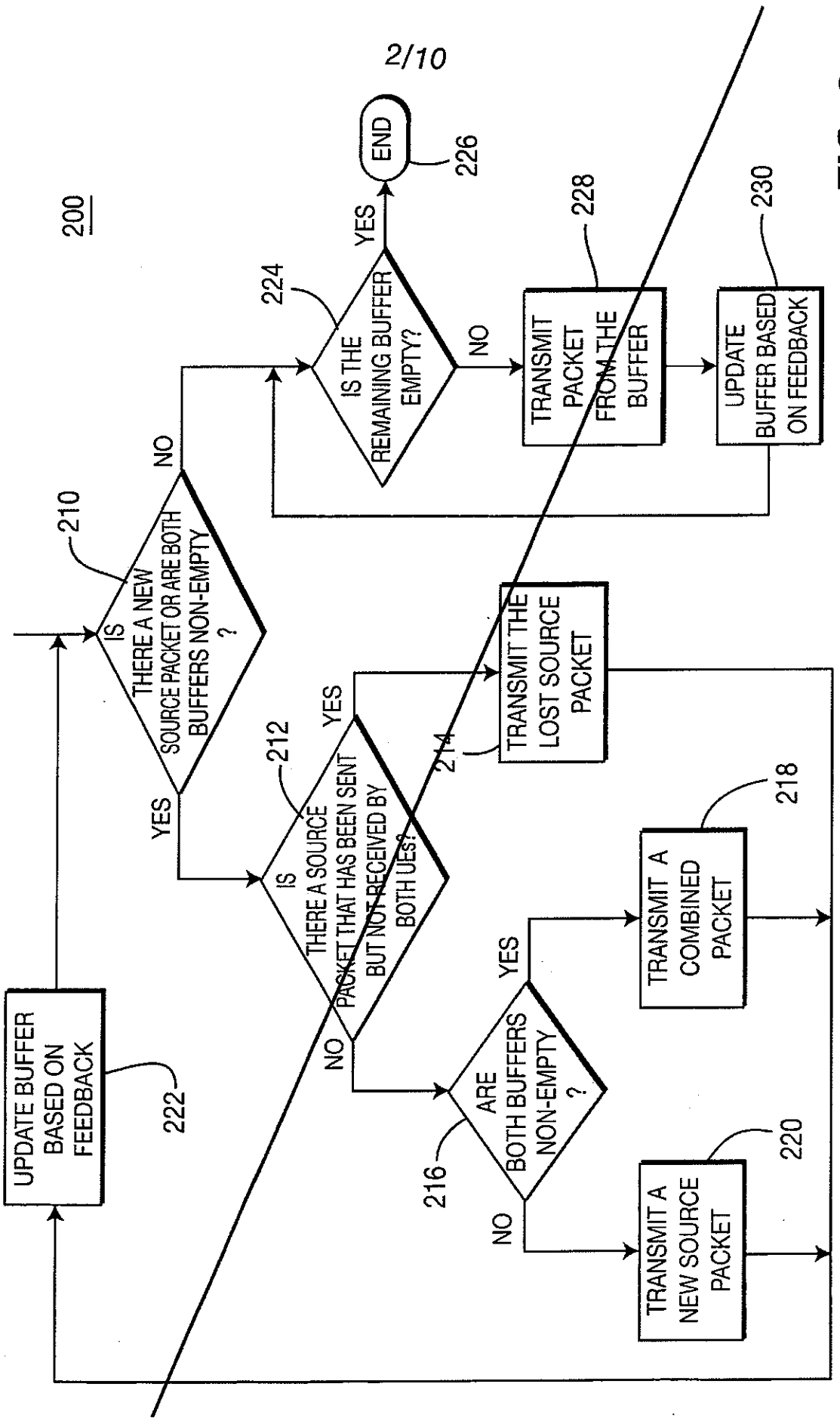

200
UPDATE BUFFER BASED ON FEEDBACK
222
IS THERE A NEW SOURCE PACKET OR ARE BOTH BUFFERS NON-EMPTY ?
210
NO
YES
IS THERE A SOURCE PACKET THAT HAS BEEN SENT BUT NOT RECEIVED BY BOTH UES?
212
YES
NO
TRANSMIT THE LOST SOURCE PACKET
214
ARE BOTH BUFFERS NON-EMPTY ?
216
YES
NO
TRANSMIT A COMBINED PACKET
218
TRANSMIT A NEW SOURCE PACKET
220
IS THE REMAINING BUFFER EMPTY?
224
YES
NO
END
226
TRANSMIT PACKET FROM THE BUFFER
228
UPDATE BUFFER BASED ON FEEDBACK
230

FIG. 2

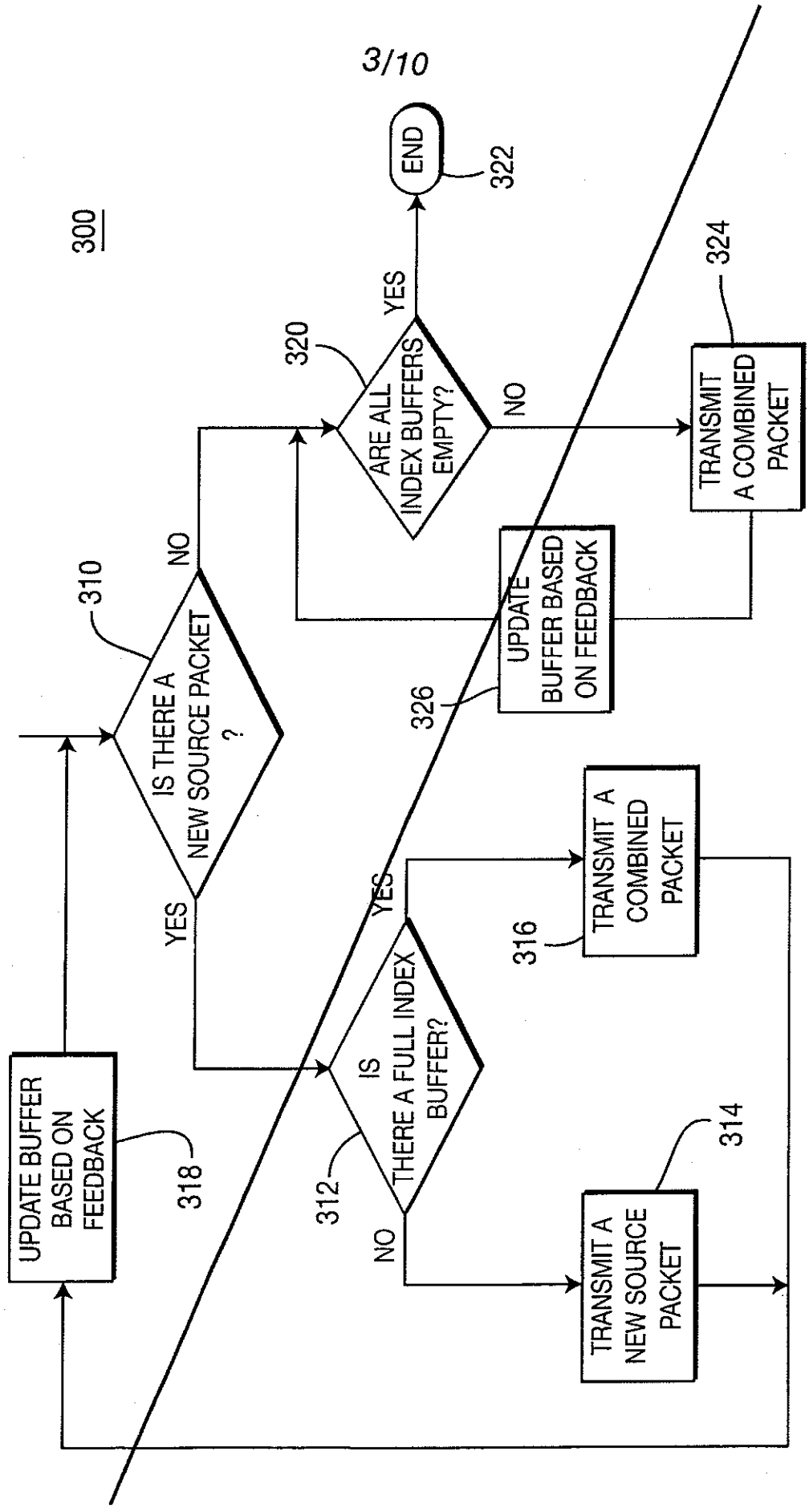

300
UPDATE BUFFER BASED ON FEEDBACK
318
IS THERE A NEW SOURCE PACKET ?
310
NO
YES
IS THERE A FULL INDEX BUFFER?
312
NO
YES
TRANSMIT A NEW SOURCE PACKET
314
TRANSMIT A COMBINED PACKET
316
ARE ALL INDEX BUFFERS EMPTY?
320
YES
NO
END
322
TRANSMIT A COMBINED PACKET
324
UPDATE BUFFER BASED ON FEEDBACK
326

FIG. 3

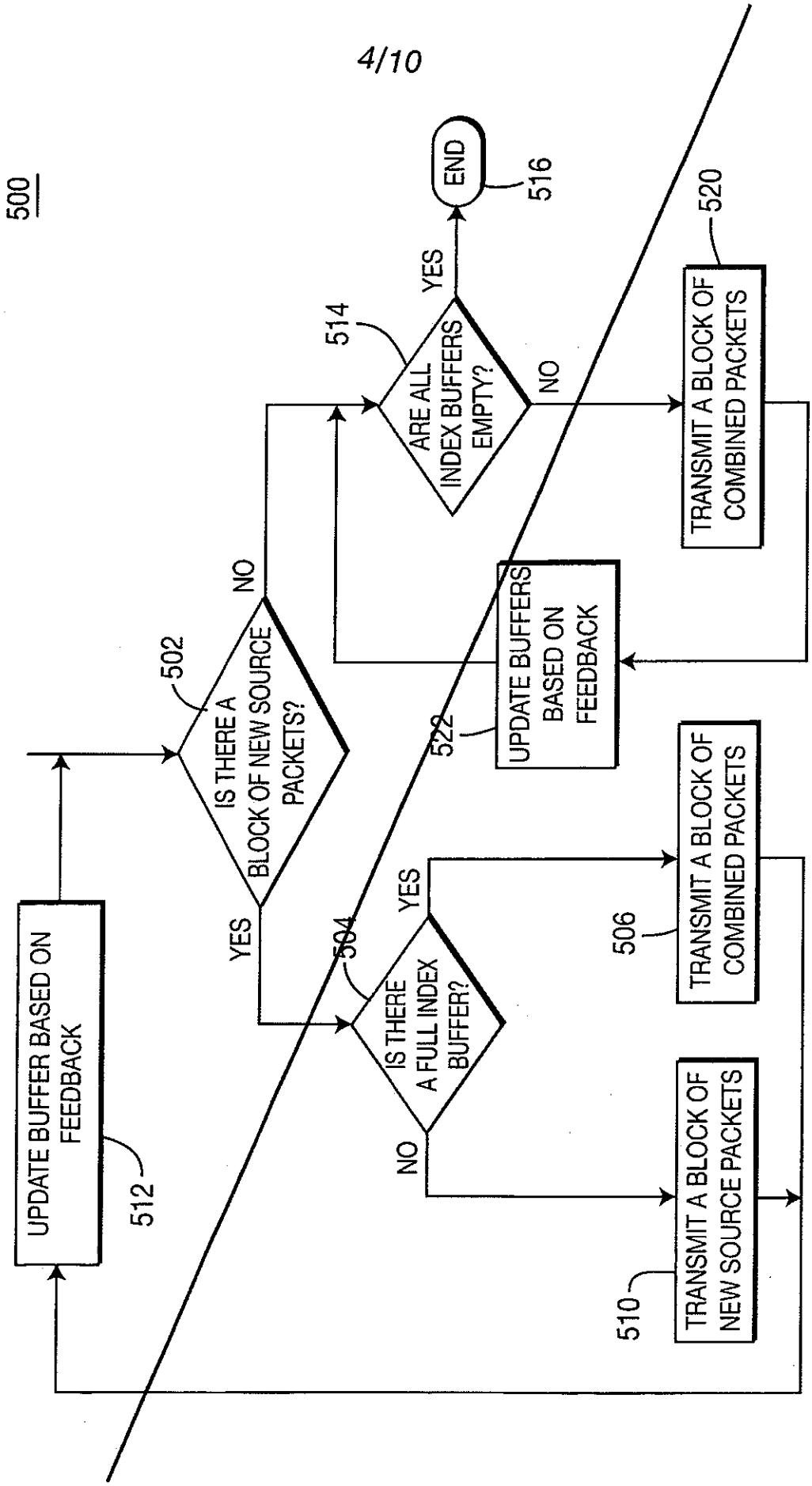

500
UPDATE BUFFER BASED ON FEEDBACK
512
IS THERE A BLOCK OF NEW SOURCE PACKETS?
502
YES
NO
IS THERE A FULL INDEX BUFFER?
504
YES
NO
TRANSMIT A BLOCK OF NEW SOURCE PACKETS
510
TRANSMIT A BLOCK OF COMBINED PACKETS
506
UPDATE BUFFERS BASED ON FEEDBACK
522
ARE ALL INDEX BUFFERS EMPTY?
514
YES
NO
END
516
TRANSMIT A BLOCK OF COMBINED PACKETS
520

FIG. 5

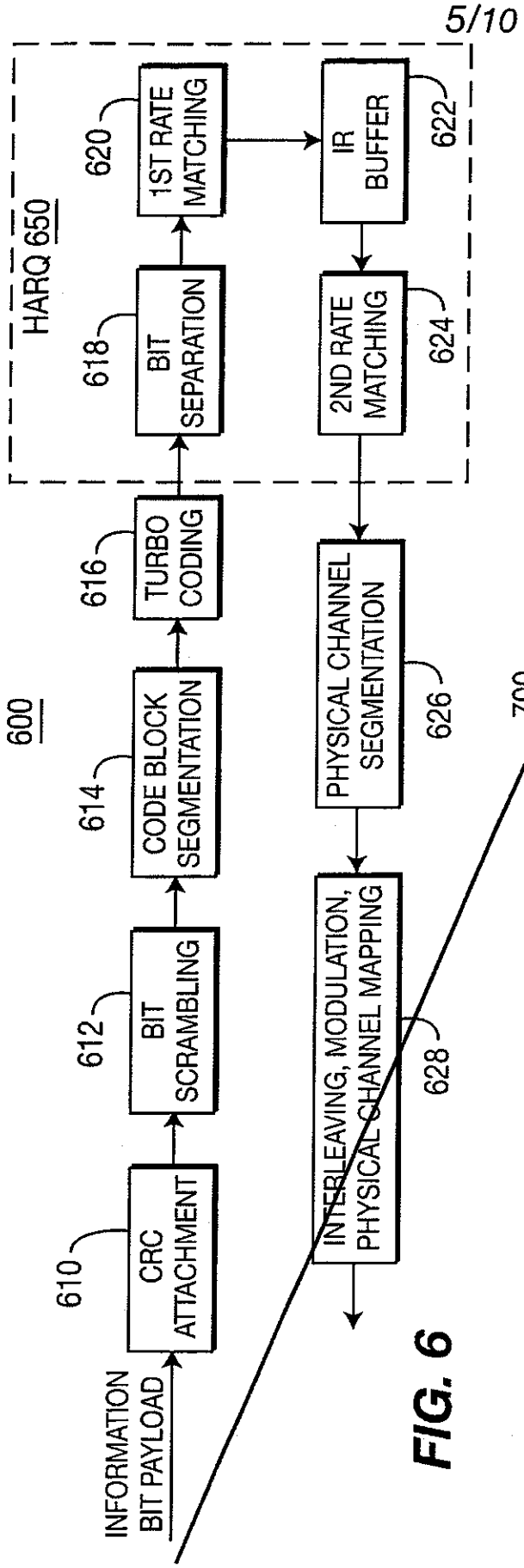

600
INFORMATION BIT PAYLOAD
610
CRC ATTACHMENT
612
BIT SCRAMBLING
614
CODE BLOCK SEGMENTATION
616
TURBO CODING
HARQ 650
618
BIT SEPARATION
620
1ST RATE MATCHING
622
IR BUFFER
624
2ND RATE MATCHING
626
PHYSICAL CHANNEL SEGMENTATION
628
INTERLEAVING, MODULATION, PHYSICAL CHANNEL MAPPING

FIG. 6

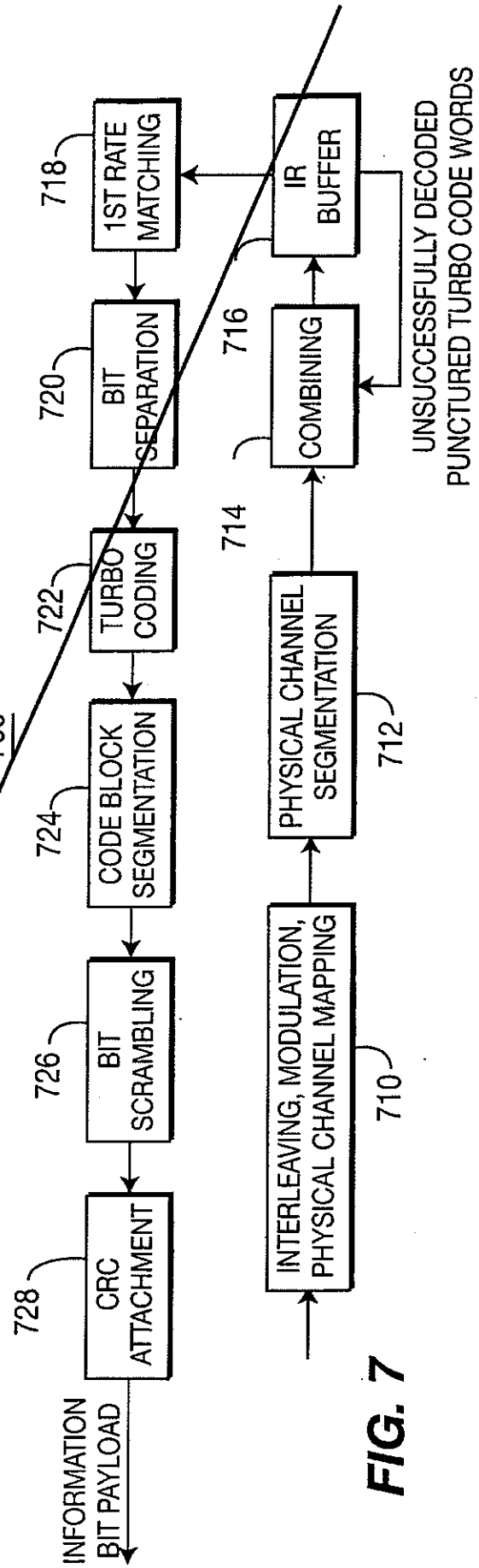

700
INFORMATION BIT PAYLOAD
728
CRC ATTACHMENT
726
BIT SCRAMBLING
724
CODE BLOCK SEGMENTATION
722
TURBO CODING
720
BIT SEPARATION
718
1ST RATE MATCHING
716
IR BUFFER
714
COMBINING
712
PHYSICAL CHANNEL SEGMENTATION
710
INTERLEAVING, MODULATION, PHYSICAL CHANNEL MAPPING
UNSUCCESSFULLY DECODED PUNCTURED TURBO CODE WORDS

FIG. 7

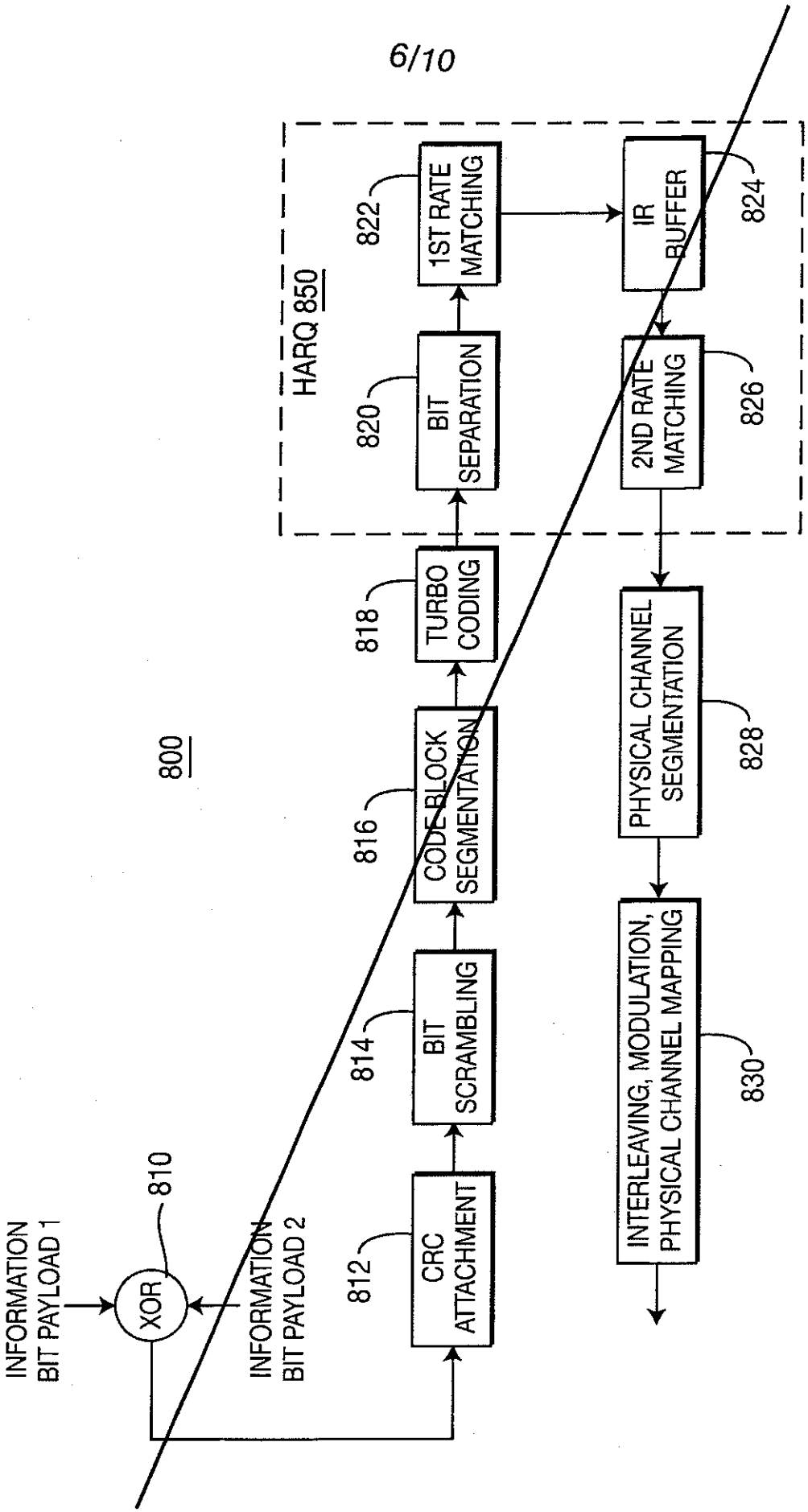

800
INFORMATION BIT PAYLOAD 1
INFORMATION BIT PAYLOAD 2
XOR
810
CRC ATTACHMENT
812
BIT SCRAMBLING
814
CODE BLOCK SEGMENTATION
816
TURBO CODING
818
HARQ 850
BIT SEPARATION
820
1ST RATE MATCHING
822
IR BUFFER
824
2ND RATE MATCHING
826
PHYSICAL CHANNEL SEGMENTATION
828
INTERLEAVING, MODULATION, PHYSICAL CHANNEL MAPPING
830

FIG. 8

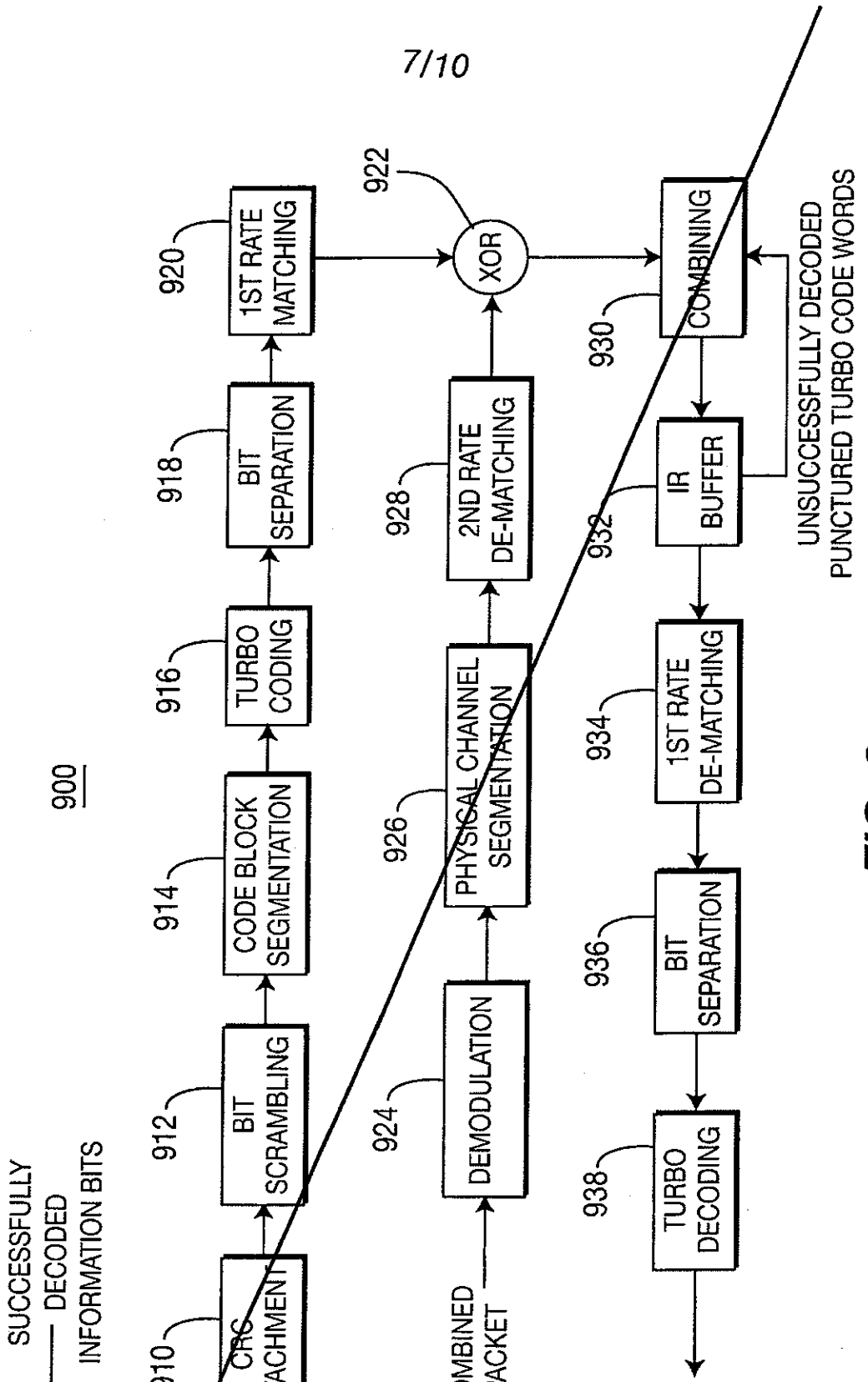

900
SUCCESSFULLY DECODED INFORMATION BITS
910
CRC ATTACHMENT
912
BIT SCRAMBLING
914
CODE BLOCK SEGMENTATION
916
TURBO CODING
918
BIT SEPARATION
920
1ST RATE MATCHING
922
XOR
924
DEMODULATION
926
PHYSICAL CHANNEL SEGMENTATION
928
2ND RATE DE-MATCHING
930
COMBINING
932
IR BUFFER
934
1ST RATE DE-MATCHING
936
BIT SEPARATION
938
TURBO DECODING
COMBINED PACKET
UNSUCCESSFULLY DECODED PUNCTURED TURBO CODE WORDS

FIG. 9

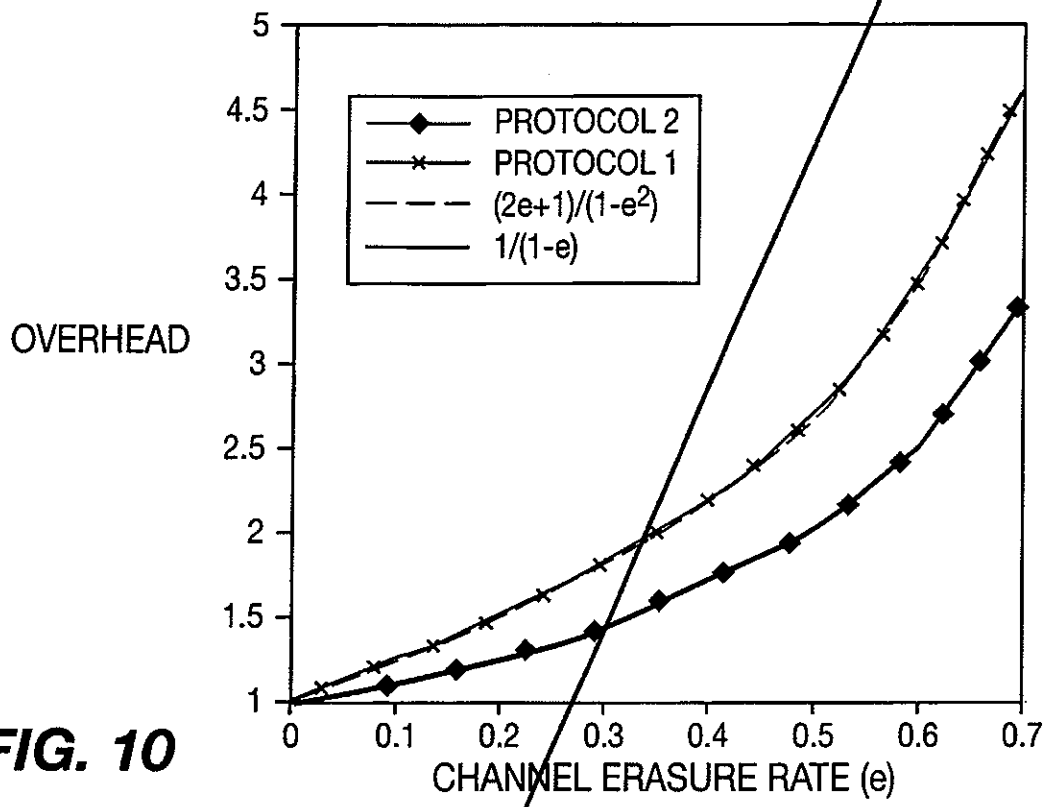

PROTOCOL 2
PROTOCOL 1
(2e+1)/(1-e²)
1/(1-e)
OVERHEAD
CHANNEL ERASURE RATE (e)
5
4.5
4
3.5
3
2.5
2
1.5
1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7

FIG. 10

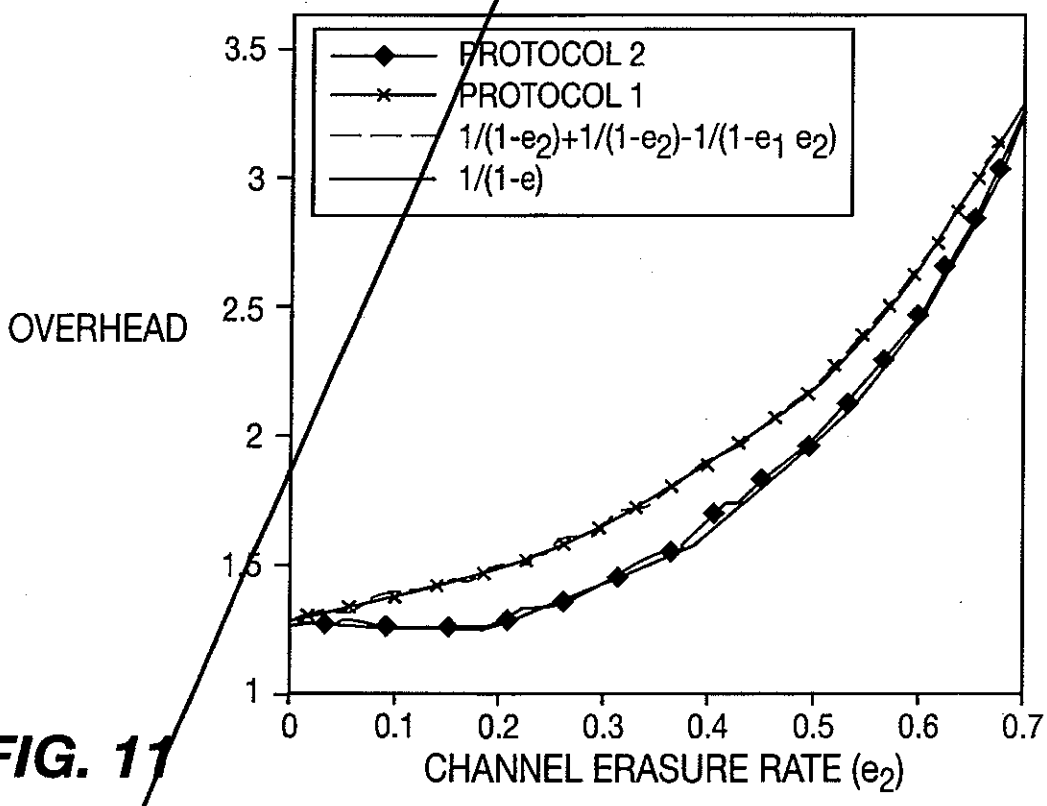

PROTOCOL 2
PROTOCOL 1
1/(1-e2)+1/(1-e2)-1/(1-e1 e2)
1/(1-e)
OVERHEAD
CHANNEL ERASURE RATE (e2)
3.5
3
2.5
2
1.5
1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7

FIG. 11

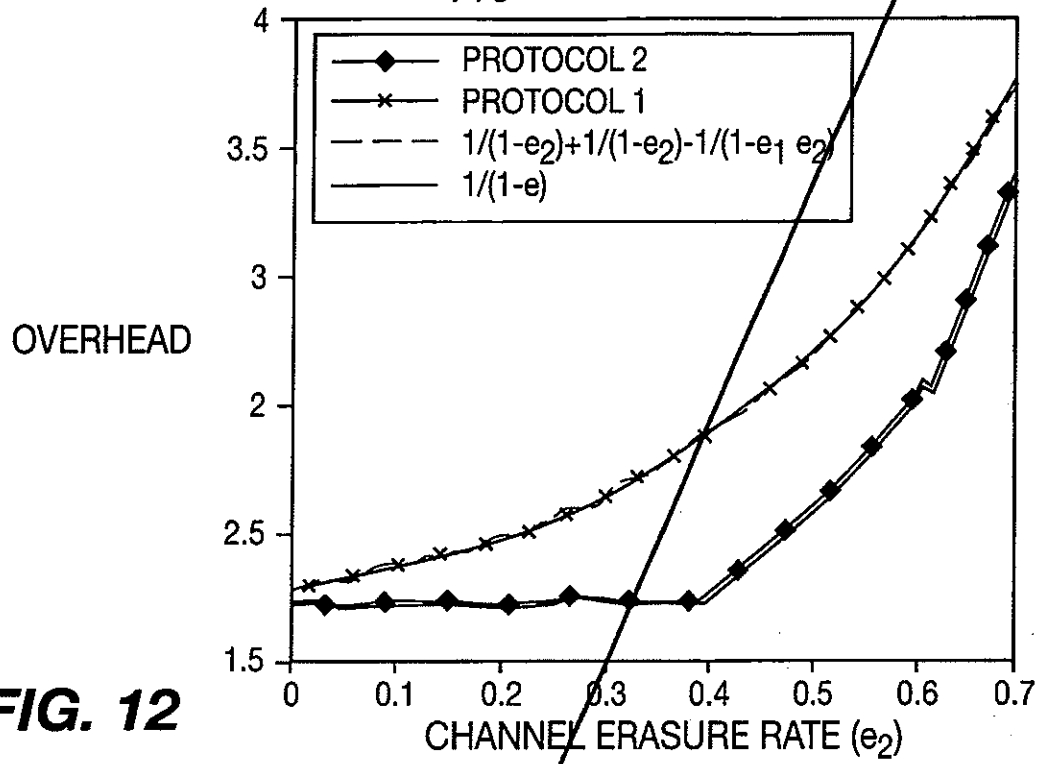

PROTOCOL 2
PROTOCOL 1
1/(1-e2)+1/(1-e2)-1/(1-e1 e2)
1/(1-e)
OVERHEAD
4
3.5
3
2.5
2
1.5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
CHANNEL ERASURE RATE (e2)

FIG. 12

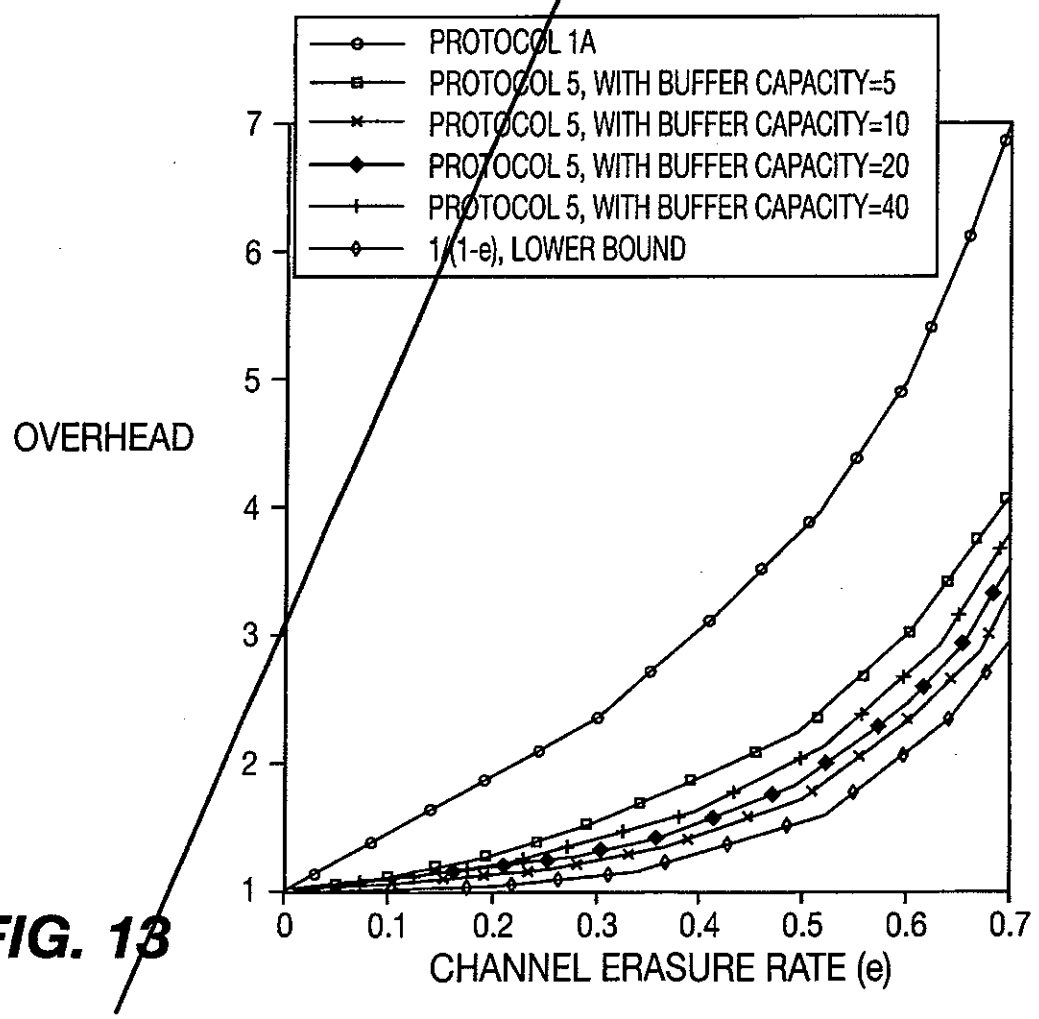

PROTOCOL 1A
PROTOCOL 5, WITH BUFFER CAPACITY=5
PROTOCOL 5, WITH BUFFER CAPACITY=10
PROTOCOL 5, WITH BUFFER CAPACITY=20
PROTOCOL 5, WITH BUFFER CAPACITY=40
1/(1-e), LOWER BOUND
OVERHEAD
7
6
5
4
3
2
1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
CHANNEL ERASURE RATE (e)

FIG. 13

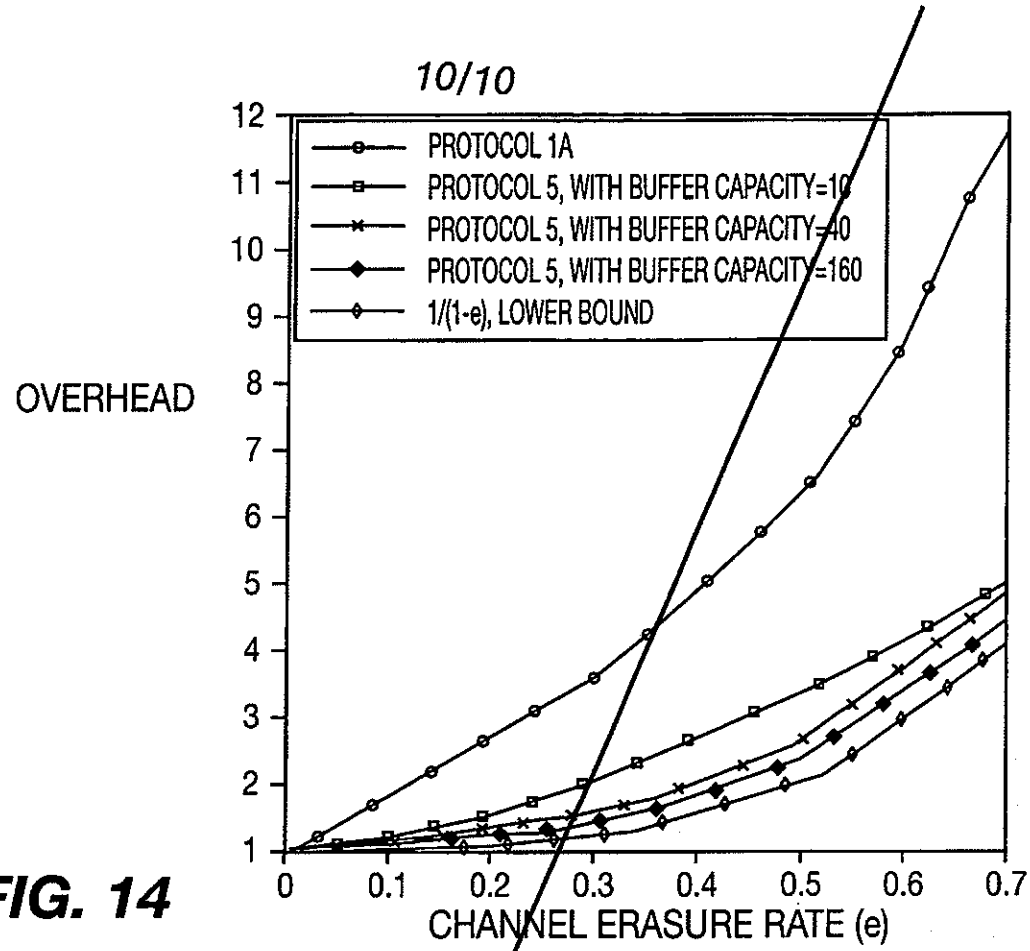

PROTOCOL 1A
PROTOCOL 5, WITH BUFFER CAPACITY=10
PROTOCOL 5, WITH BUFFER CAPACITY=40
PROTOCOL 5, WITH BUFFER CAPACITY=160
1/(1-e), LOWER BOUND
OVERHEAD
CHANNEL ERASURE RATE (e)
1
2
3
4
5
6
7
8
9
10
11
12
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7

FIG. 14

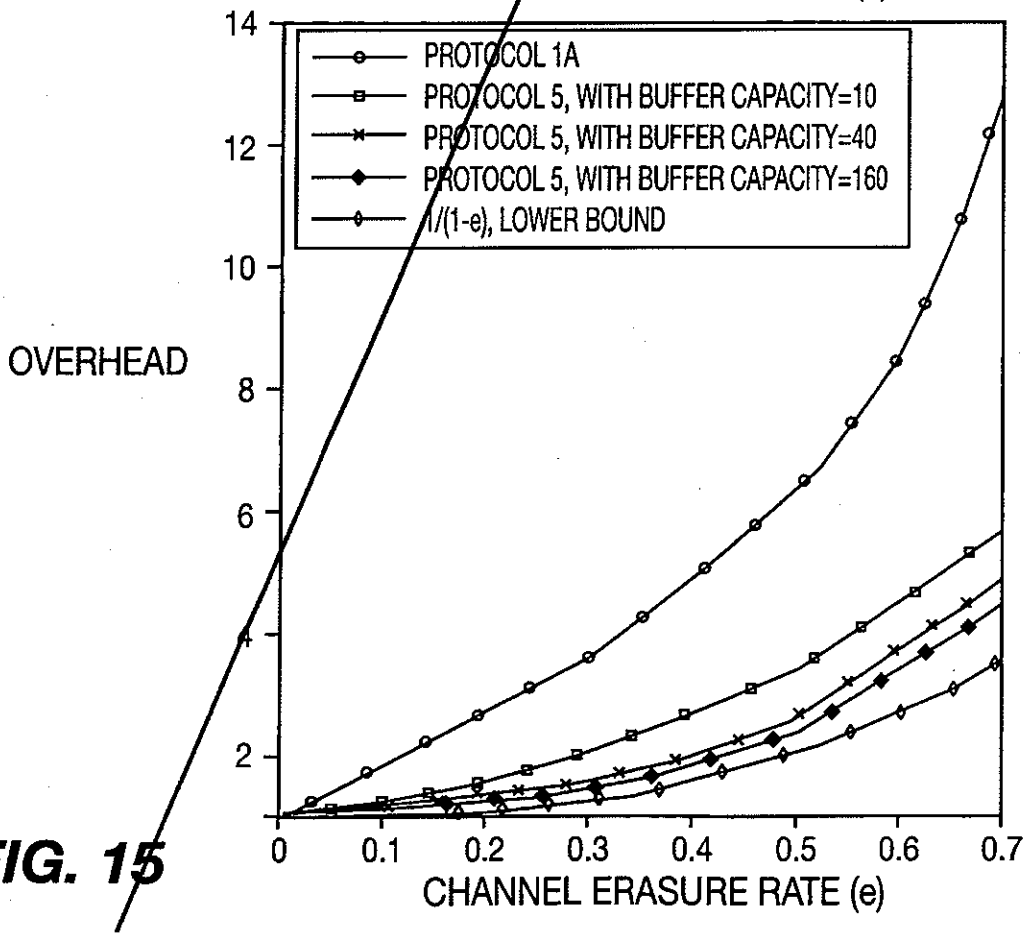

PROTOCOL 1A
PROTOCOL 5, WITH BUFFER CAPACITY=10
PROTOCOL 5, WITH BUFFER CAPACITY=40
PROTOCOL 5, WITH BUFFER CAPACITY=160
1/(1-e), LOWER BOUND
OVERHEAD
CHANNEL ERASURE RATE (e)
2
4
6
8
10
12
14
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7

FIG. 15

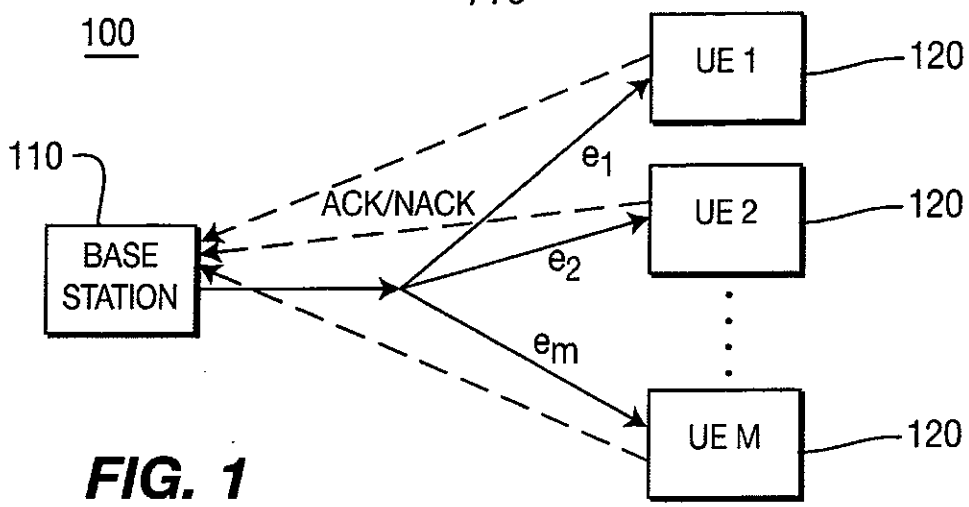

100
110
BASE STATION
ACK/NACK
e_1
e_2
e_m
UE 1
UE 2
UE M
120
120
120

FIG. 1

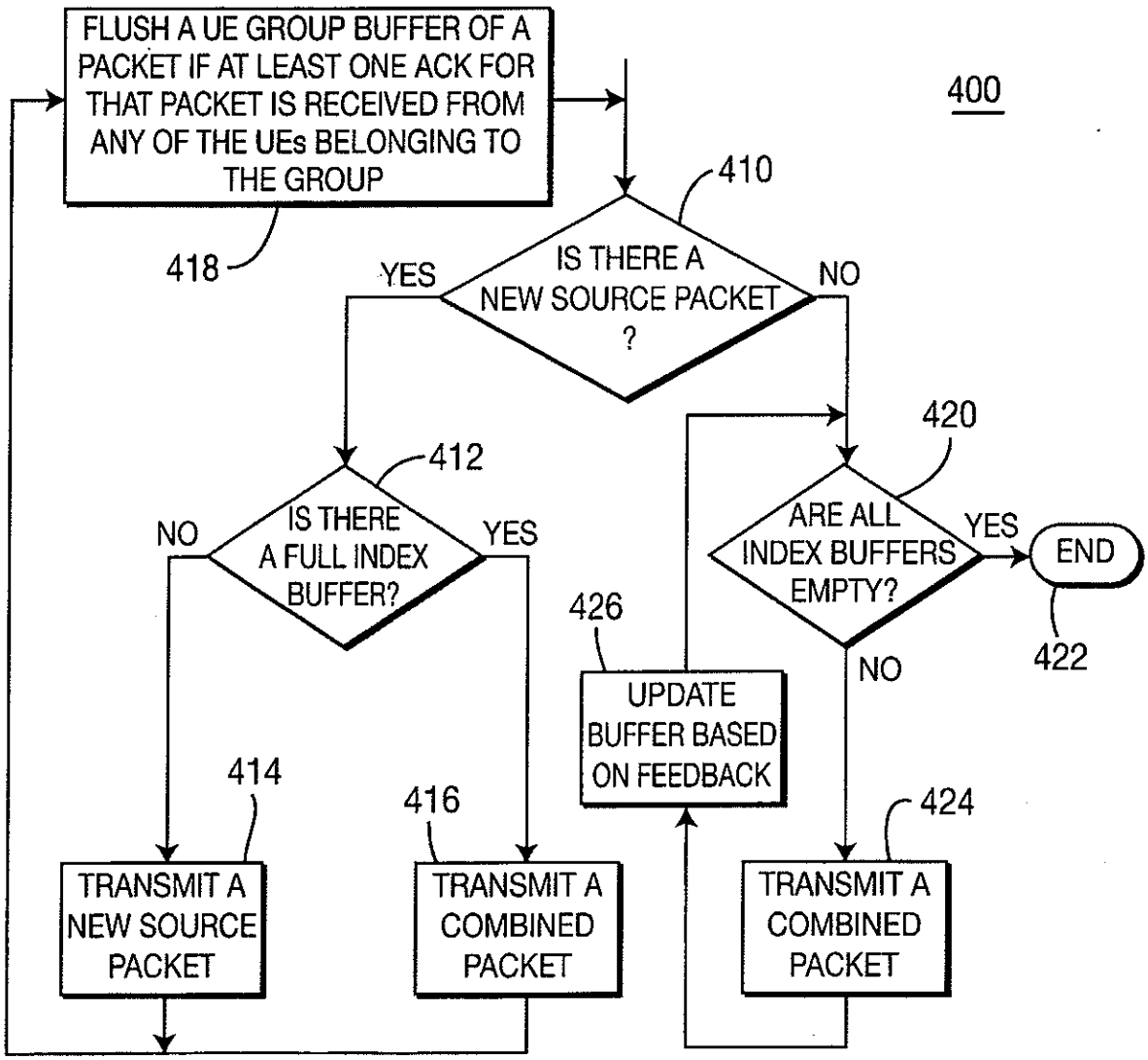

400
FLUSH A UE GROUP BUFFER OF A PACKET IF AT LEAST ONE ACK FOR THAT PACKET IS RECEIVED FROM ANY OF THE UEs BELONGING TO THE GROUP
418
410
IS THERE A NEW SOURCE PACKET ?
YES
NO
412
IS THERE A FULL INDEX BUFFER?
NO
YES
420
ARE ALL INDEX BUFFERS EMPTY?
YES
END
422
NO
426
UPDATE BUFFER BASED ON FEEDBACK
414
TRANSMIT A NEW SOURCE PACKET
416
TRANSMIT A COMBINED PACKET
424
TRANSMIT A COMBINED PACKET

FIG. 4

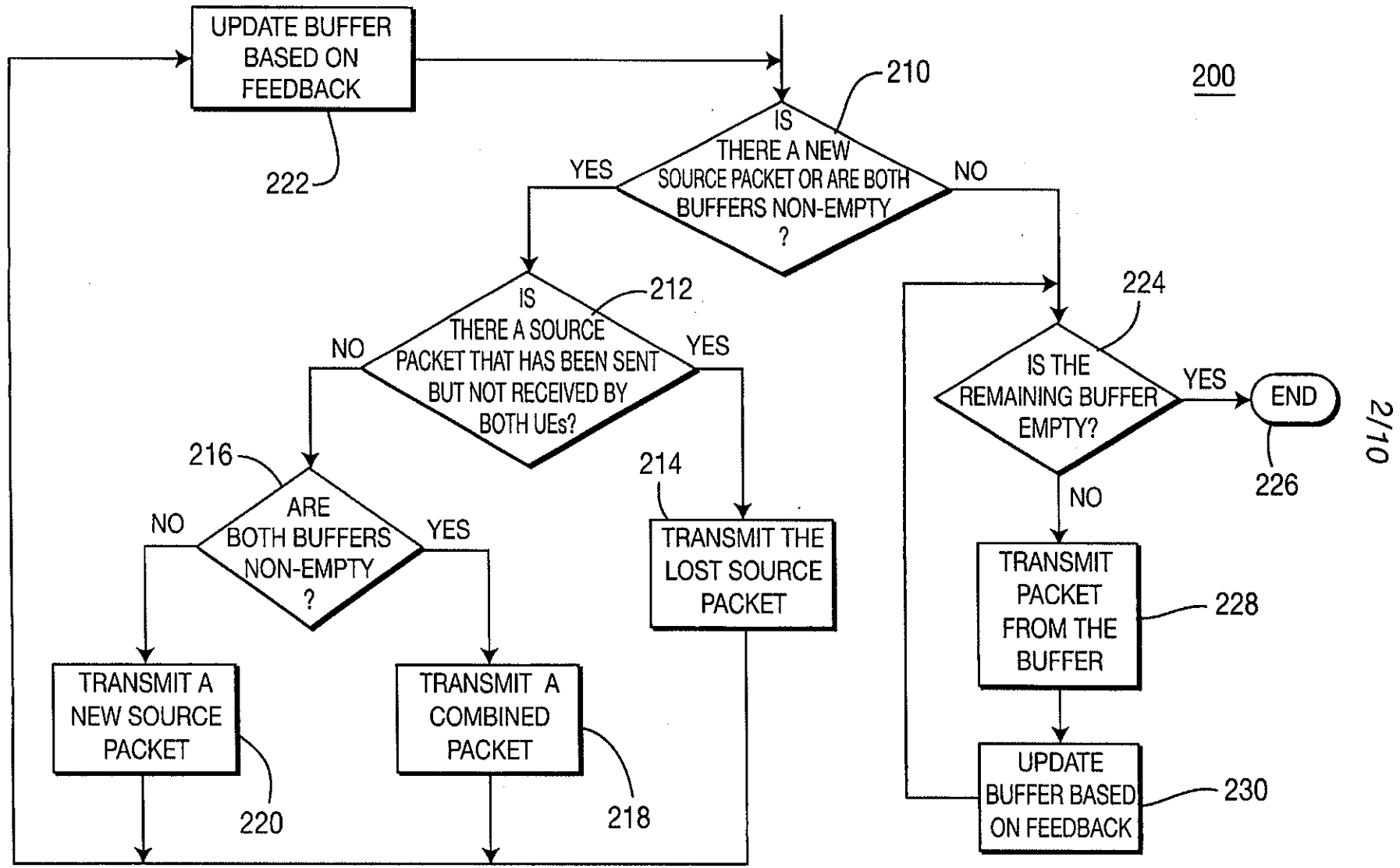

UPDATE BUFFER BASED ON FEEDBACK
222
210
200
IS THERE A NEW SOURCE PACKET OR ARE BOTH BUFFERS NON-EMPTY ?
YES
NO
212
IS THERE A SOURCE PACKET THAT HAS BEEN SENT BUT NOT RECEIVED BY BOTH UEs?
NO
YES
216
ARE BOTH BUFFERS NON-EMPTY ?
NO
YES
214
TRANSMIT THE LOST SOURCE PACKET
TRANSMIT A NEW SOURCE PACKET
220
TRANSMIT A COMBINED PACKET
218
224
IS THE REMAINING BUFFER EMPTY?
YES
END
226
NO
TRANSMIT PACKET FROM THE BUFFER
228
UPDATE BUFFER BASED ON FEEDBACK
230
2/10

FIG. 2

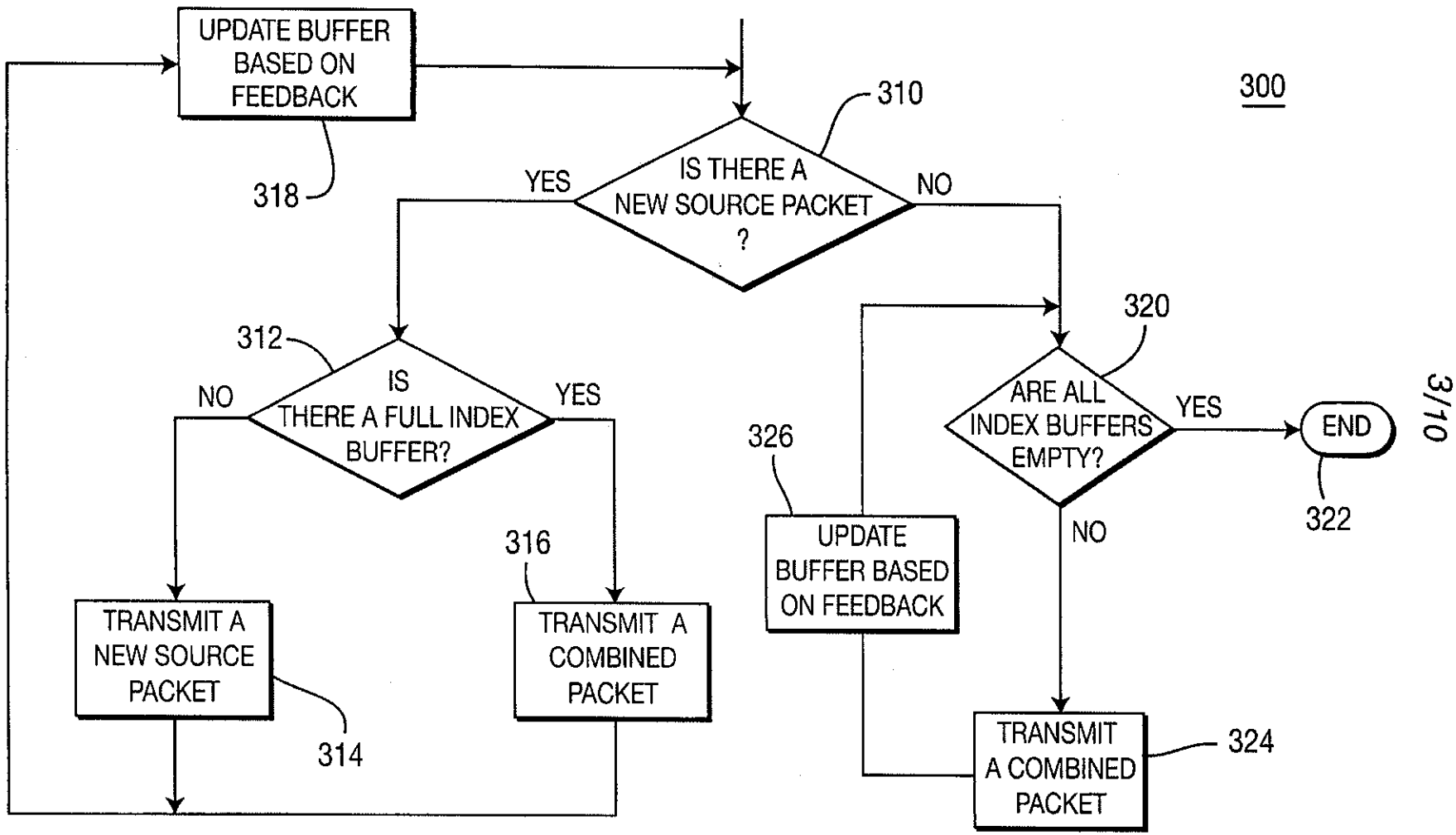

UPDATE BUFFER BASED ON FEEDBACK
318
310
300
IS THERE A NEW SOURCE PACKET ?
YES
NO
312
IS THERE A FULL INDEX BUFFER?
NO
YES
320
ARE ALL INDEX BUFFERS EMPTY?
YES
END
322
326
UPDATE BUFFER BASED ON FEEDBACK
NO
316
TRANSMIT A NEW SOURCE PACKET
314
TRANSMIT A COMBINED PACKET
TRANSMIT A COMBINED PACKET
324
3/10

FIG. 3

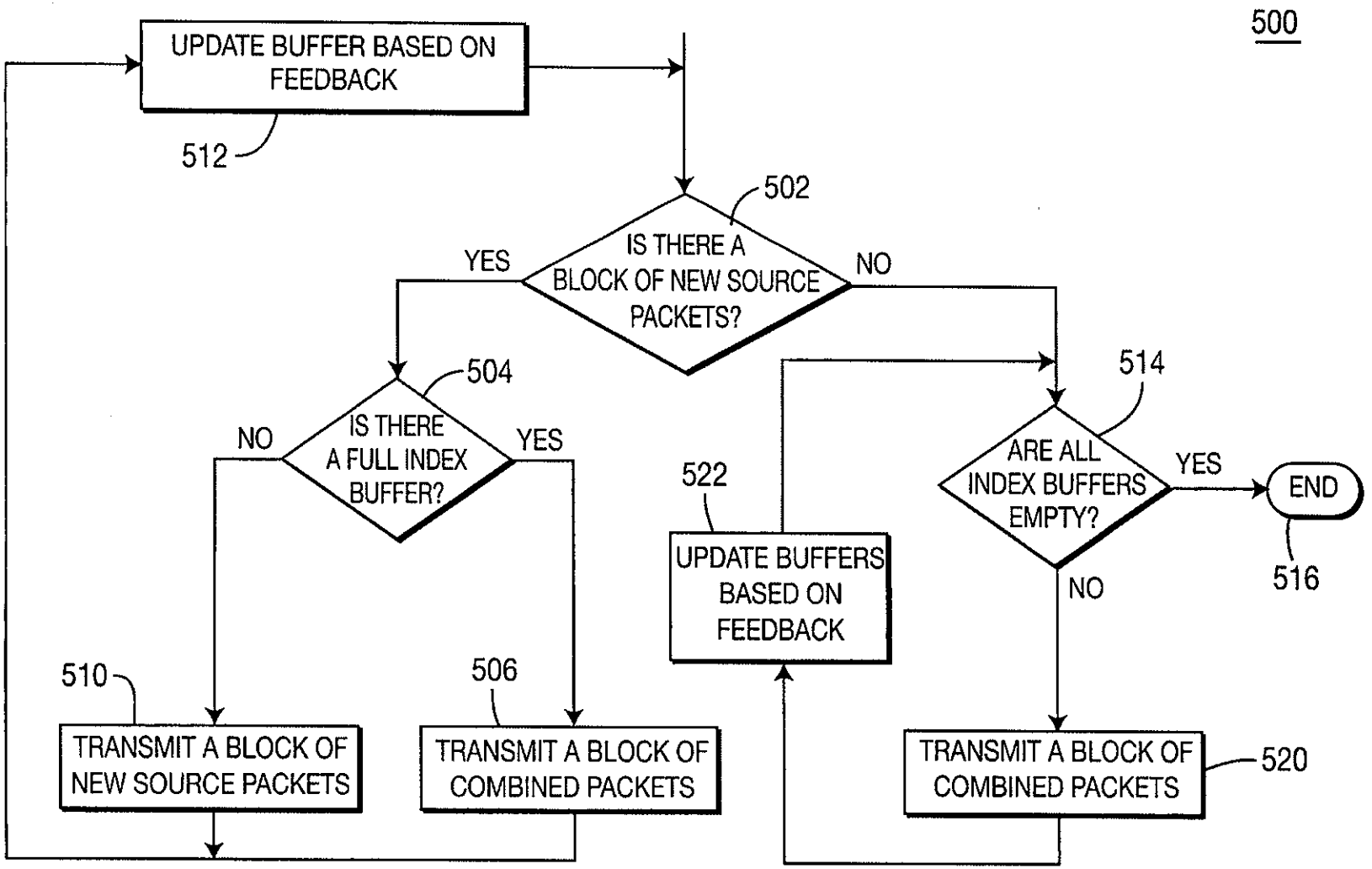

500
UPDATE BUFFER BASED ON FEEDBACK
512
502
IS THERE A BLOCK OF NEW SOURCE PACKETS?
YES
NO
504
IS THERE A FULL INDEX BUFFER?
NO
YES
514
ARE ALL INDEX BUFFERS EMPTY?
YES
END
516
NO
522
UPDATE BUFFERS BASED ON FEEDBACK
510
TRANSMIT A BLOCK OF NEW SOURCE PACKETS
506
TRANSMIT A BLOCK OF COMBINED PACKETS
TRANSMIT A BLOCK OF COMBINED PACKETS
520

FIG. 5

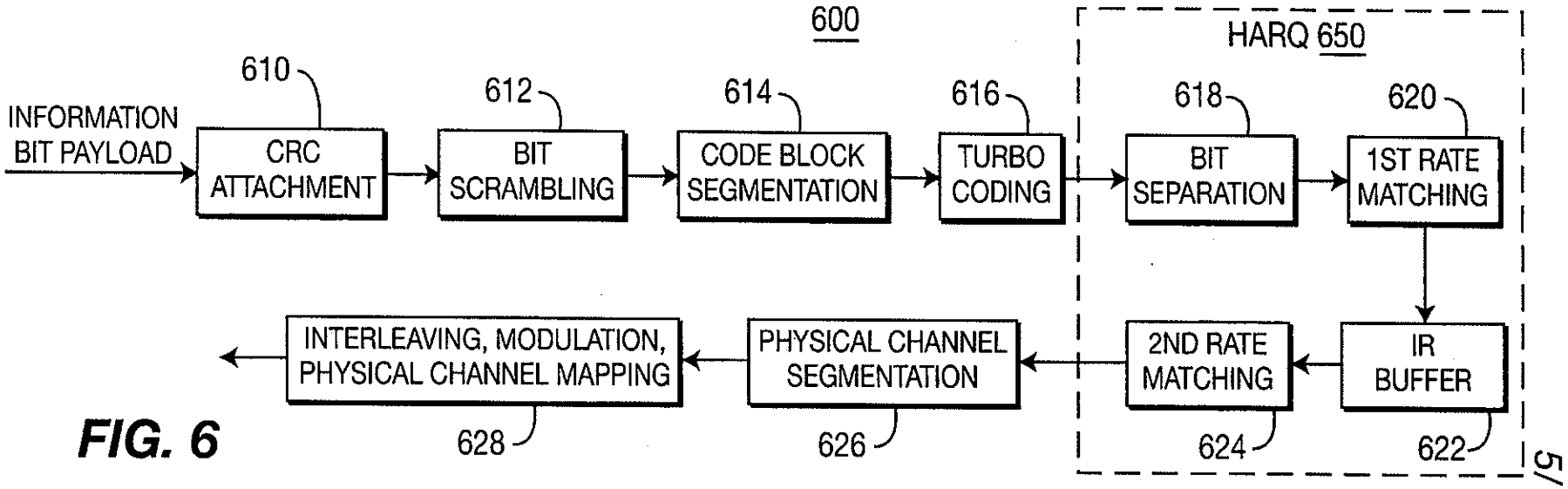

600
HARQ 650
610
612
614
616
618
620
INFORMATION BIT PAYLOAD
CRC ATTACHMENT
BIT SCRAMBLING
CODE BLOCK SEGMENTATION
TURBO CODING
BIT SEPARATION
1ST RATE MATCHING
INTERLEAVING, MODULATION, PHYSICAL CHANNEL MAPPING
PHYSICAL CHANNEL SEGMENTATION
2ND RATE MATCHING
IR BUFFER
628
626
624
622

FIG. 6

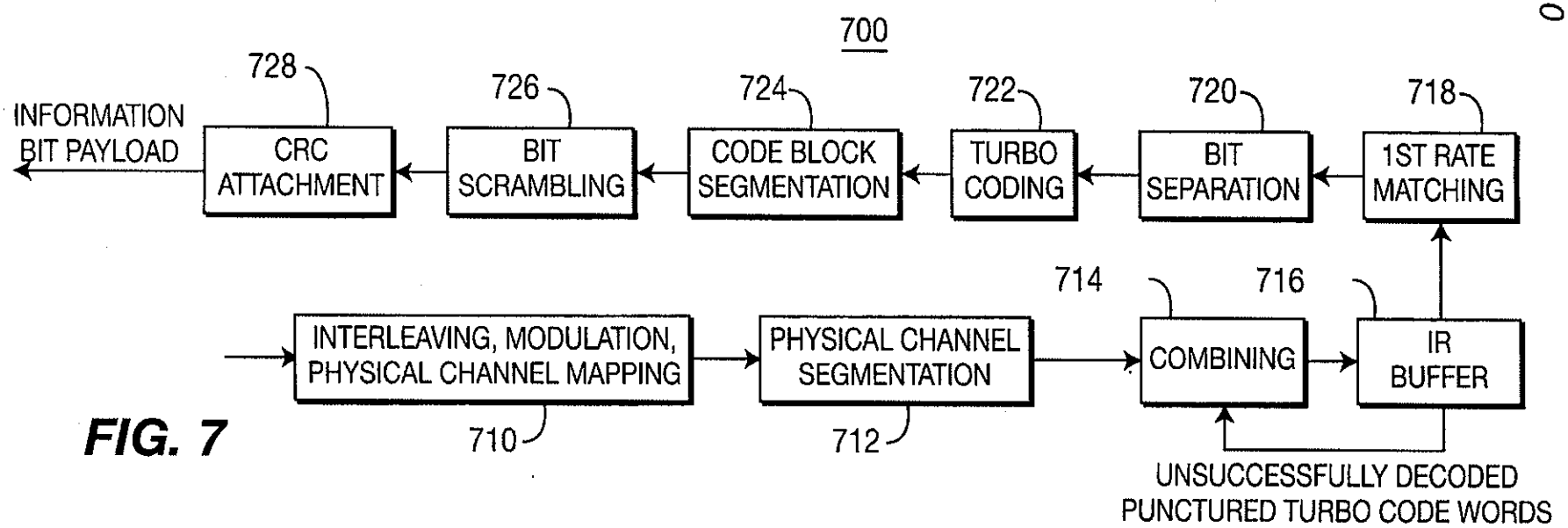

700
728
726
724
722
720
718
INFORMATION BIT PAYLOAD
CRC ATTACHMENT
BIT SCRAMBLING
CODE BLOCK SEGMENTATION
TURBO CODING
BIT SEPARATION
1ST RATE MATCHING
714
716
INTERLEAVING, MODULATION, PHYSICAL CHANNEL MAPPING
PHYSICAL CHANNEL SEGMENTATION
COMBINING
IR BUFFER
710
712
UNSUCCESSFULLY DECODED PUNCTURED TURBO CODE WORDS

FIG. 7

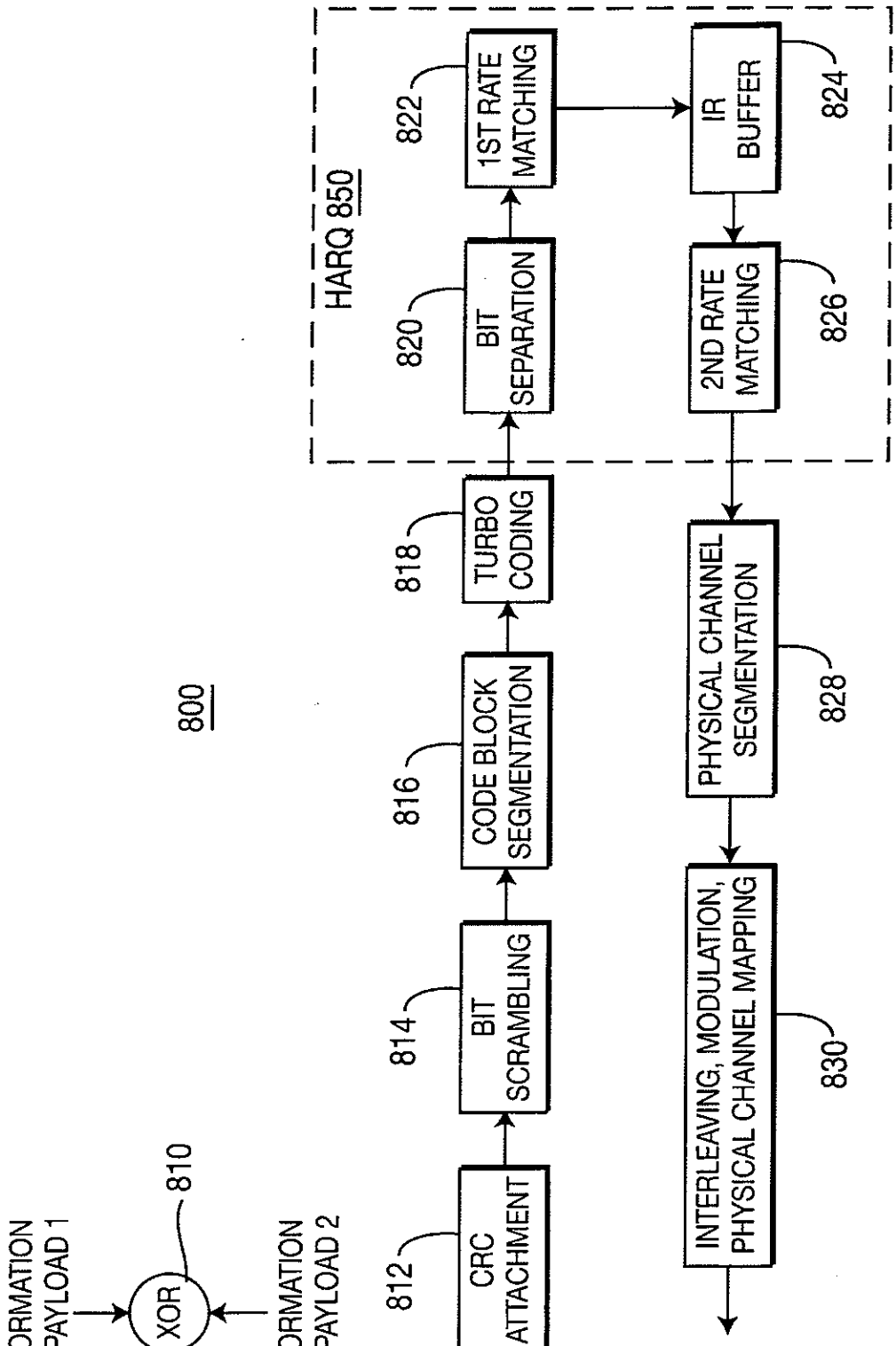

800
INFORMATION BIT PAYLOAD 1
INFORMATION BIT PAYLOAD 2
XOR
810
812
CRC ATTACHMENT
814
BIT SCRAMBLING
816
CODE BLOCK SEGMENTATION
818
TURBO CODING
HARQ 850
820
BIT SEPARATION
822
1ST RATE MATCHING
824
IR BUFFER
826
2ND RATE MATCHING
828
PHYSICAL CHANNEL SEGMENTATION
830
INTERLEAVING, MODULATION, PHYSICAL CHANNEL MAPPING

FIG. 8

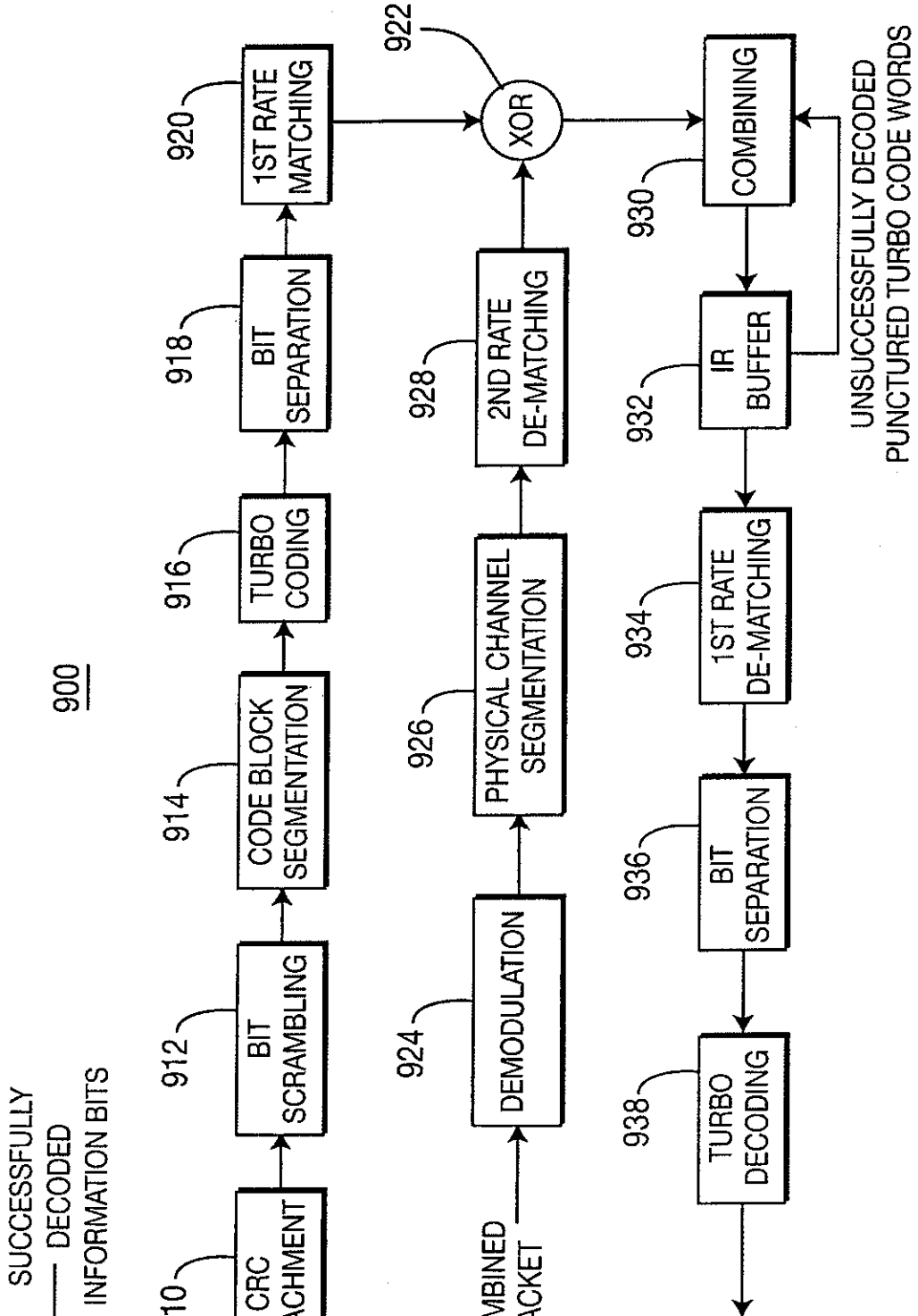

900
SUCCESSFULLY DECODED INFORMATION BITS
910
CRC ATTACHMENT
912
BIT SCRAMBLING
914
CODE BLOCK SEGMENTATION
916
TURBO CODING
918
BIT SEPARATION
920
1ST RATE MATCHING
922
XOR
924
DEMODULATION
926
PHYSICAL CHANNEL SEGMENTATION
928
2ND RATE DE-MATCHING
930
COMBINING
932
IR BUFFER
934
1ST RATE DE-MATCHING
936
BIT SEPARATION
938
TURBO DECODING
COMBINED PACKET
UNSUCCESSFULLY DECODED PUNCTURED TURBO CODE WORDS

FIG. 9

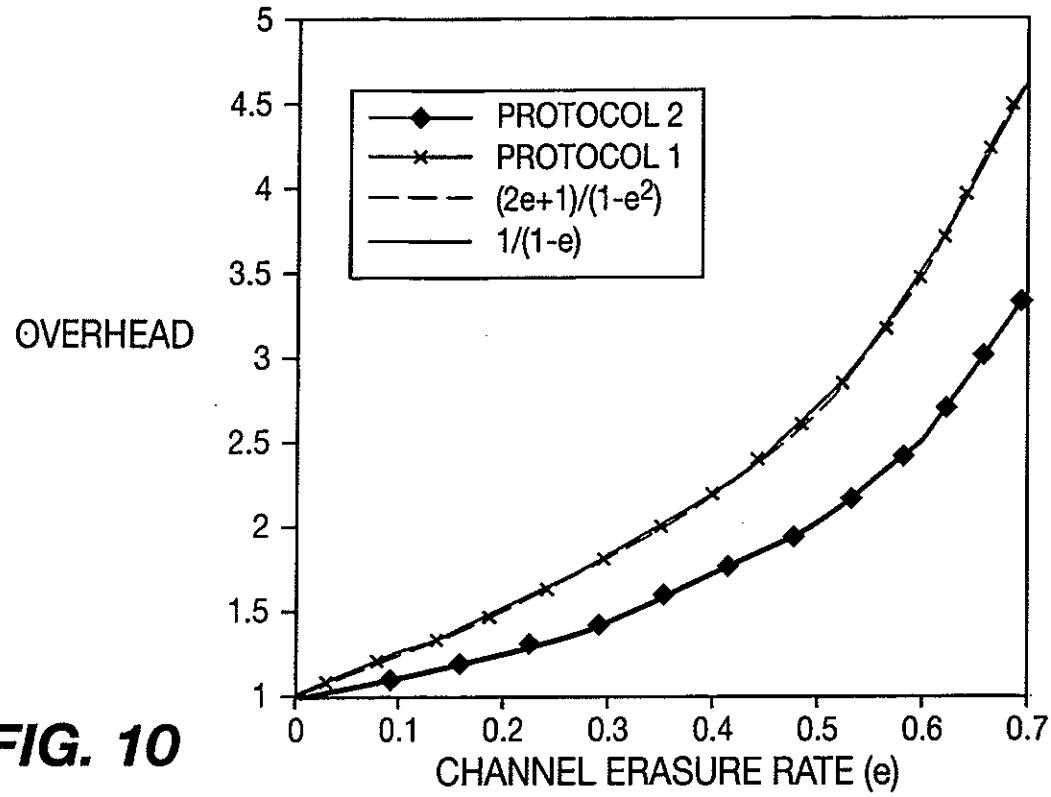

OVERHEAD
5
4.5
4
3.5
3
2.5
2
1.5
1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
CHANNEL ERASURE RATE (e)
PROTOCOL 2
PROTOCOL 1
(2e+1)/(1-e2)
1/(1-e)

FIG. 10

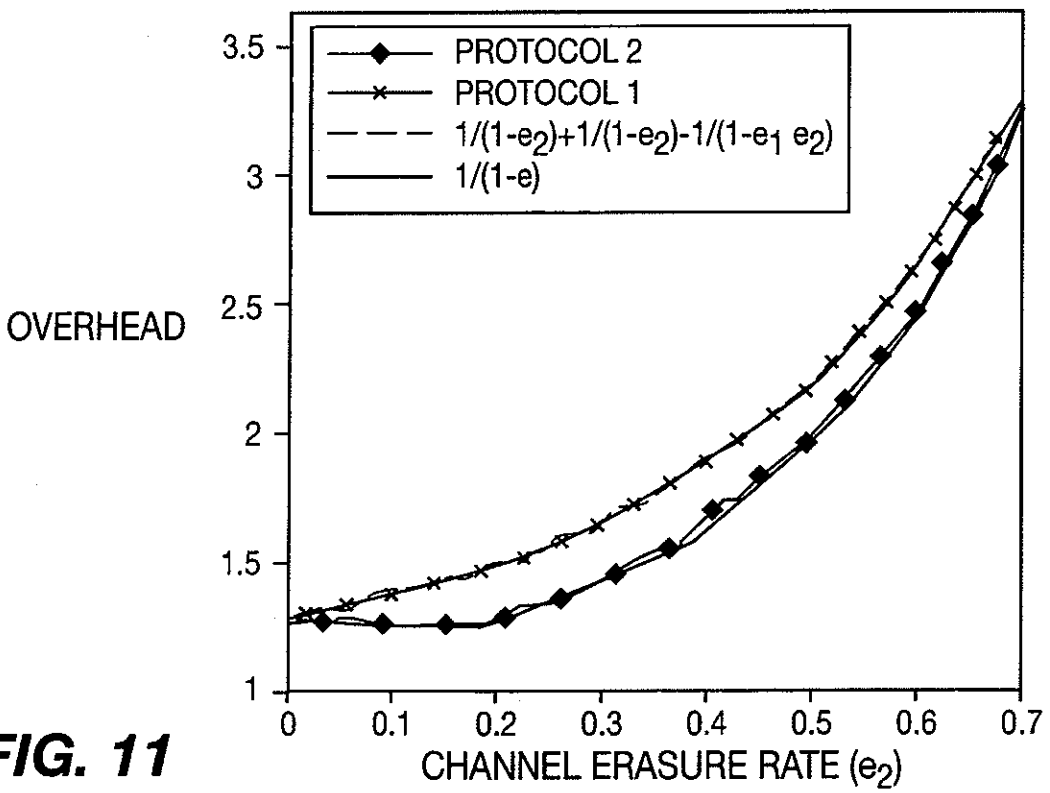

OVERHEAD
3.5
3
2.5
2
1.5
1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
CHANNEL ERASURE RATE (e2)
PROTOCOL 2
PROTOCOL 1
1/(1-e2)+1/(1-e2)-1/(1-e1 e2)
1/(1-e)

FIG. 11

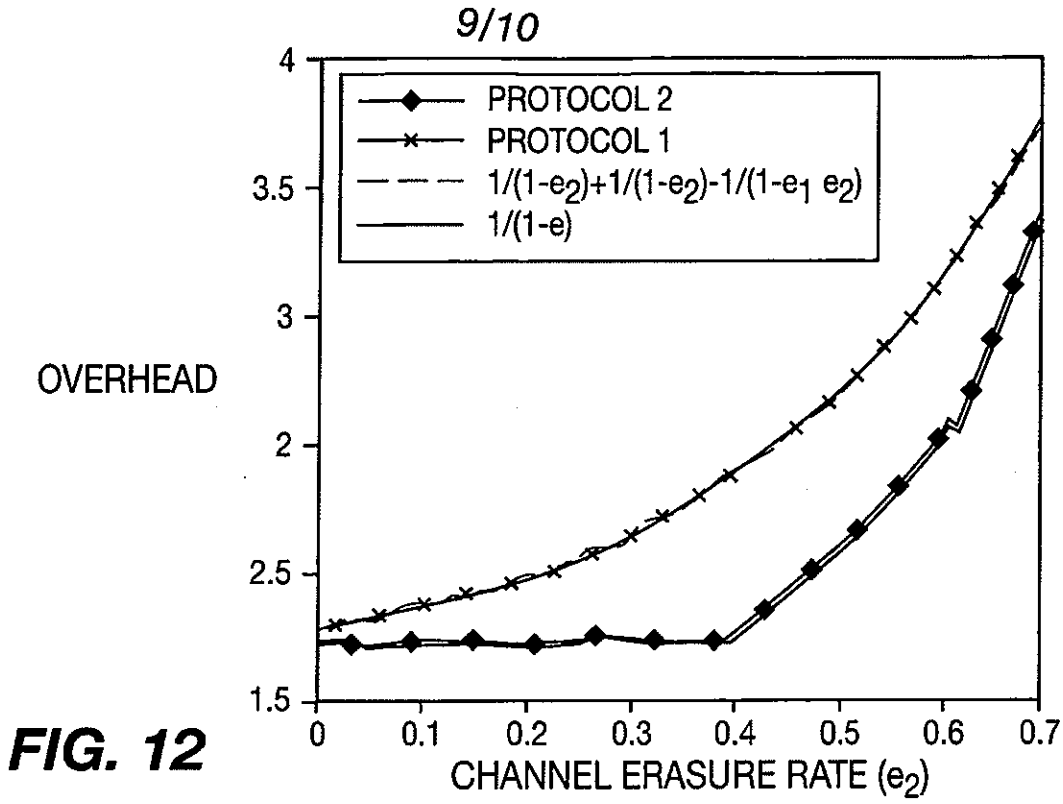

PROTOCOL 2
PROTOCOL 1
1/(1-e2)+1/(1-e2)-1/(1-e1 e2)
1/(1-e)
OVERHEAD
4
3.5
3
2.5
2
1.5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
CHANNEL ERASURE RATE (e2)

FIG. 12

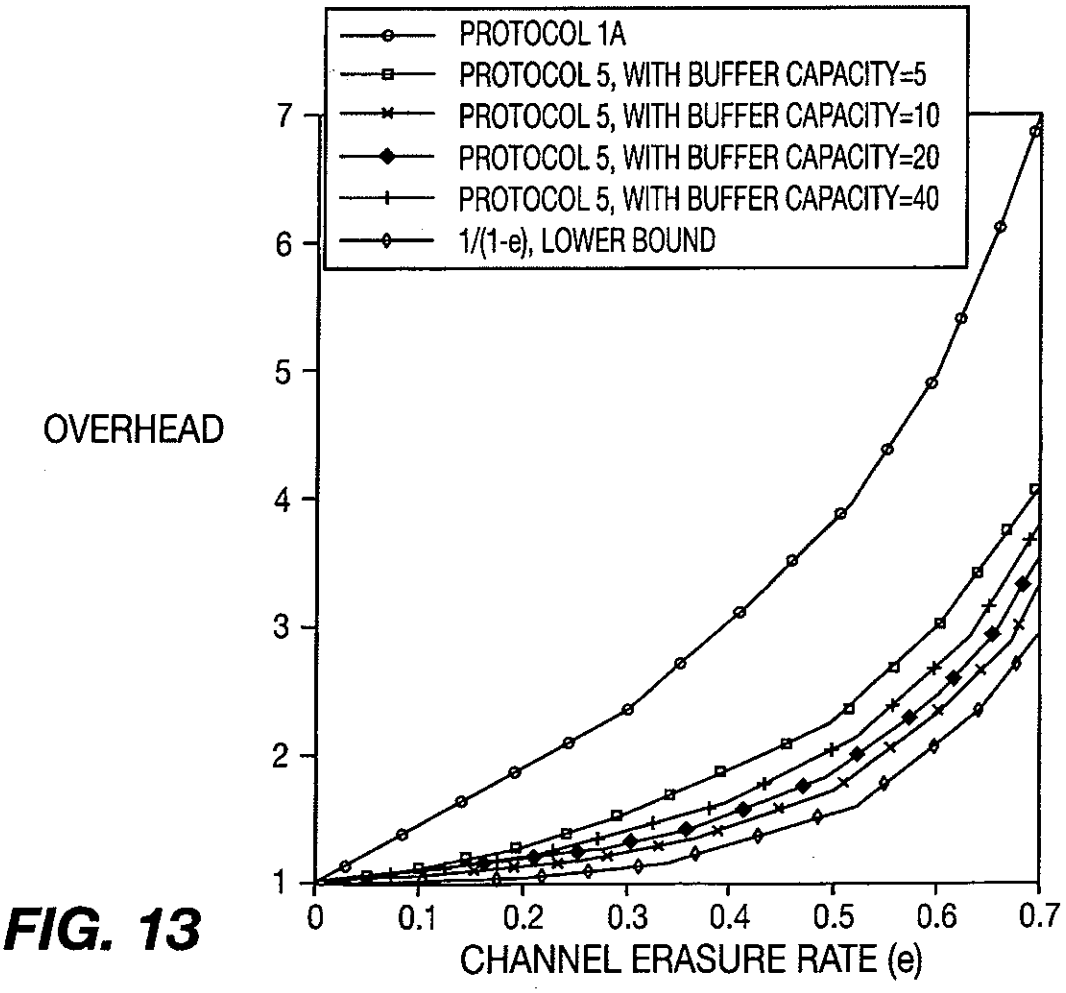

PROTOCOL 1A
PROTOCOL 5, WITH BUFFER CAPACITY=5
PROTOCOL 5, WITH BUFFER CAPACITY=10
PROTOCOL 5, WITH BUFFER CAPACITY=20
PROTOCOL 5, WITH BUFFER CAPACITY=40
1/(1-e), LOWER BOUND
OVERHEAD
7
6
5
4
3
2
1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
CHANNEL ERASURE RATE (e)

FIG. 13

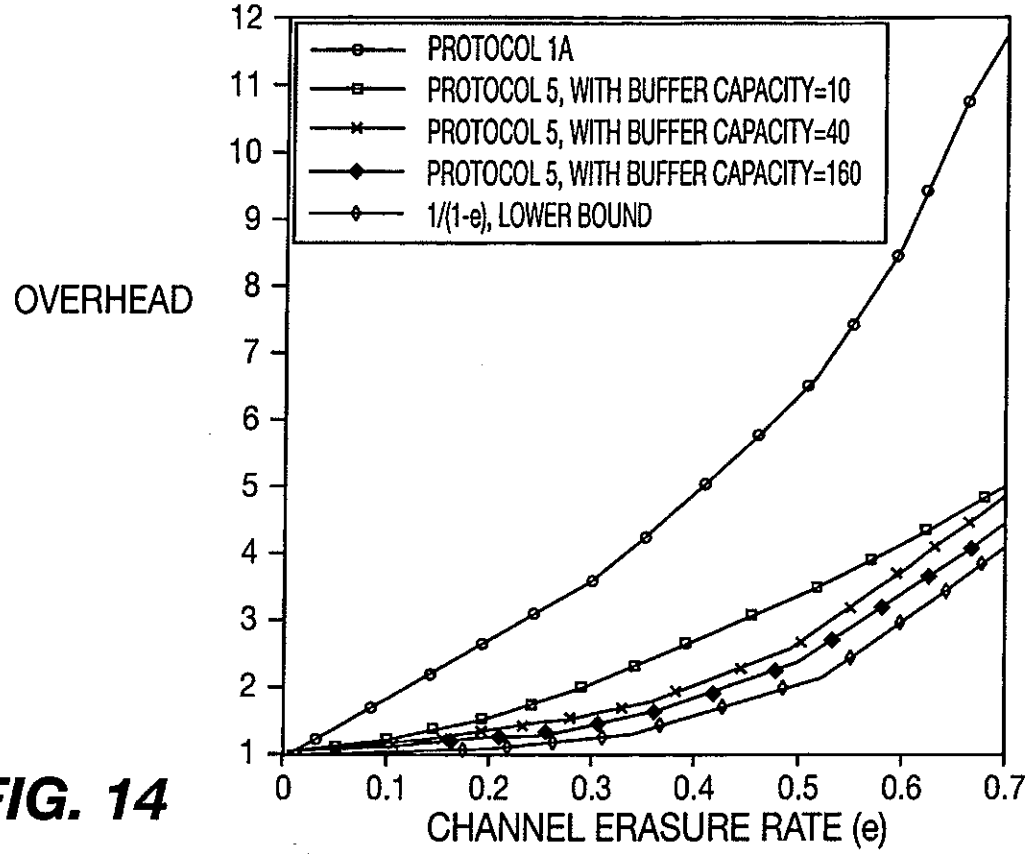

PROTOCOL 1A
PROTOCOL 5, WITH BUFFER CAPACITY=10
PROTOCOL 5, WITH BUFFER CAPACITY=40
PROTOCOL 5, WITH BUFFER CAPACITY=160
1/(1-e), LOWER BOUND
OVERHEAD
CHANNEL ERASURE RATE (e)
12
11
10
9
8
7
6
5
4
3
2
1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7

FIG. 14

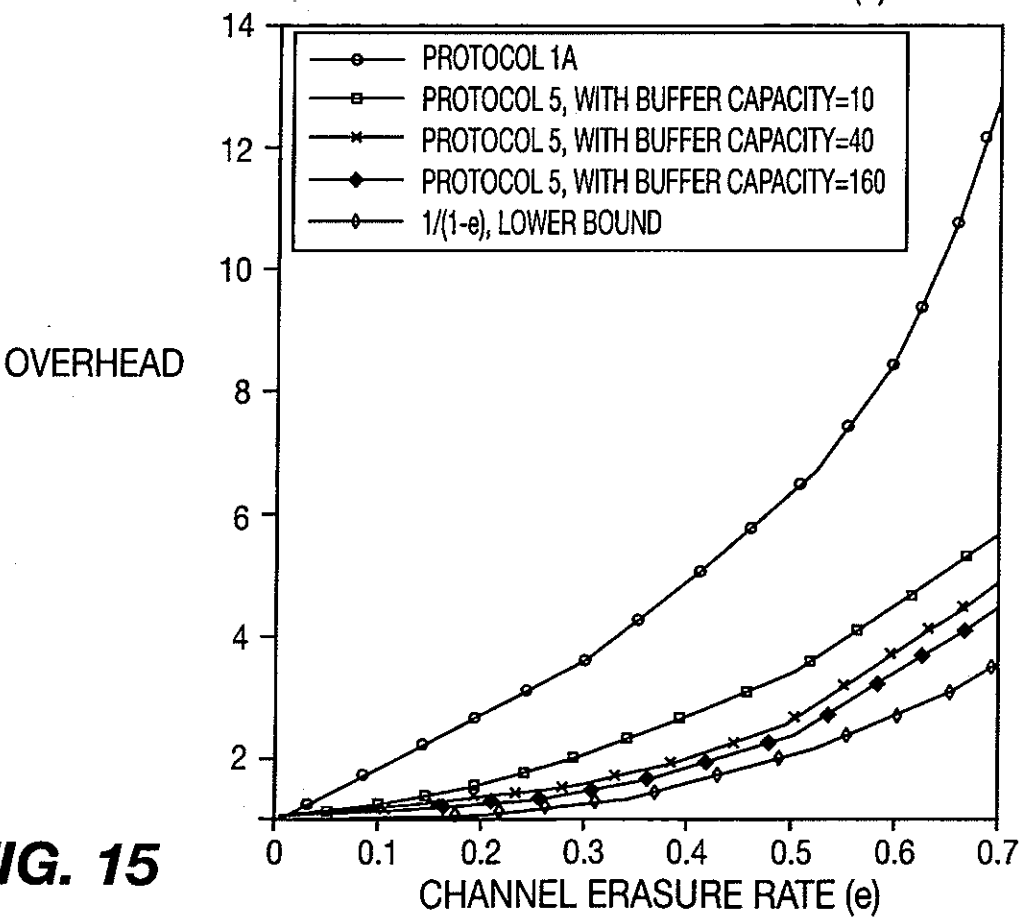

PROTOCOL 1A
PROTOCOL 5, WITH BUFFER CAPACITY=10
PROTOCOL 5, WITH BUFFER CAPACITY=40
PROTOCOL 5, WITH BUFFER CAPACITY=160
1/(1-e), LOWER BOUND
OVERHEAD
CHANNEL ERASURE RATE (e)
14
12
10
8
6
4
2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7

FIG. 15