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PUBLISHED JUNE 1, 1976

947 O.G. 13

T947,005

MULTI-LEVEL COMPRESSED INDEX INSERTION AND DELETION METHOD AND MEANS

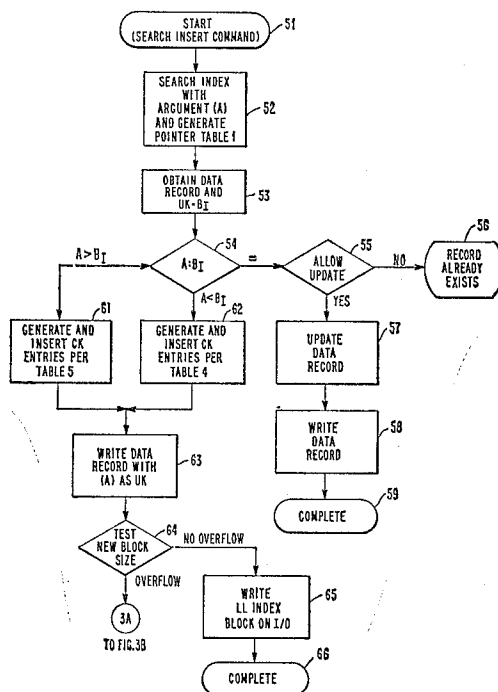
Edward Loizides, Poughkeepsie, and George F. Steigerwalt, Jr., Hyde Park, N.Y., assignors to International Business Machines Corporation, Armonk, N.Y.

Continuation of application Ser. No. 417,459, Nov. 19, 1973, which is a continuation of application Ser. No. 99,863, Dec. 21, 1970. This application Apr. 24, 1975, Ser. No. 573,494

Int. Cl. G06f 7/00

U.S. Cl. 444-1

34 Sheets Drawing. 111 Pages Specification



To enable the maintenance on a real-time basis of a multi-level compressed index generated by the method and means disclosed in U.S. Pat. 3,603,937 issued Sept. 7, 1971. Such index can be searched by the method and means disclosed in U.S. Pat. 3,643,226 issued Feb. 15, 1972. Two types of operation on an existing multi-level compressed index structure are disclosed; they are (1) insertion of new compressed key entries, and (2) deletion of existing compressed key entries. Both operations (1) and (2) begin at the lowest index level and proceed upward through the multi-level compressed index hierarchy until the operations are complete.

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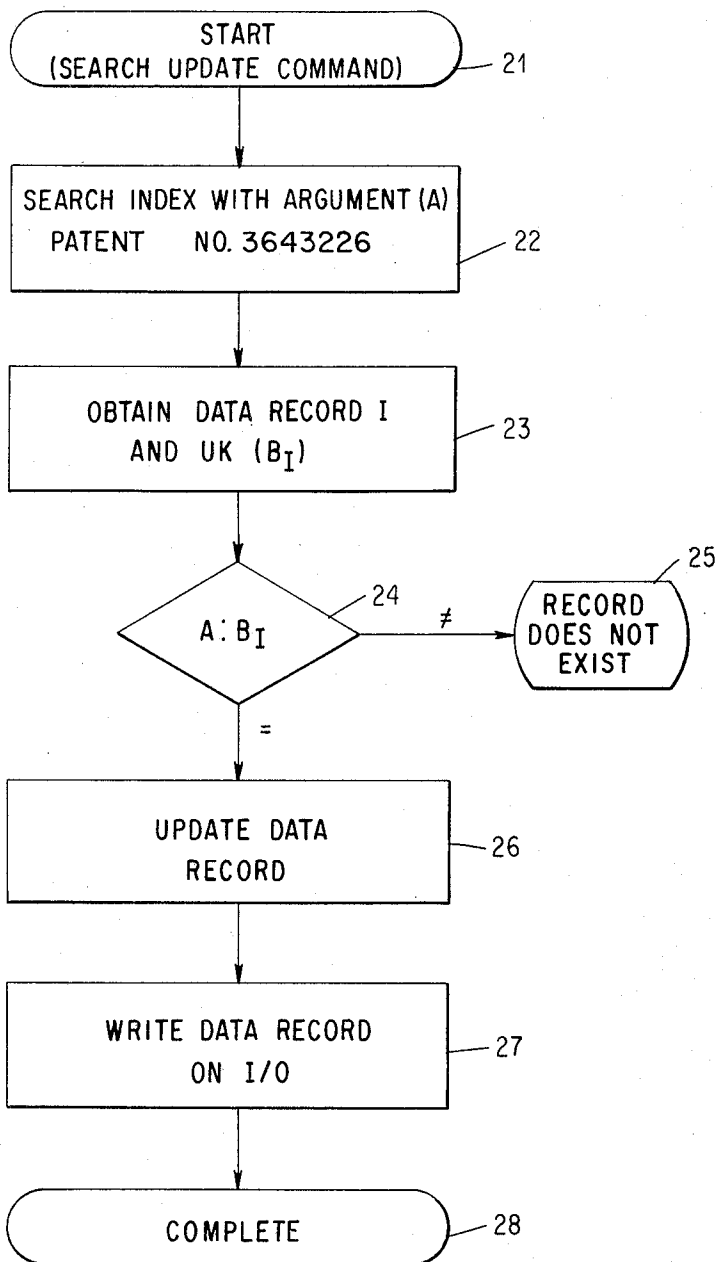
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FIG. 1

SEARCH UPDATE
COMMAND



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ATTORNEY

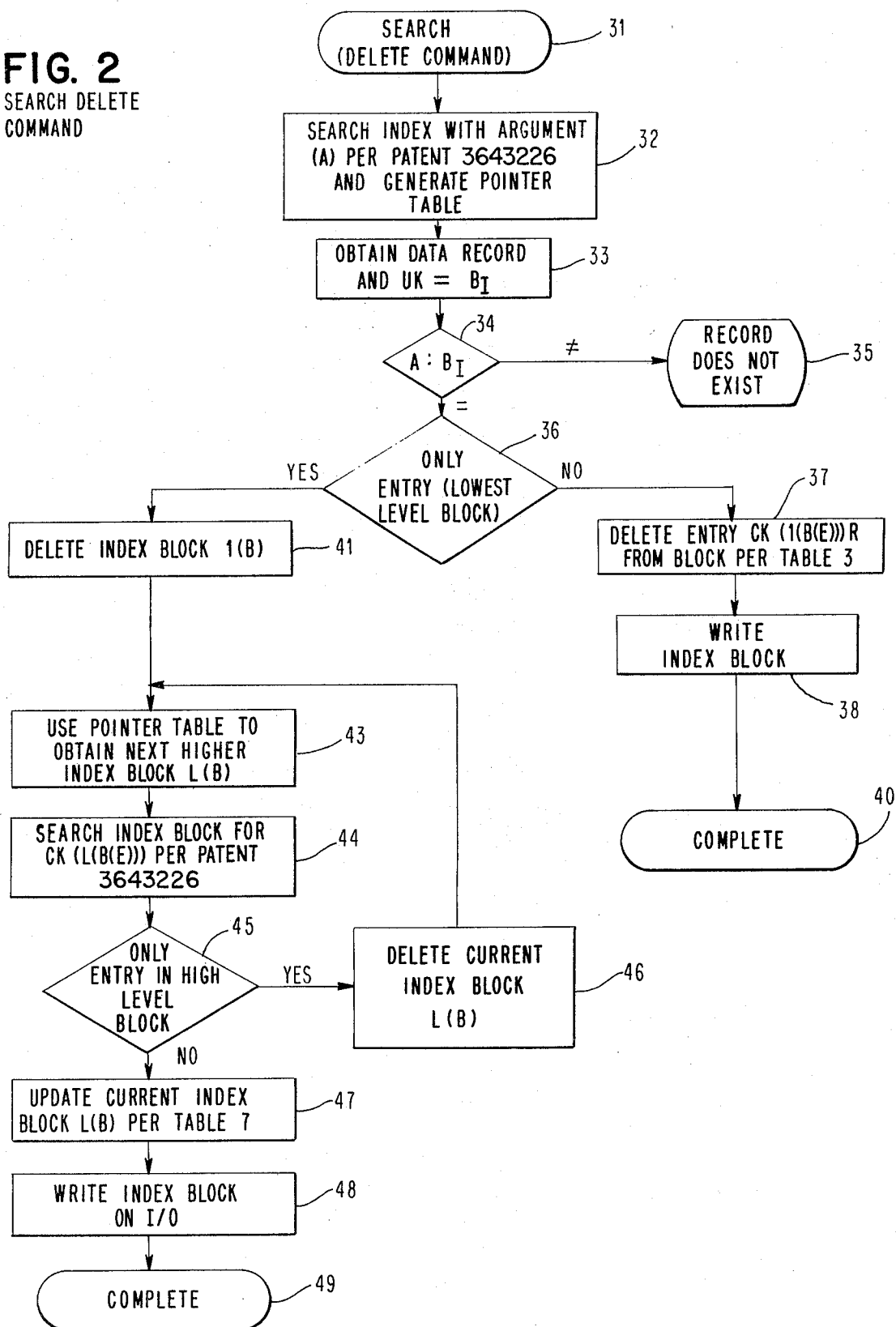
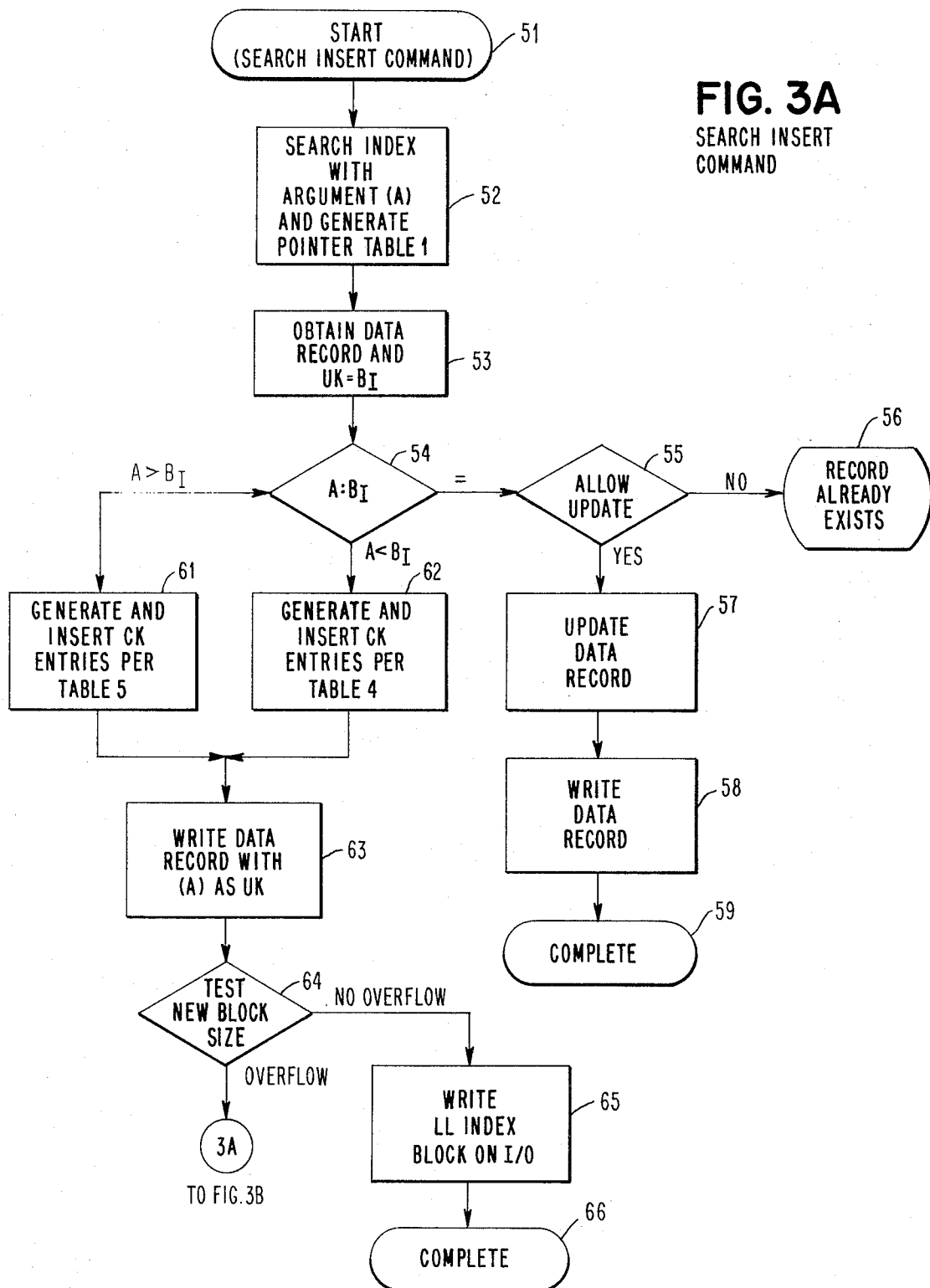
FIG. 2
SEARCH DELETE
COMMAND

FIG. 3A
SEARCH INSERT
COMMAND

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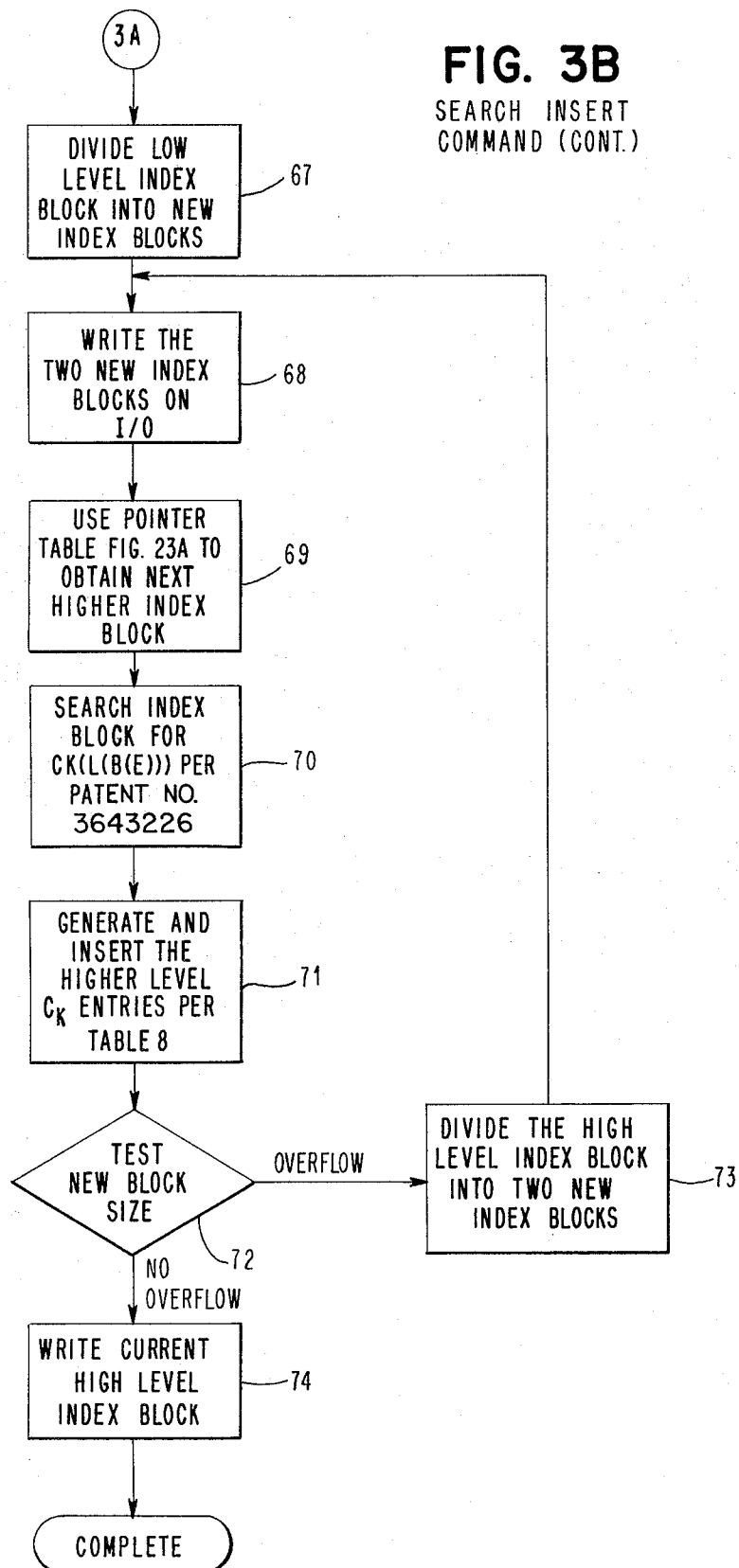
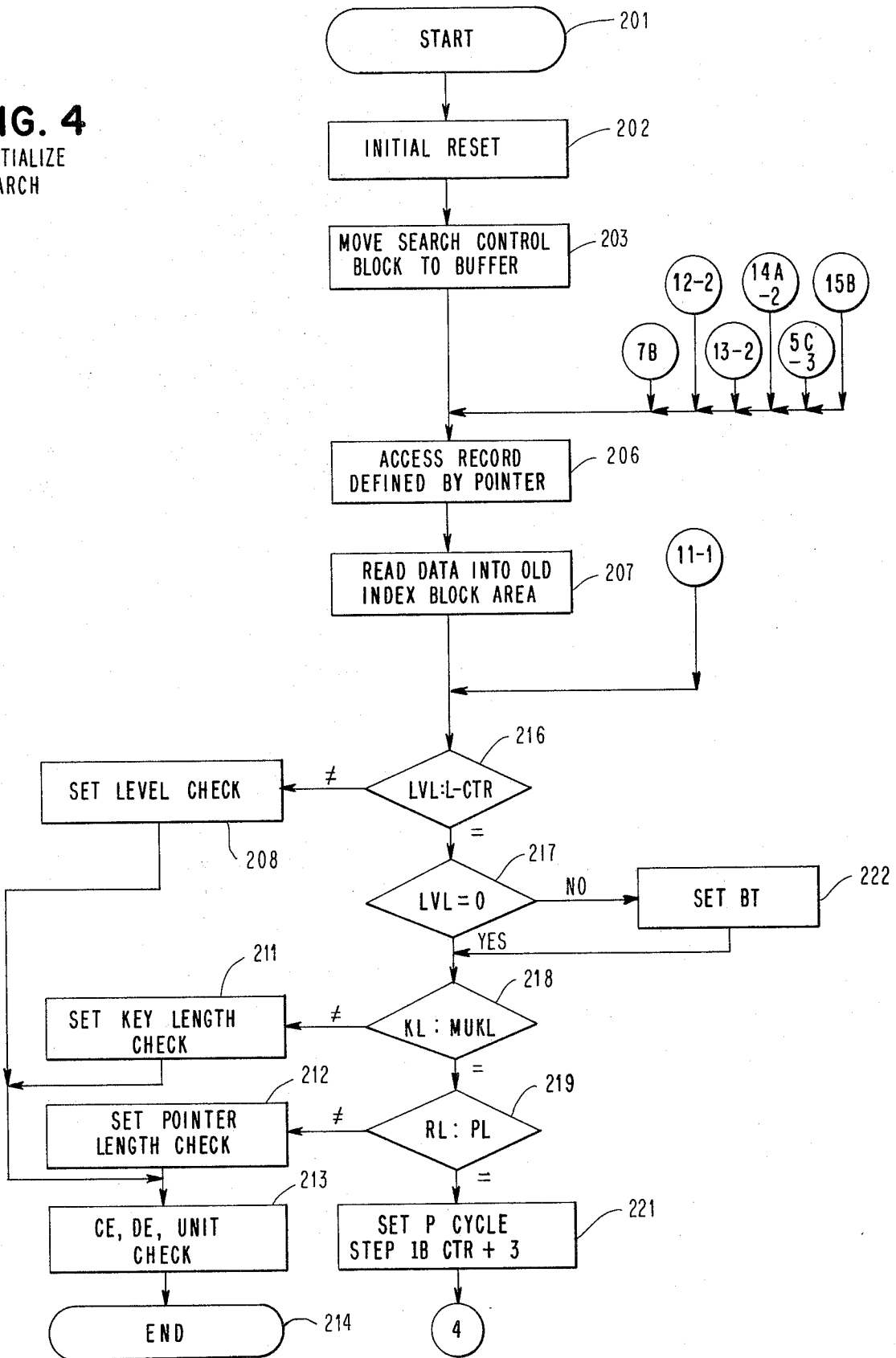


FIG. 4
INITIALIZE
SEARCH

TO FIG. 5A

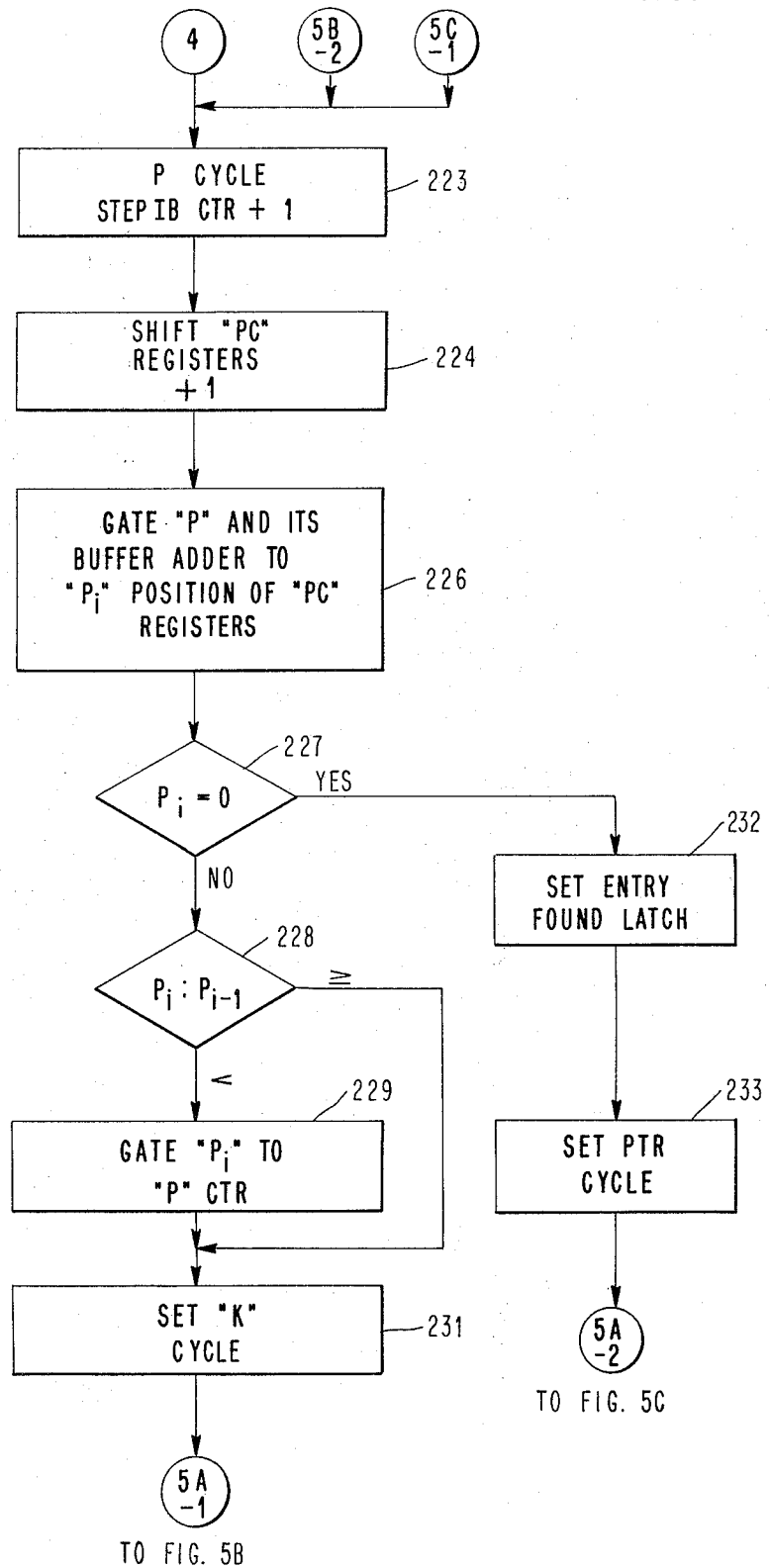
FIG. 5AP CYCLE OF
SEARCH

FIG. 5B

K CYCLE OF SEARCH

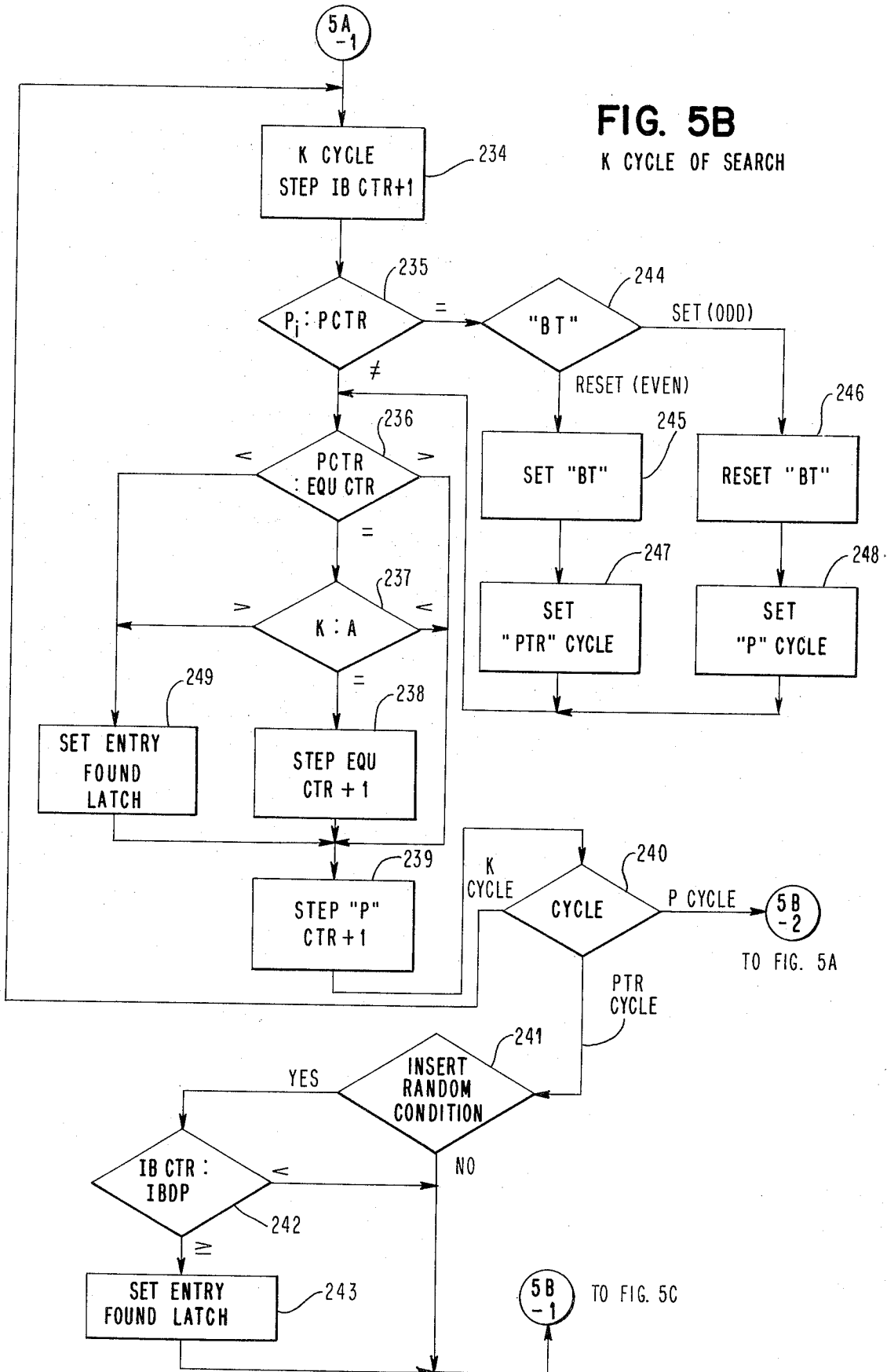


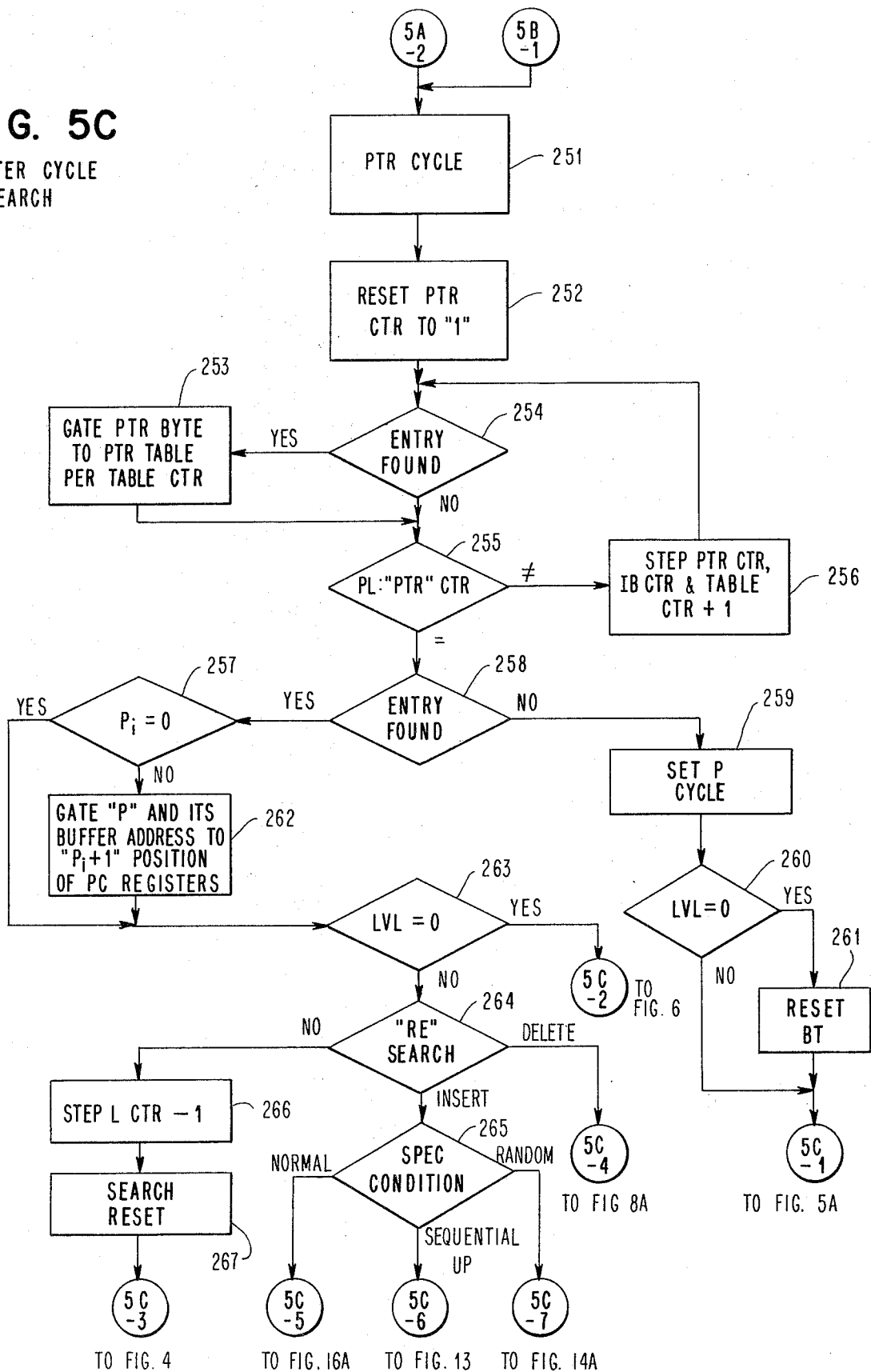
FIG. 5CPOINTER CYCLE
OF SEARCH

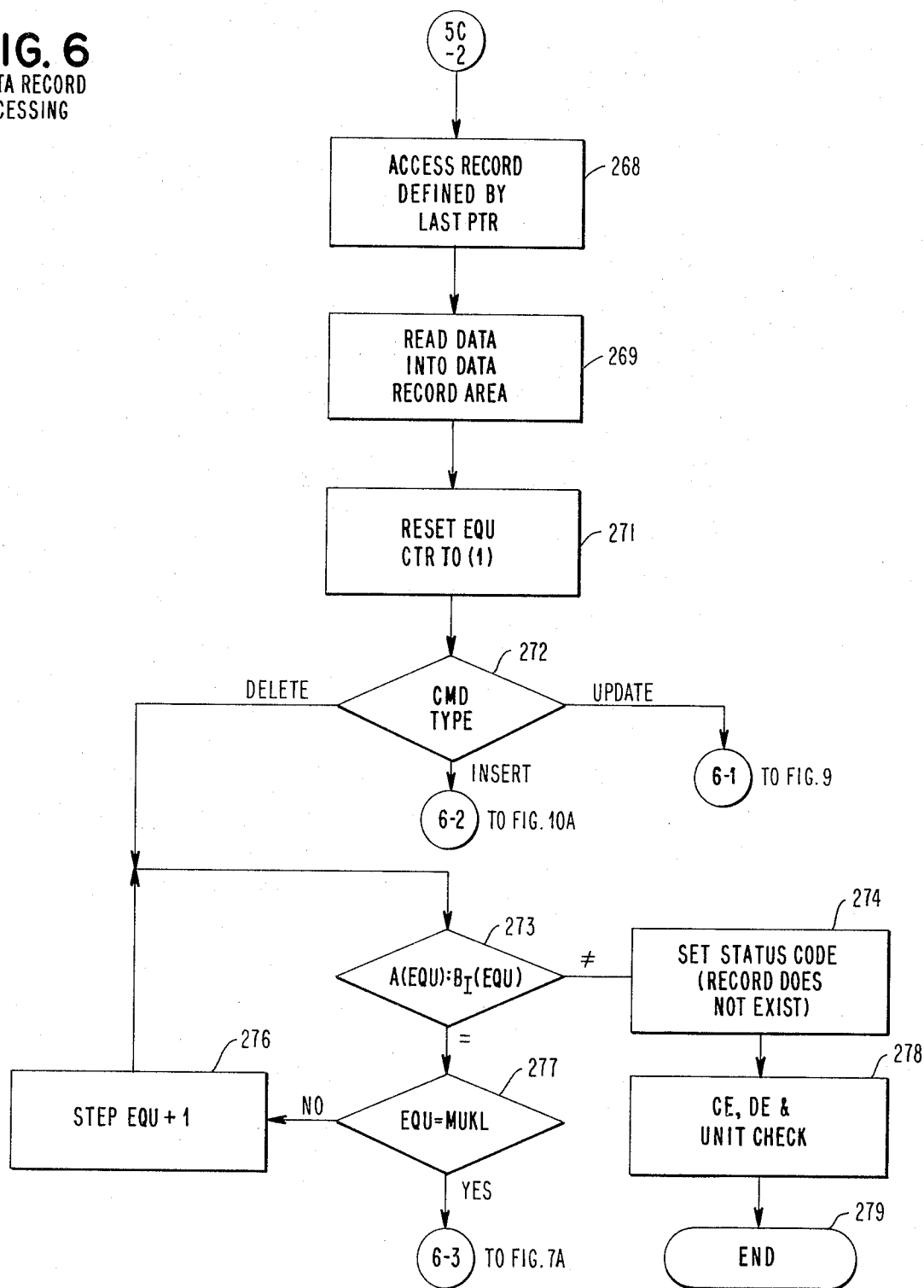
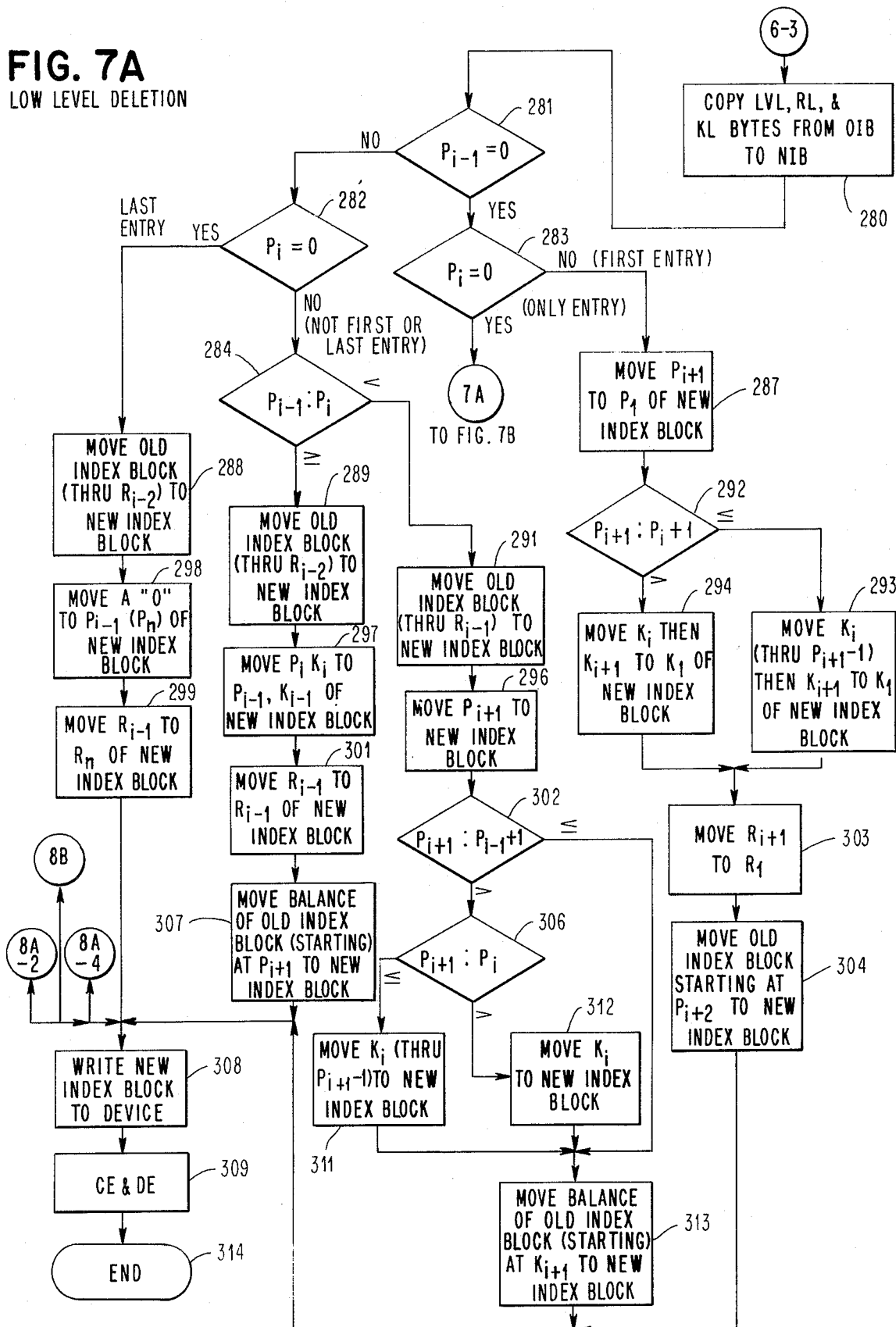
FIG. 6
DATA RECORD
ACCESSING

FIG. 7A
LOW LEVEL DELETION

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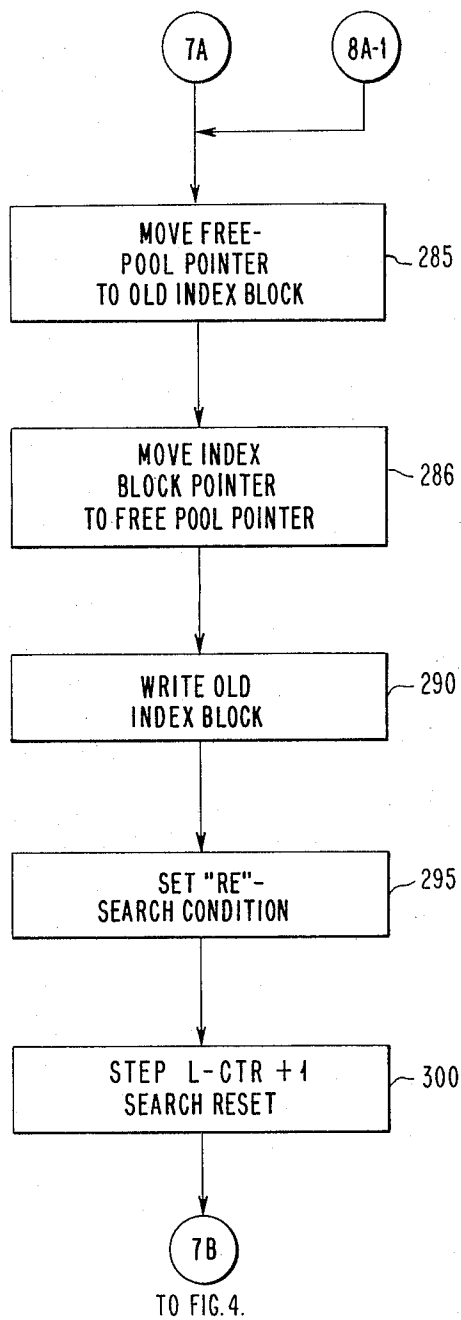
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FIG. 7B

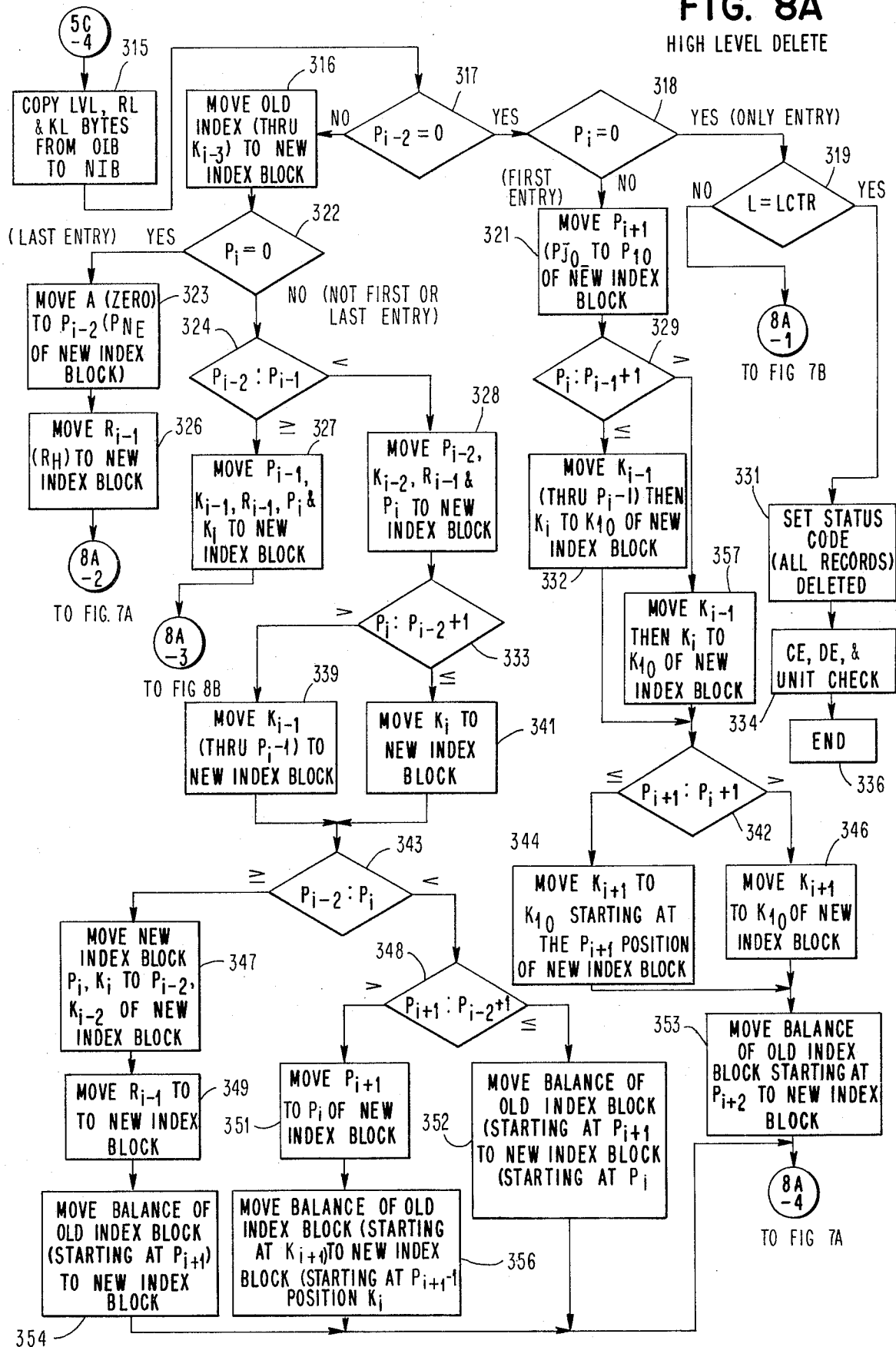
INDEX BLOCK
DELETION



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FIG. 8A
HIGH LEVEL DELETED



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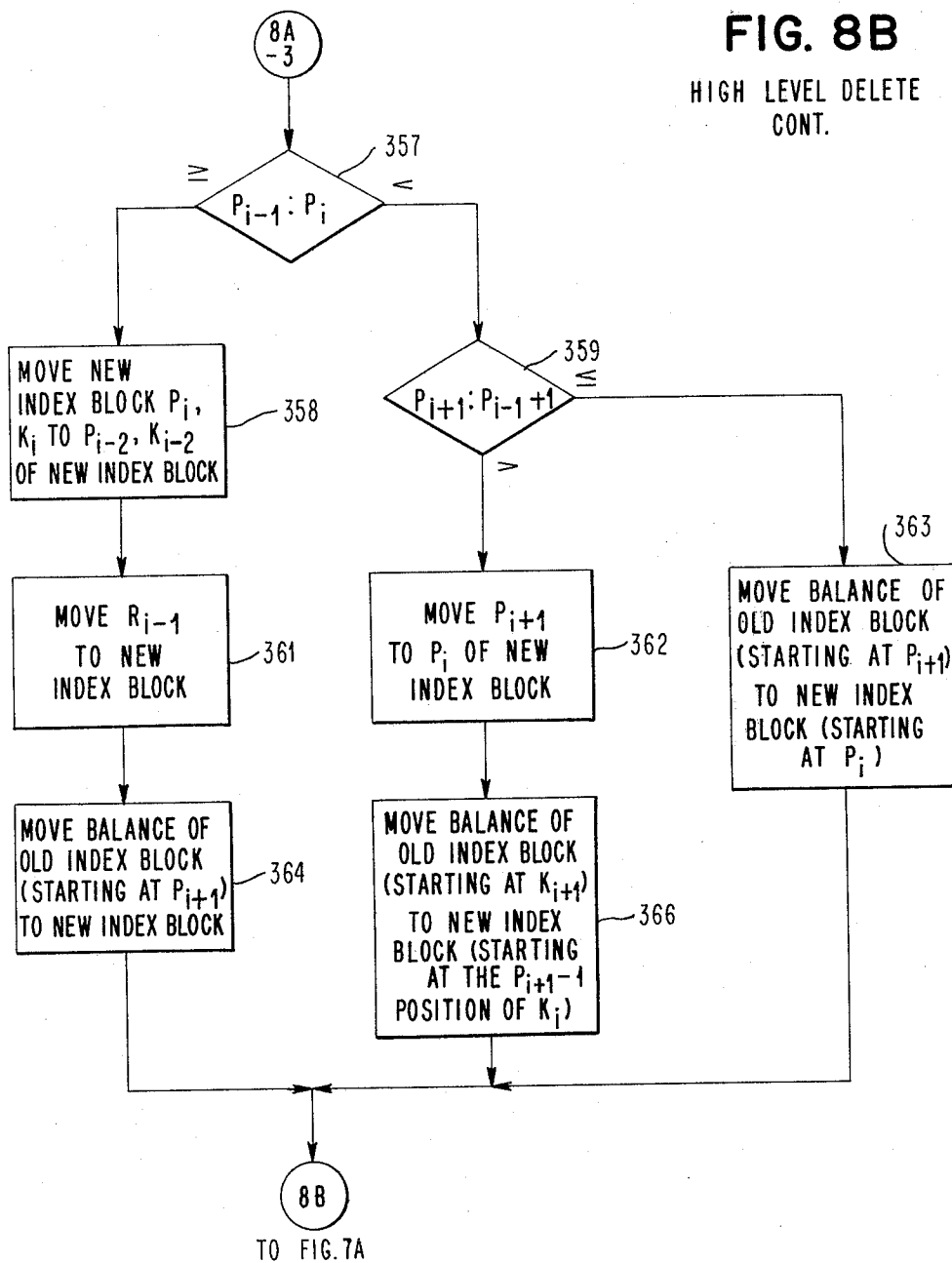
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FIG. 8B

HIGH LEVEL DELETE
CONT.



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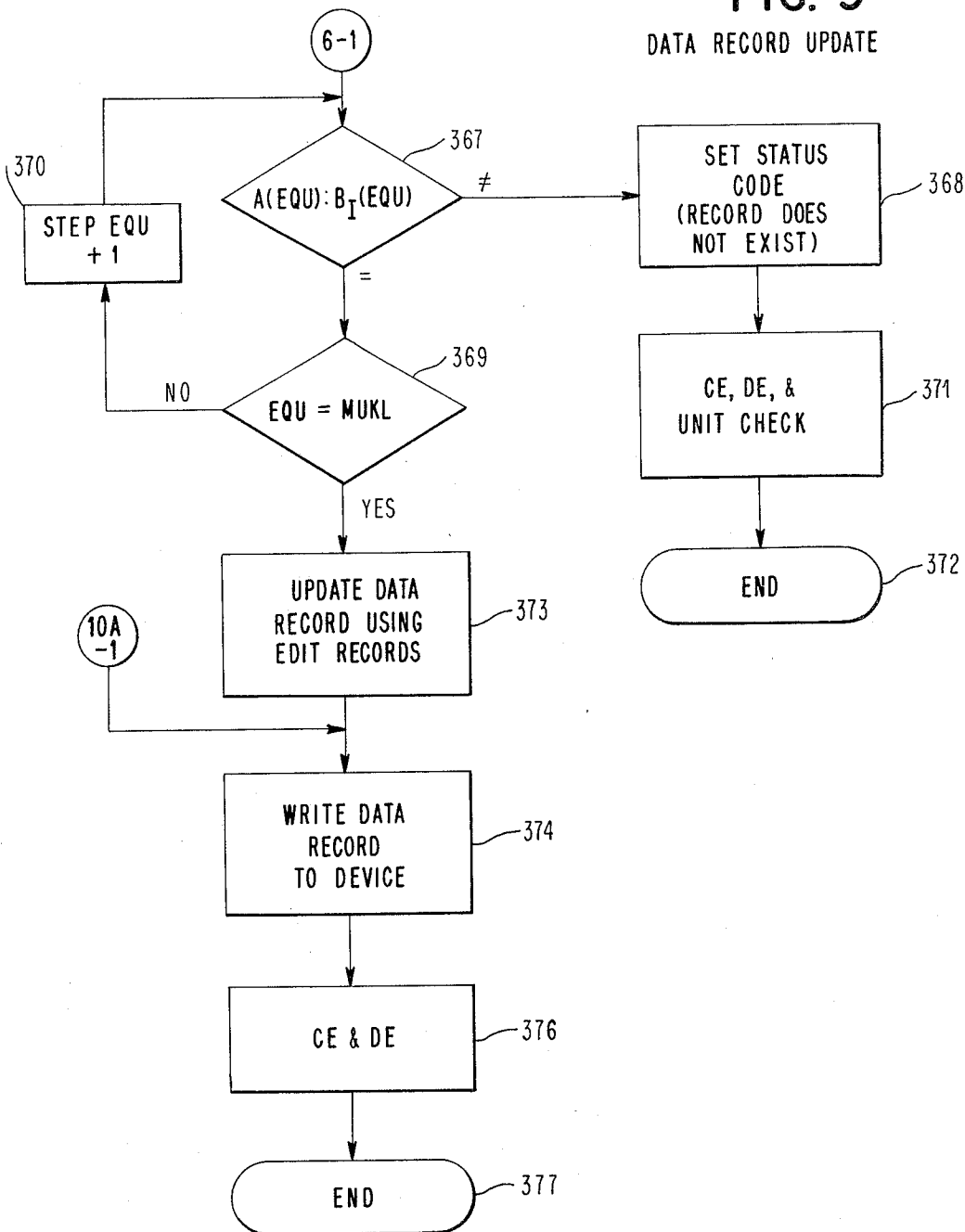
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FIG. 9

DATA RECORD UPDATE



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FIG. 10A

LOW-LEVEL INSERT
COMPRESSED ENTRY GENERATION

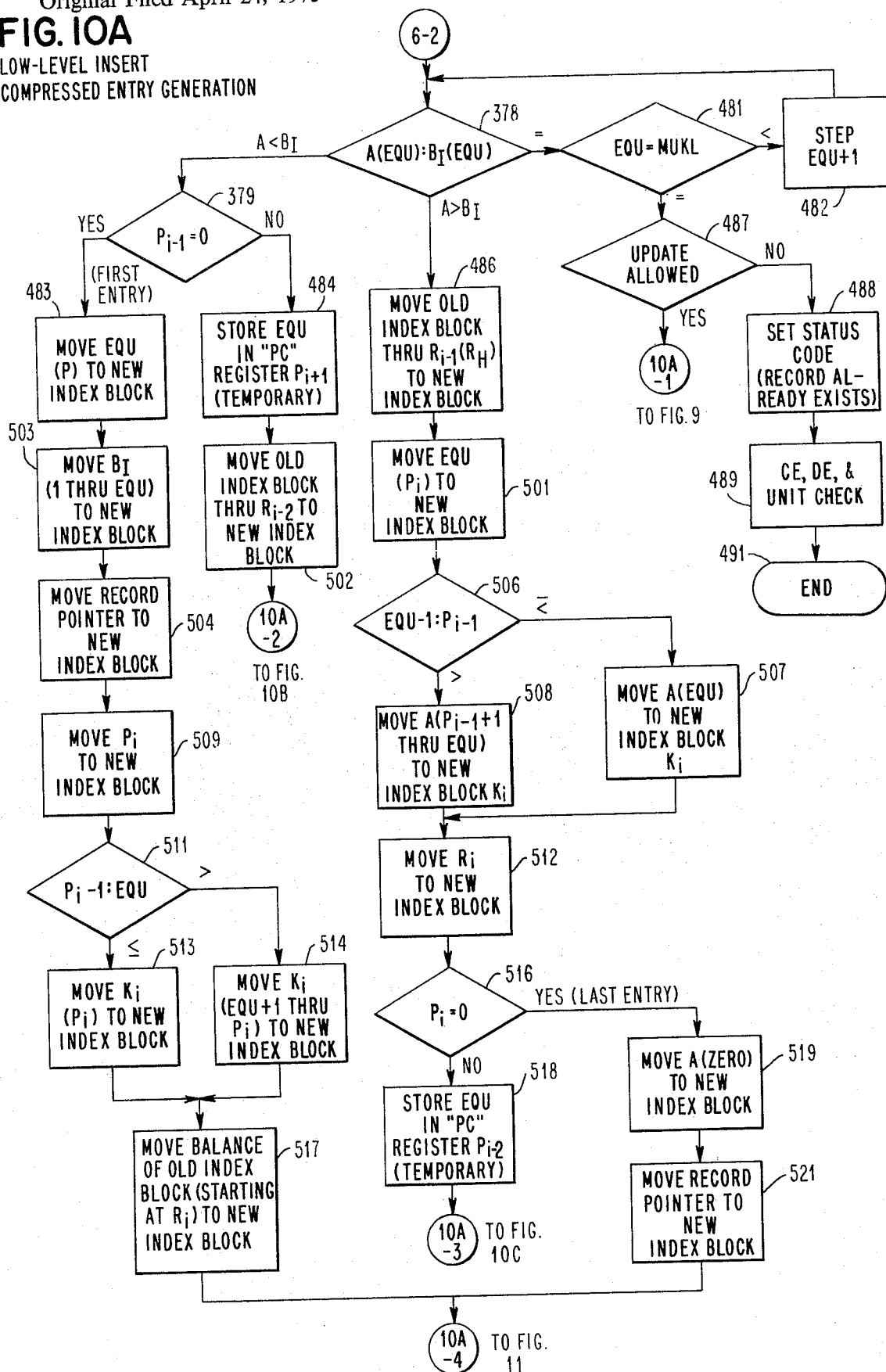


FIG. 10B

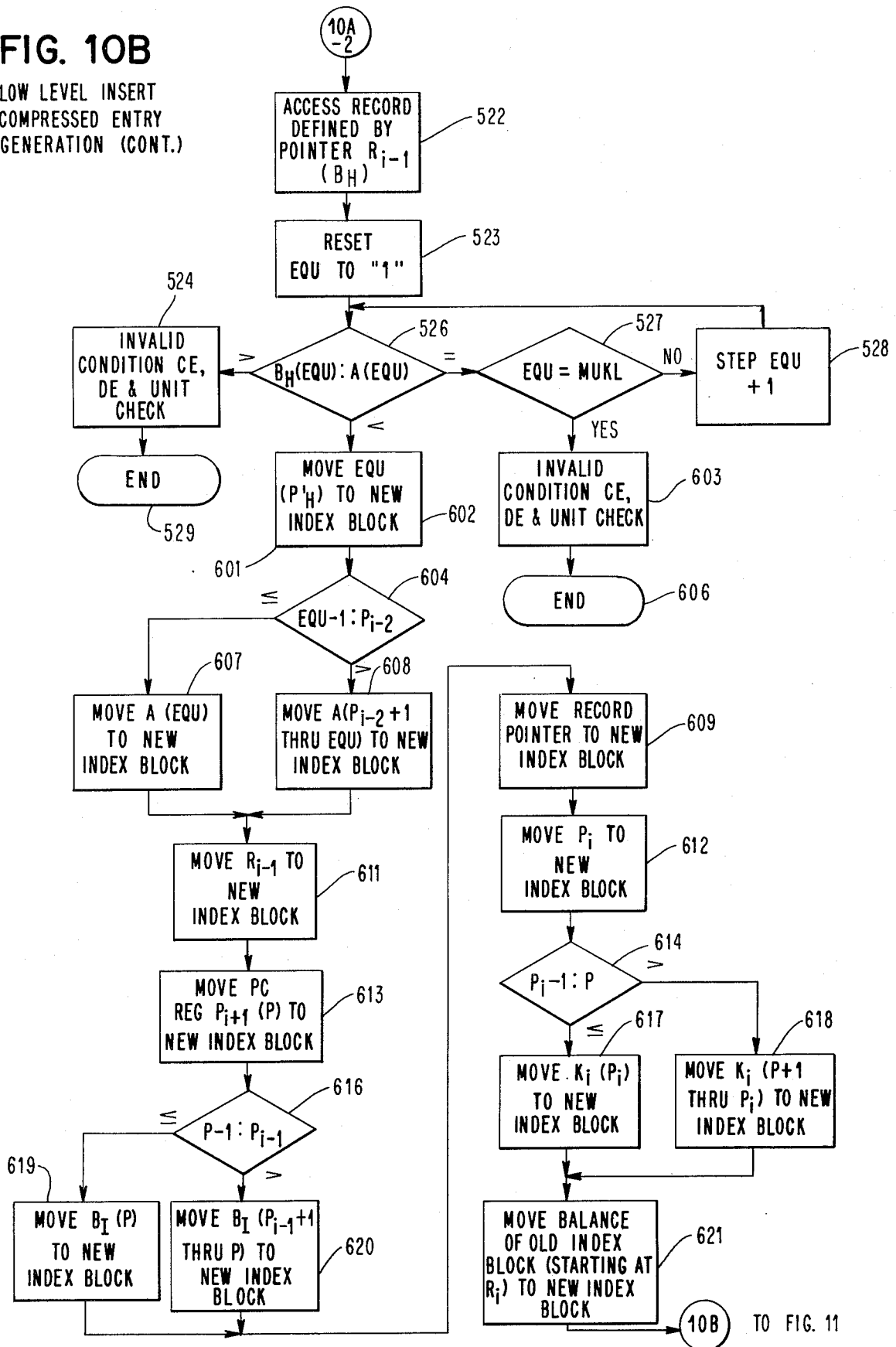
LOW LEVEL INSERT
COMPRESSED ENTRY
GENERATION (CONT.)

FIG. 10C

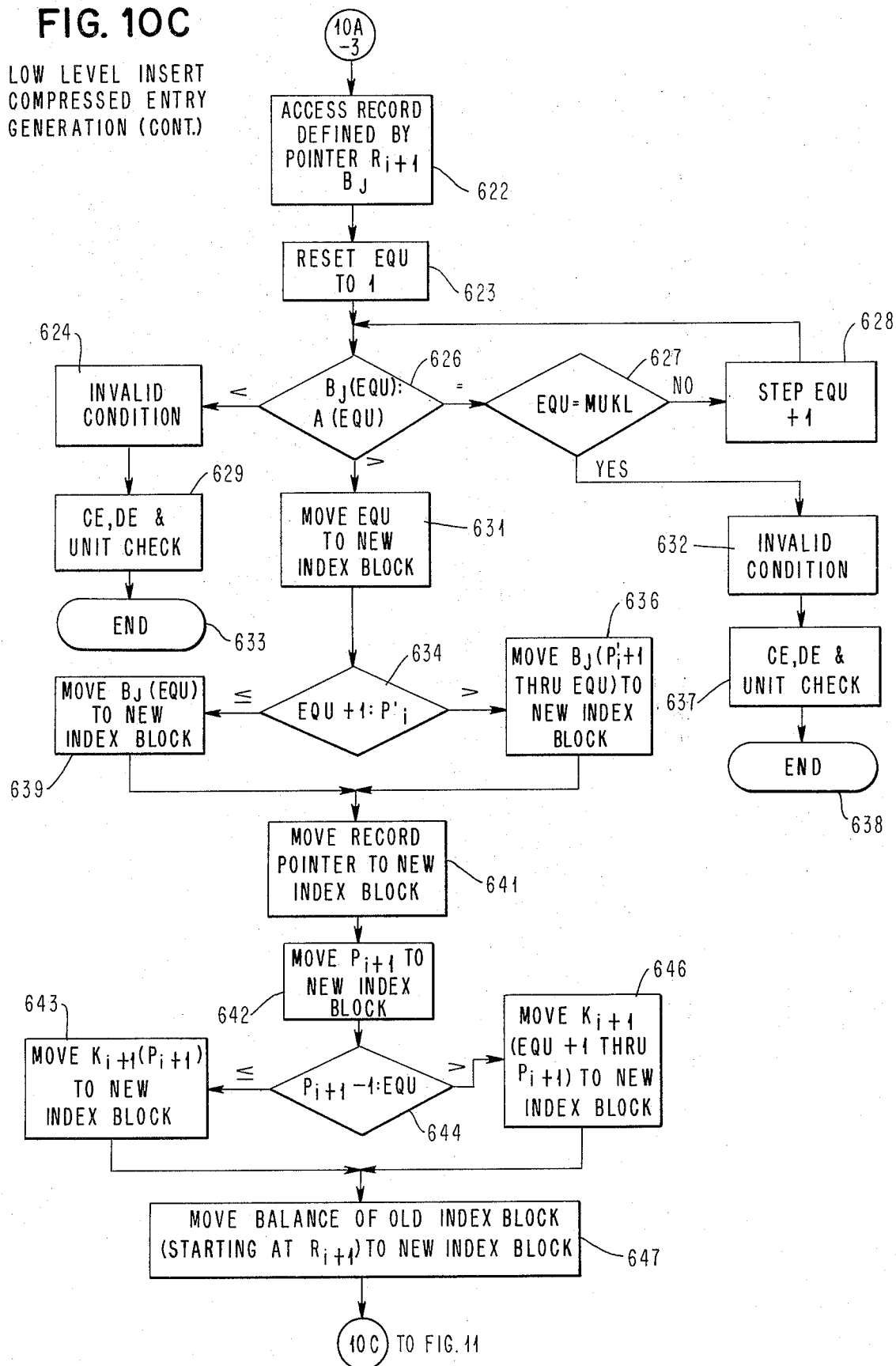
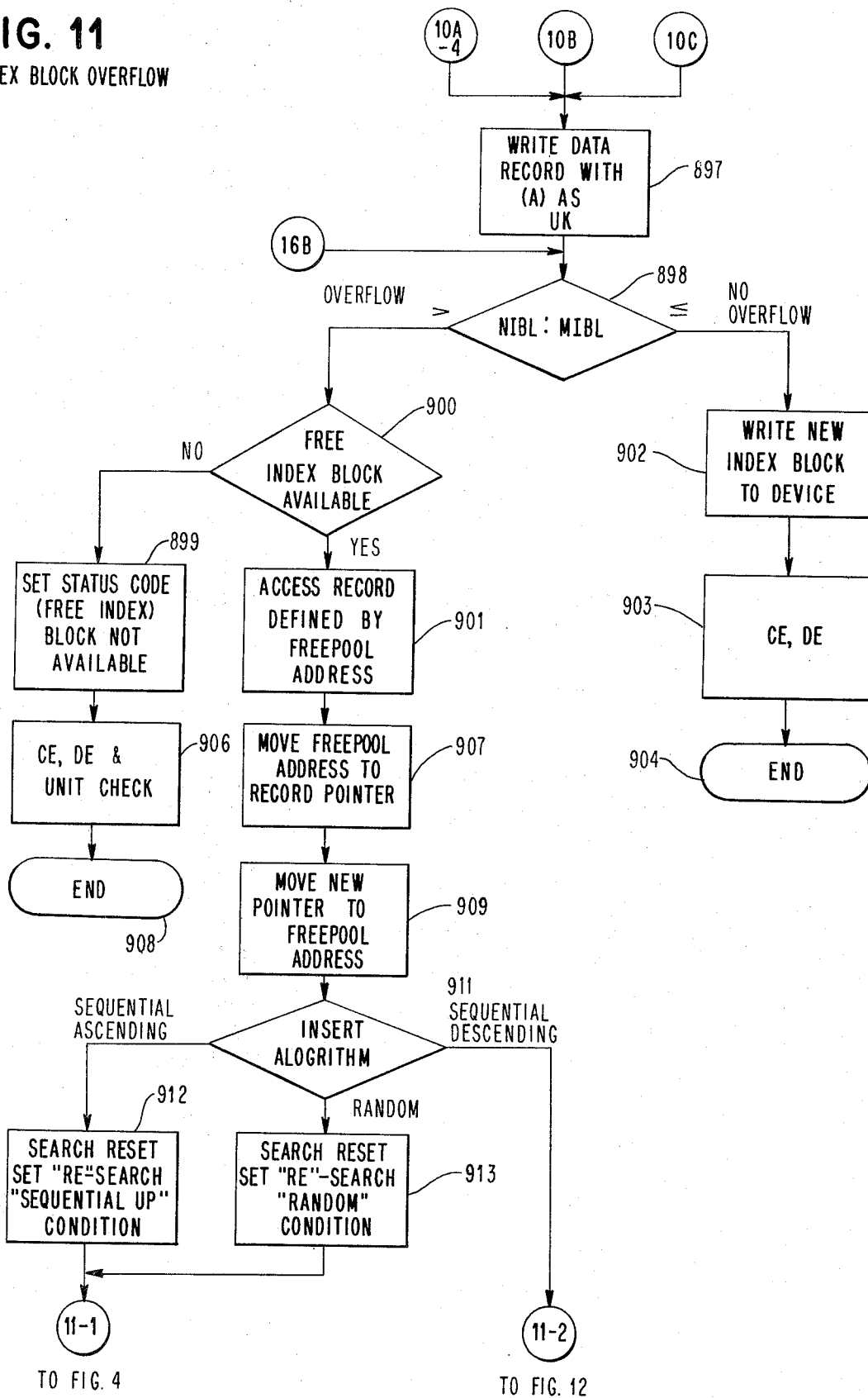
LOW LEVEL INSERT
COMPRESSED ENTRY
GENERATION (CONT.)

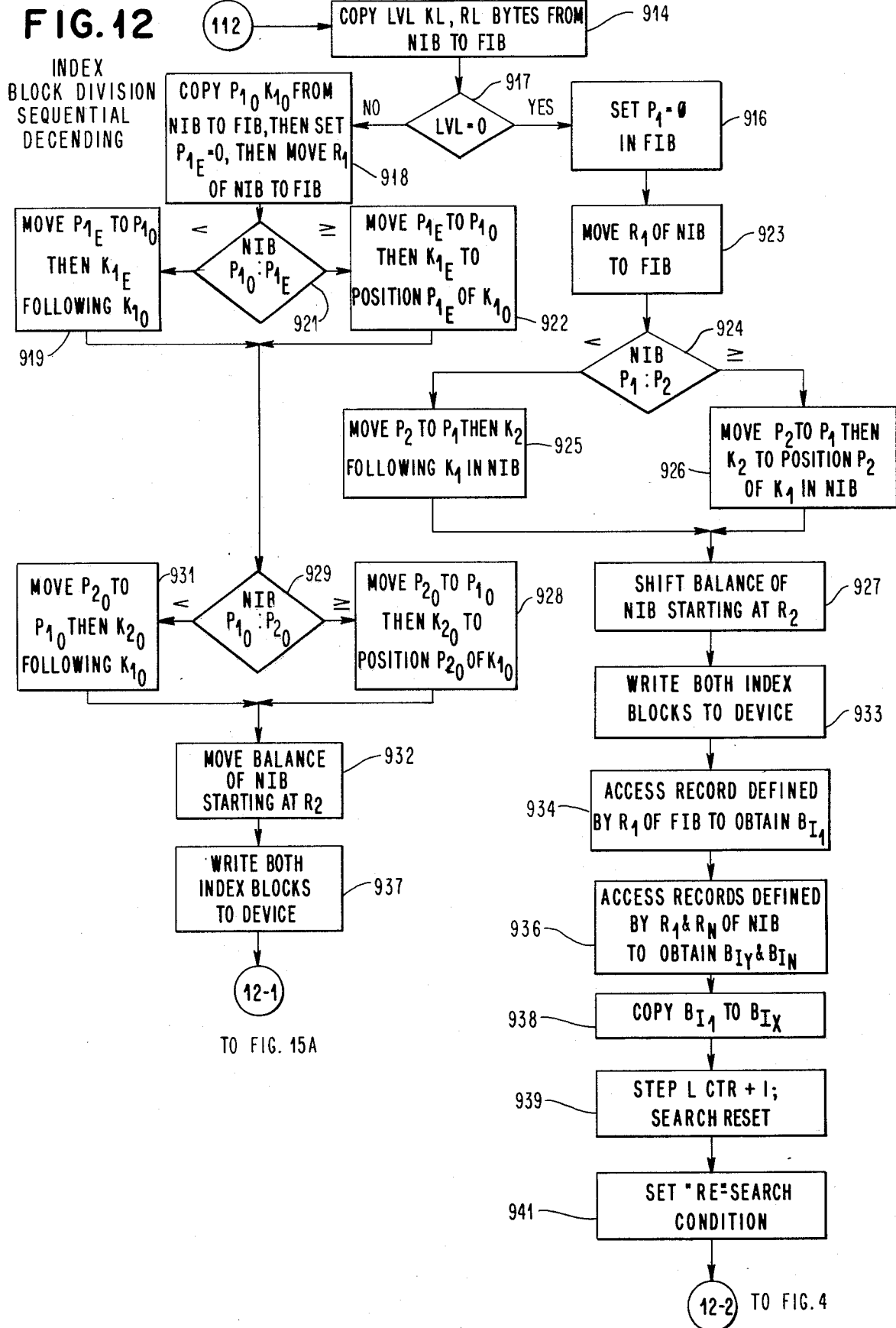
FIG. 11

INDEX BLOCK OVERFLOW



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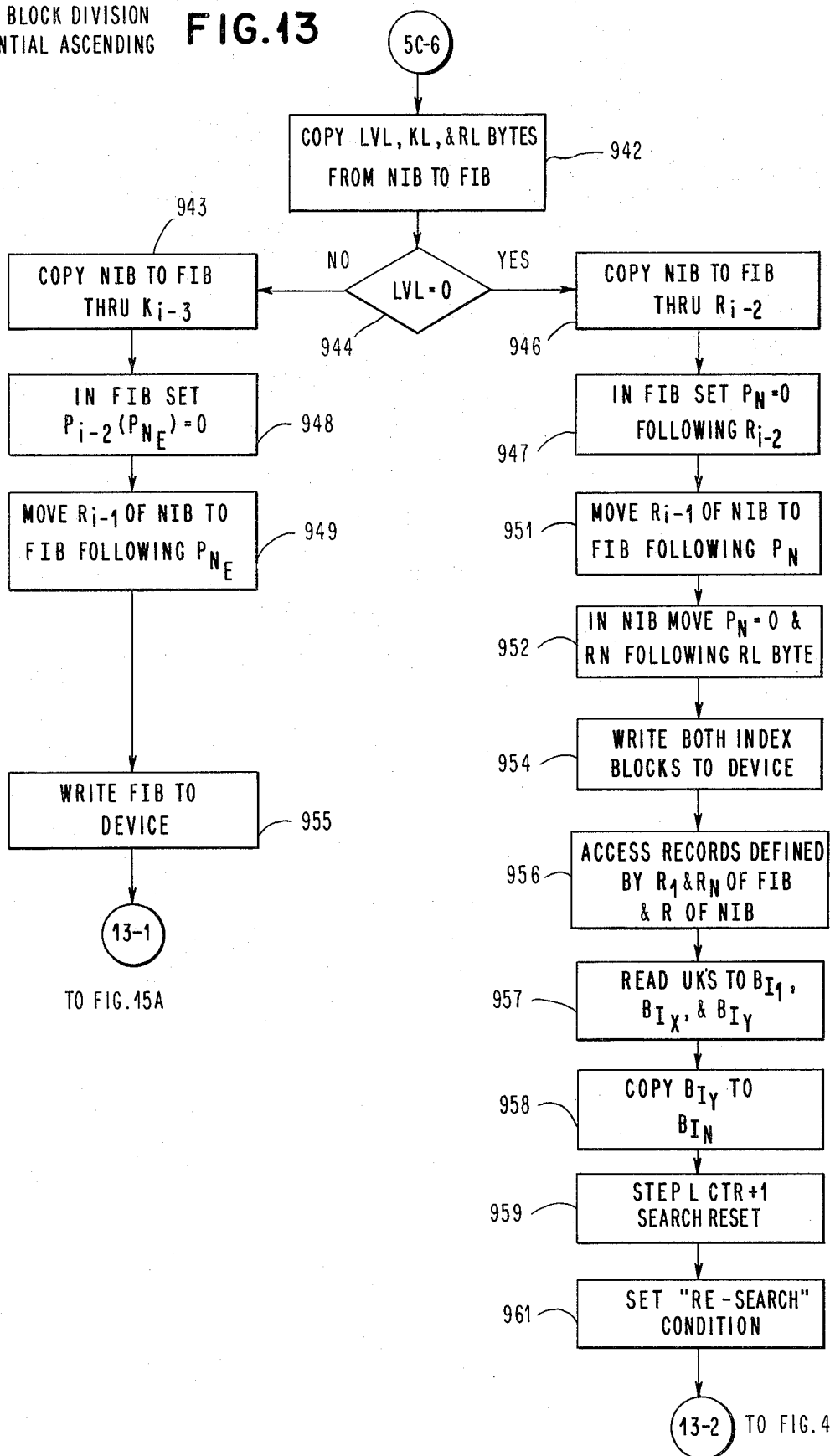
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INDEX BLOCK DIVISION
SEQUENTIAL ASCENDING

FIG. 13



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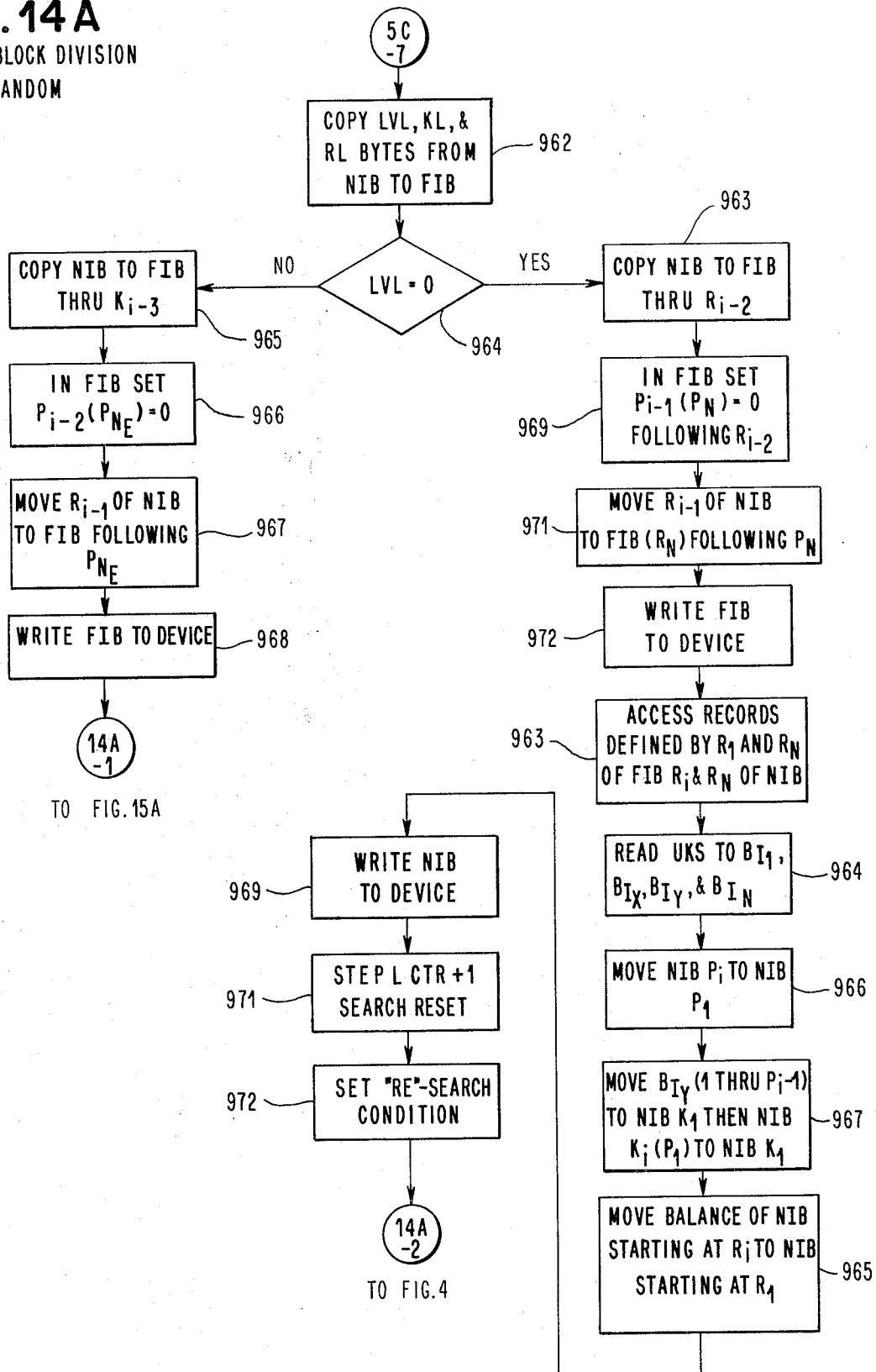
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FIG. 14A
INDEX BLOCK DIVISION
RANDOM



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AND MEANS

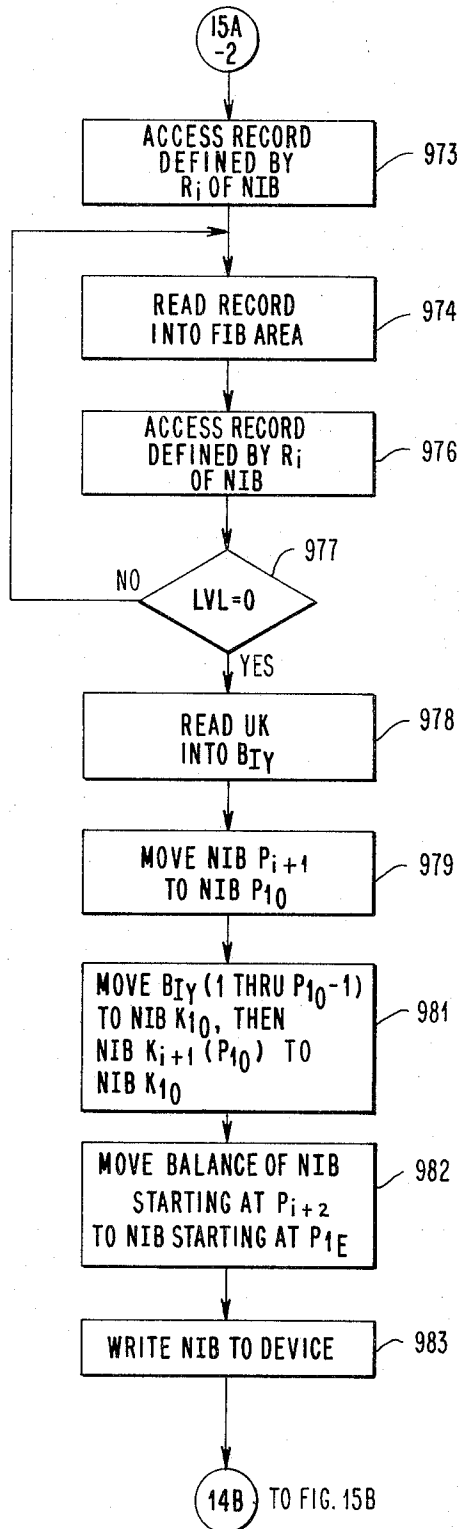
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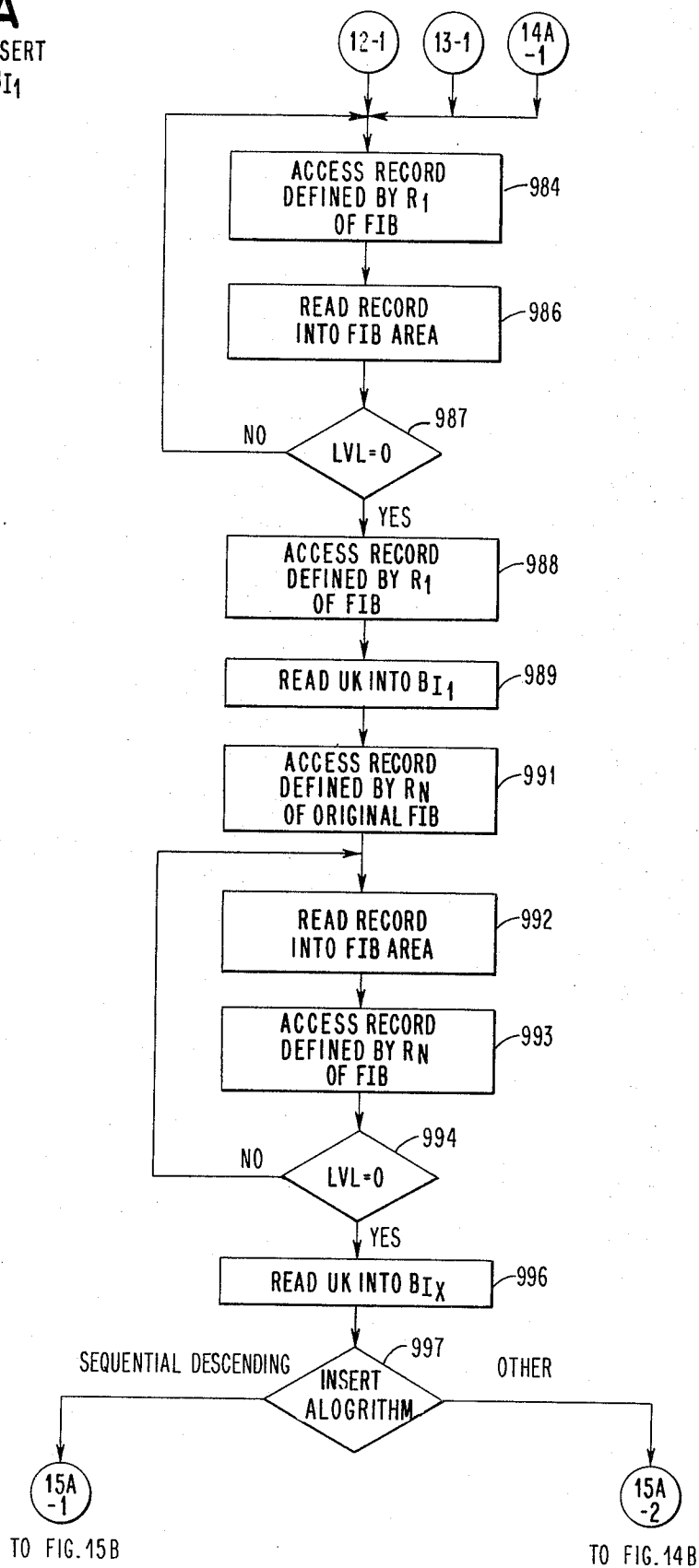
FIG. 14B

INDEX BLOCK
DIVISION RANDOM
(CONT.)



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FIG. 15AHIGH LEVEL INSERT
RETRIVAL OF B_{I1}
& B_{IX} 

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AND MEANS

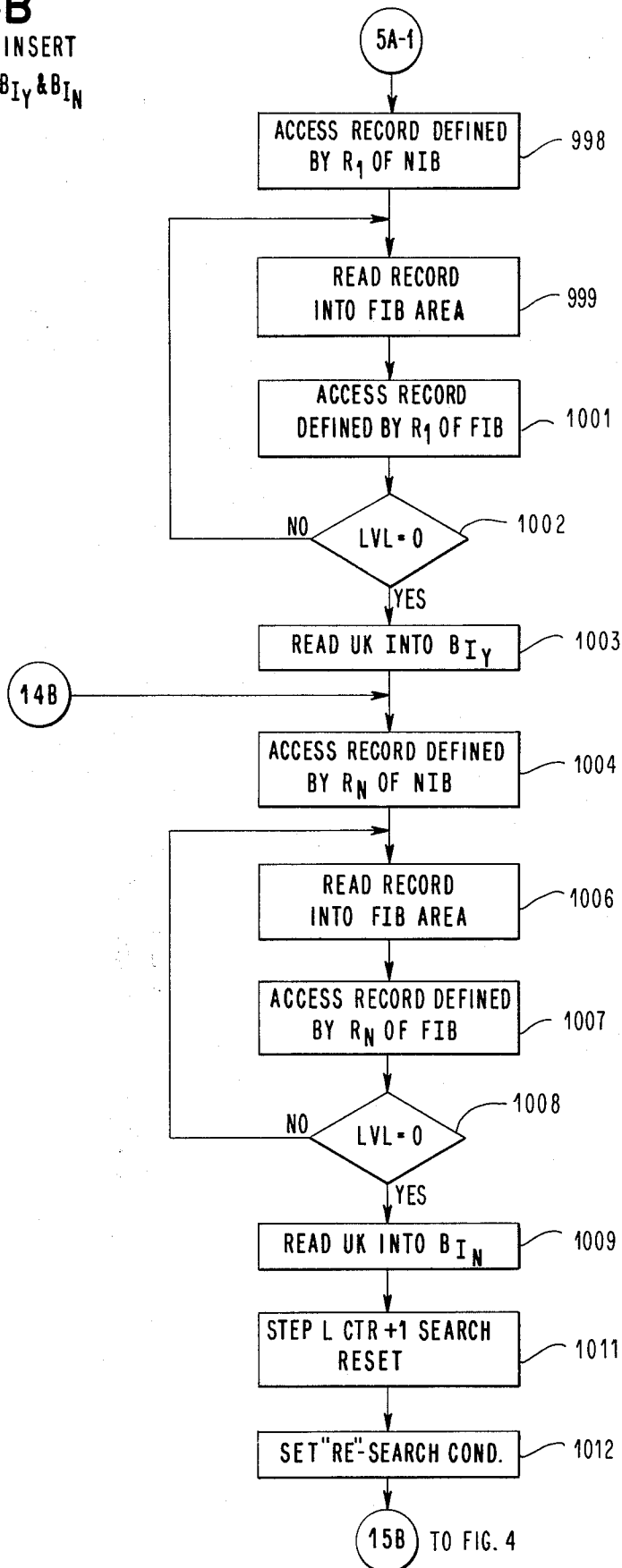
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FIG. 15B

HIGH LEVEL INSERT
RETRIVAL OF B_{I_Y} & B_{I_N}



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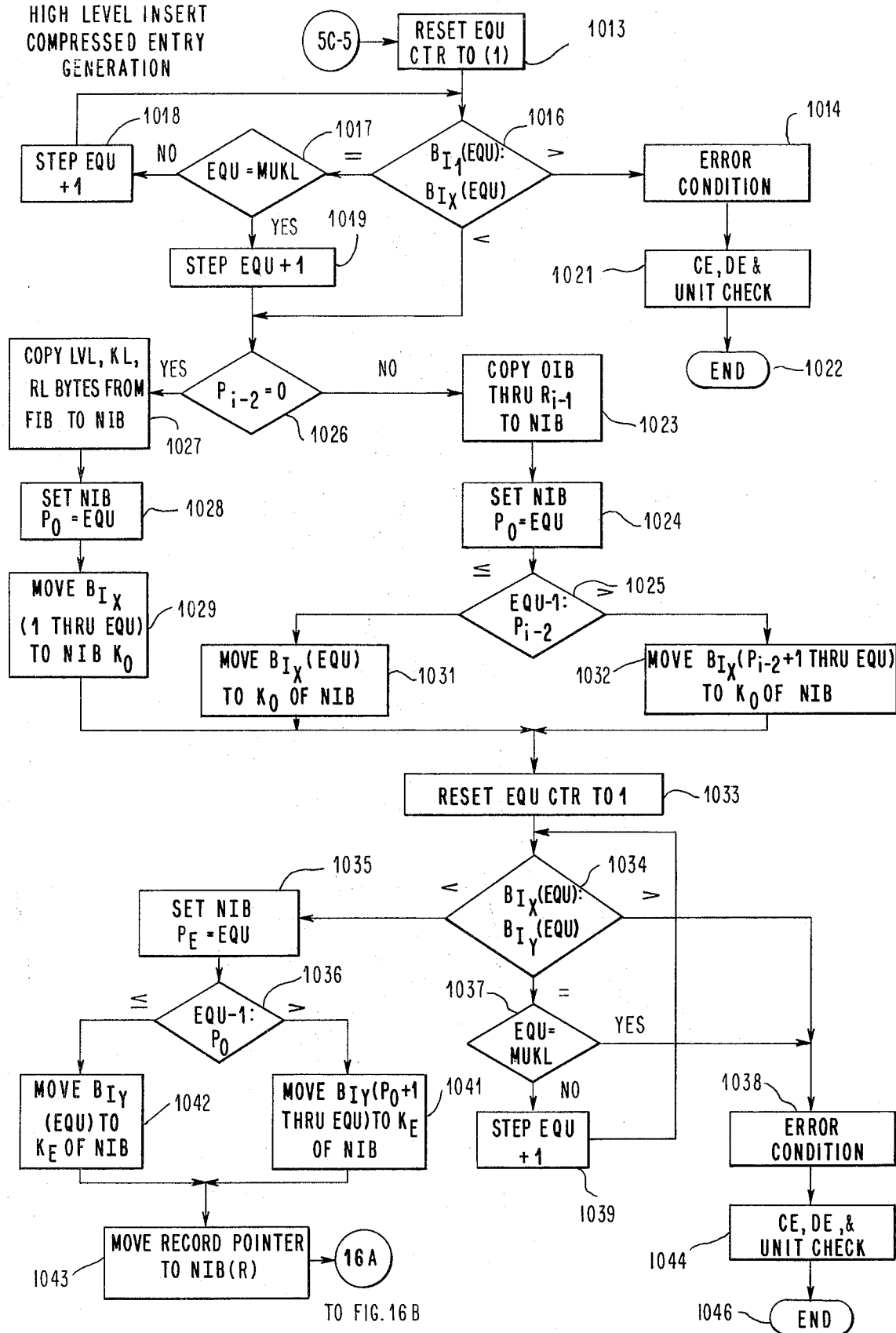
FIG. 16AHIGH LEVEL INSERT
COMPRESSED ENTRY
GENERATION

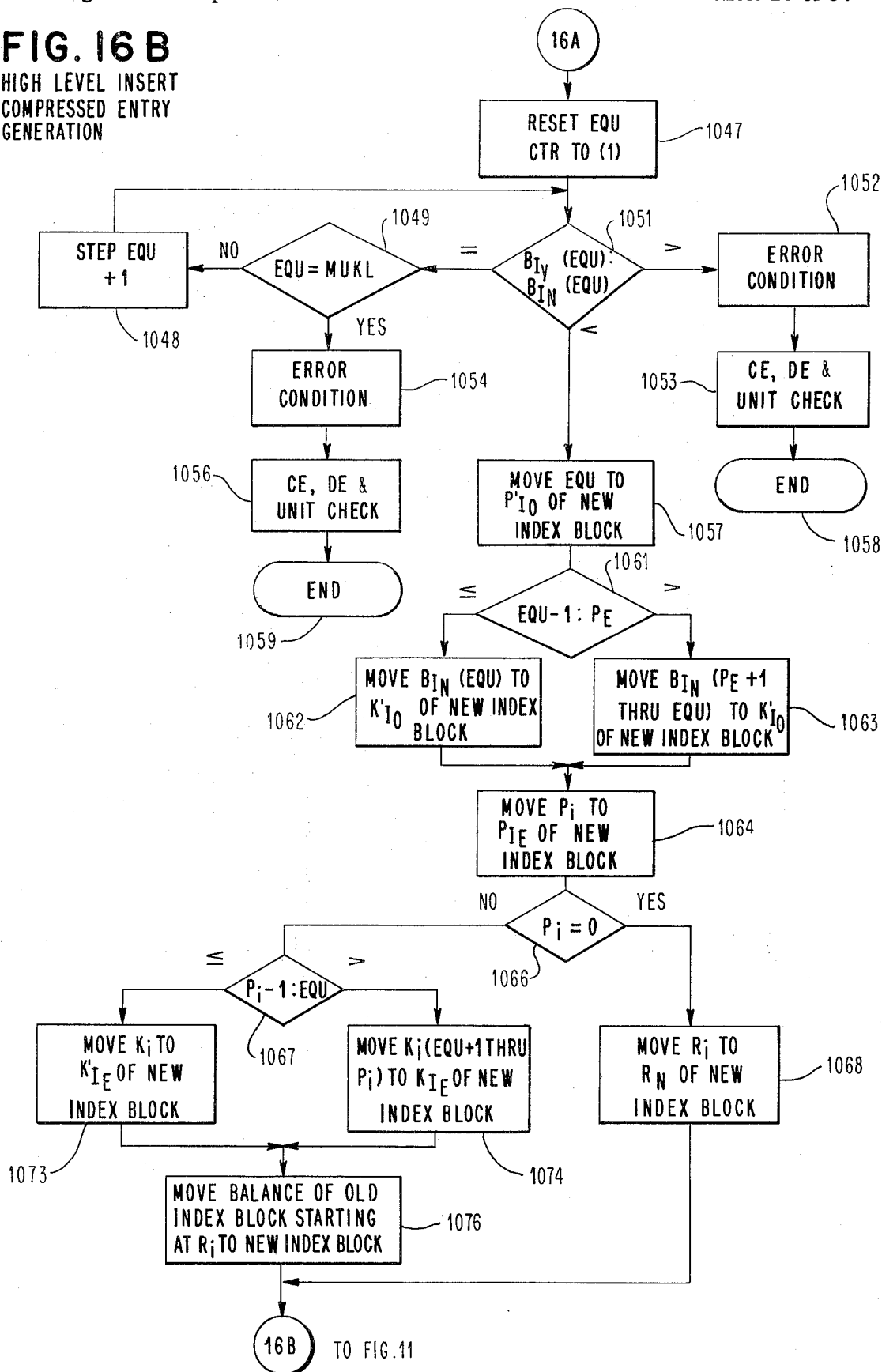
FIG. 16BHIGH LEVEL INSERT
COMPRESSED ENTRY
GENERATION

FIG. 17

LOW LEVEL COMPRESSED
INDEX BLOCK

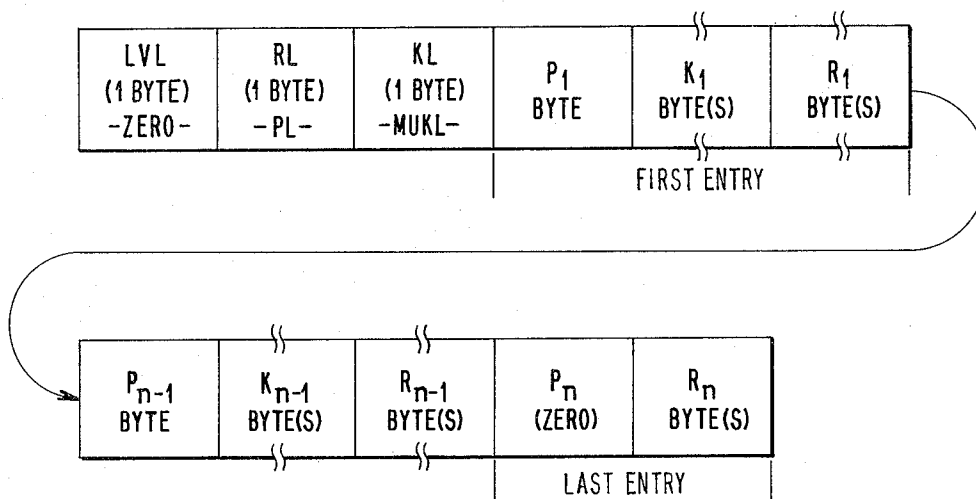
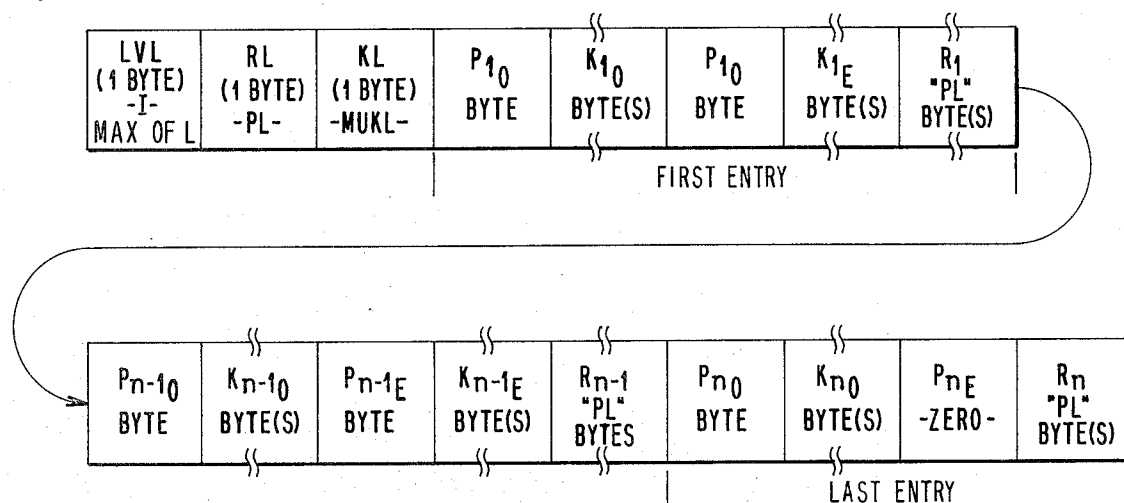


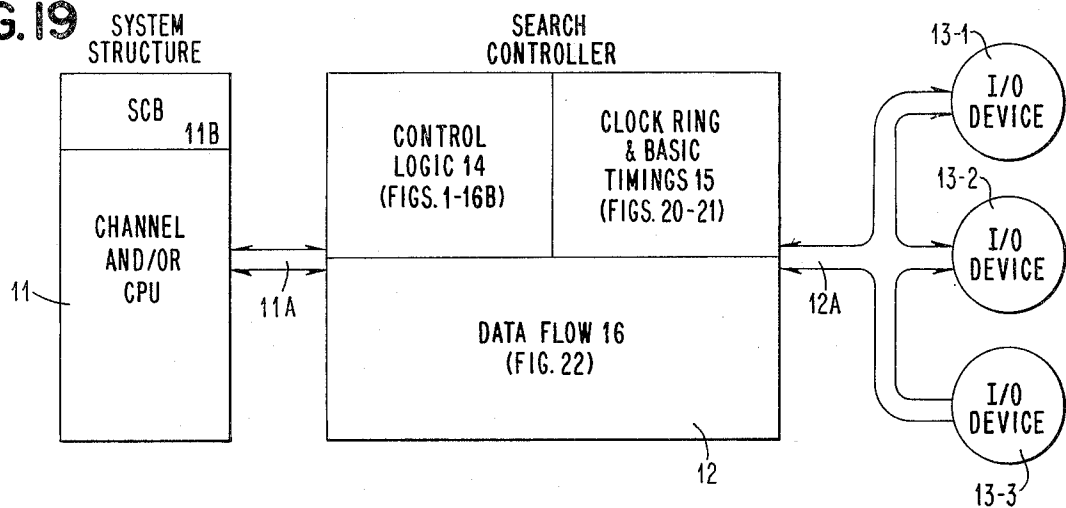
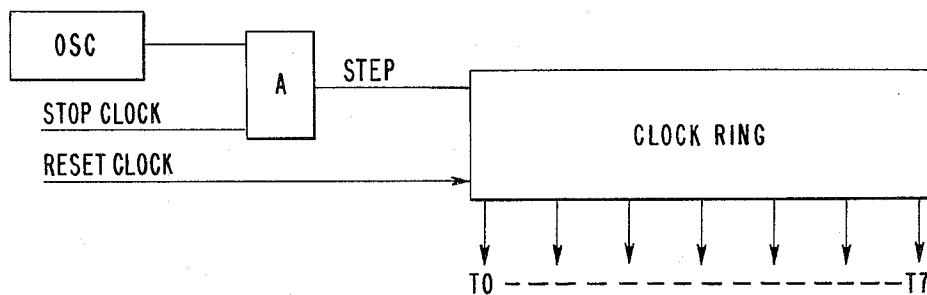
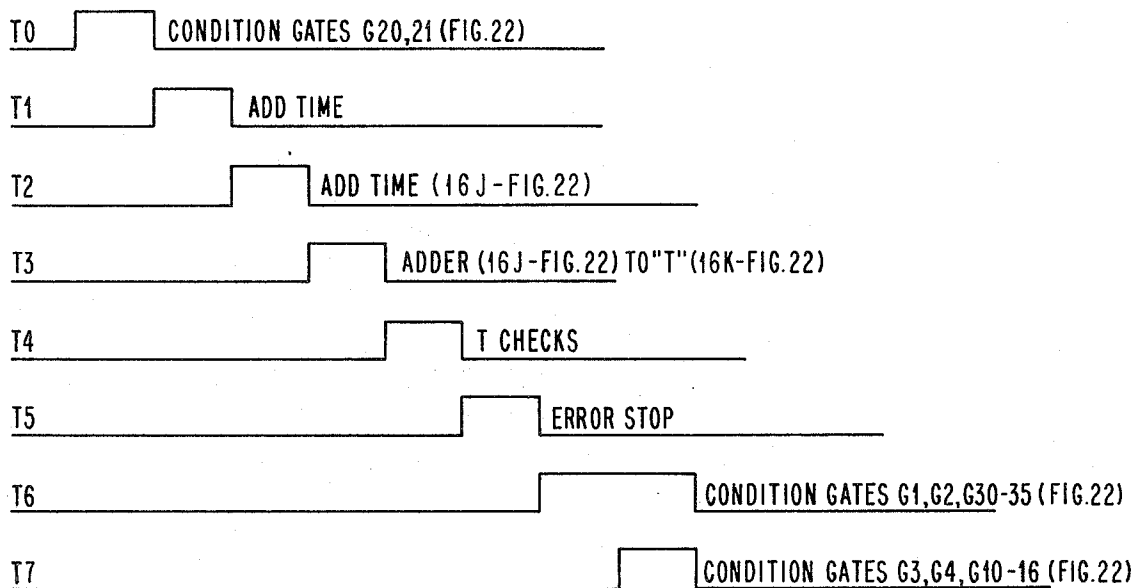
FIG. 18

HIGH LEVEL COMPRESSED INDEX
BLOCK FOR LEVEL "I"



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FIG. 19**FIG. 20** CLOCK RING & BASIC TIMINGS**FIG. 21**

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FIG. 22

DATA FLOW

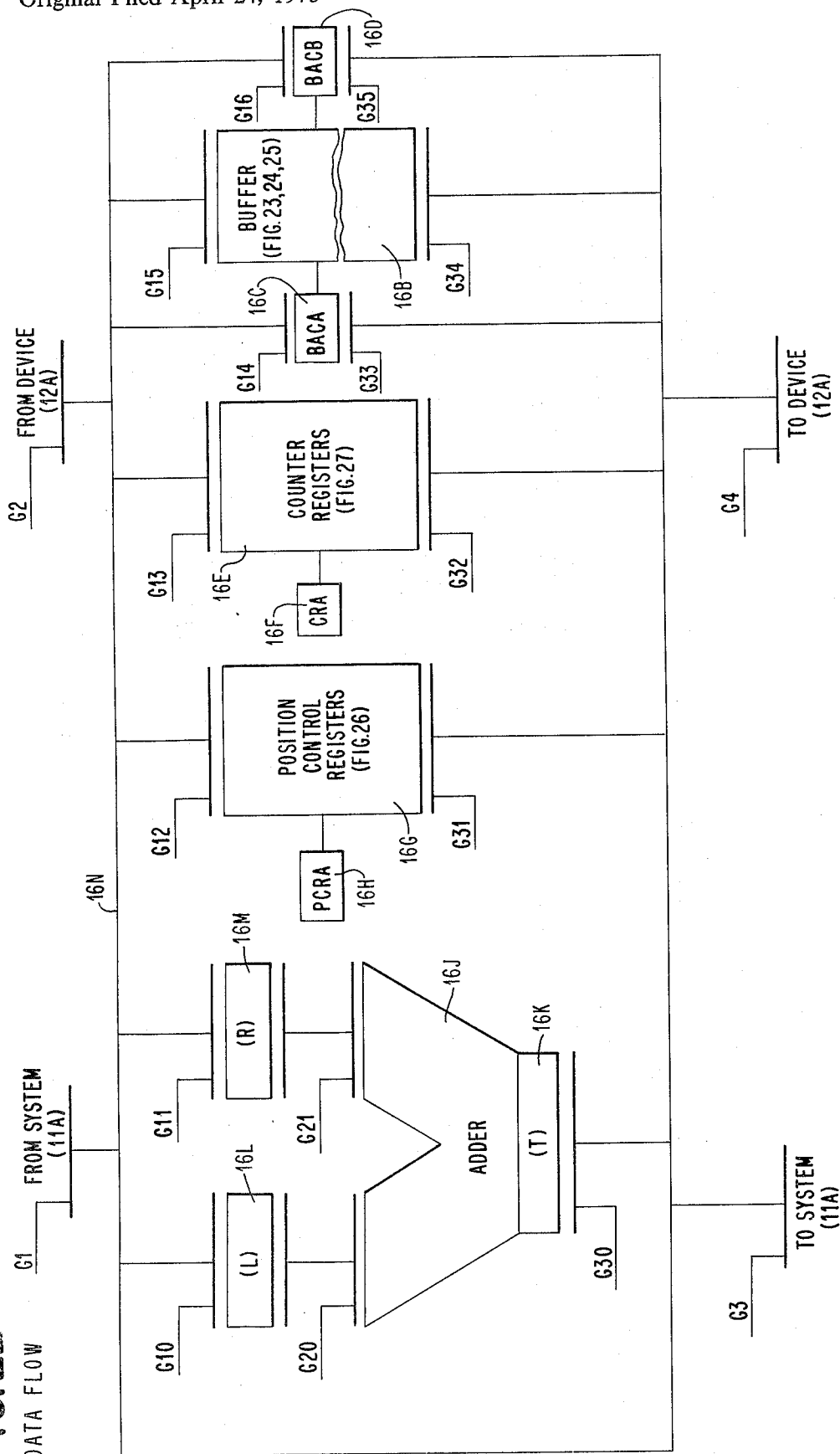


FIG. 23 BUFFER FORMAT
SEARCH INSERT

SEARCH CONTROL BLOCK (SCB) - ("SCBL" BYTES)	COMMAND (CC) CODE (1 BYTE)		SEARCH CONTROL BLOCK LENGTH (SCBL) (3 BYTES)	
	KEY DISPLACEMENT (KD) (2 BYTES)		DATA RECORD LENGTH (DRL) (2 BYTES)	
	INDEX BLOCK DIVIDE POINT (IBDP) (2 BYTES)		MAXIMUM INDEX BLOCK LENGTH (MIBL) (2 BYTES)	
	STATUS CODE (1 BYTE)	LEVEL (L) (1 BYTE)	POINTER LENGTH (PL) (1 BYTE)	MAX. UK LENGTH (MUKL) (1 BYTE)
	SEARCH ARGUMENT (A) ("MUKL" BYTES)			
	NEW DATA RECORD (NDR) ("DRL" BYTES)			
	DATA RECORD POINTER (DRP) ("PL" BYTES)			
	INDEX BLOCK FREE POOL POINTER (IBFP) ("PL" BYTES)			
	FIRST INDEX POINTER (FIP) ("PL" BYTES)			
	BALANCE OF INDEX POINTER TABLE (IPT) ("L X PL" BYTES) FIG. 23A			
	UK-B _H , OR B _J , OR B _{I₁} ("PL" BYTES)			
	UK-B _{I_X} ("PL" BYTES)			
	UK-B _{I_Y} ("PL" BYTES)			
	UK-B _{I_N} ("PL" BYTES)			
	OLD INDEX BLOCK (OIB)/FIRST INDEX BLOCK (FIB) (MIBL BYTES) FIG. 28 OR 29			
	NEW INDEX BLOCK (NIB) - (MIBL BYTES) FIG. 28 OR 29			
	DATA RECORD AREA - (DRL BYTES) (INCLUDES UK B _I)			

FIG. 23A INDEX POINTER TABLE

"L X PL" BYTES			
FIRST INDEX POINTER(FIP)	INDEX POINTER AT "L-1"	INDEX POINTER AT "L=0"	
"PL" BYTES	"PL" BYTES	"PL" BYTES	

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FIG. 24 BUFFER FORMAT
SEARCH DELETE

SEARCH CONTROL BLOCK (SCB) ("SCBL" BYTES)	COMMAND CODE (1 BYTE)		SEARCH CONTROL BLOCK LENGTH (SCBL) (3 BYTES)	
	KEY DISPLACEMENT (KD) (2 BYTES)		DATA RECORD LENGTH (DRL) (2 BYTES)	
	UNUSED (2 BYTES)		MAXIMUM INDEX BLOCK LENGTH (MIBL) (2 BYTES)	
	STATUS CODE (1 BYTE)	LEVEL (L) (1 BYTE)	POINTER LENGTH (PL) (1 BYTE)	MAX UK LENGTH (MUKL) (1 BYTE)
	SEARCH ARGUMENT (A) ("MUKL" BYTES)			
	INDEX BLOCK FREE POOL POINTER (IBFP) ("PL" BYTES)			
	FIRST INDEX POINTER (FIP) ("PL" BYTES)			
	BALANCE OF INDEX POINTER TABLE (IPT) ("PLX (L)" BYTES) FIG. 23A			
	OLD INDEX BLOCK (OIB) ("MIBL" BYTES) (FIG. 28 OR 29)			
	NEW INDEX BLOCK (NIB) ("MIBL" BYTES) (FIG. 28 OR 29)			
	DATA RECORD AREA (DRL BYTES) (INCLUDES UK B _I)			

FIG. 25 BUFFER FORMAT
SEARCH UPDATE

SEARCH CONTROL BLOCK (SCB) ("SCBL" BYTES)	COMMAND CODE (1 BYTE)		SEARCH CONTROL BLOCK LENGTH (SCBL) (3 BYTES)	
	KEY DISPLACEMENT (KD) (2 BYTES)		DATA RECORD LENGTH (DRL) (2 BYTES)	
	UNUSED (2 BYTES)		MAXIMUM INDEX BLOCK LENGTH (MIBL) (2 BYTES)	
	STATUS CODE (1 BYTE)	LEVEL (L) (1 BYTE)	POINTER LENGTH (PL) (1 BYTE)	MAX UK LENGTH (MUKL) (1 BYTE)
	SEARCH ARGUMENT (A) ("MUKL" BYTES)			
	UPDATE DATA RECORD (UDR) ("VARIABLE" NUMBER OF BYTES) FIG. 25A			
	FIRST INDEX POINTER (FIP) ("PL" BYTES)			
	OLD INDEX BLOCK (OIP) ("MIBL" BYTES) (FIG. 28 OR 29)			
	DATA RECORD AREA (DRL BYTES) (INCLUDES UK B _I)			

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FIG.25A

UPDATE DATA
RECORD FORMAT

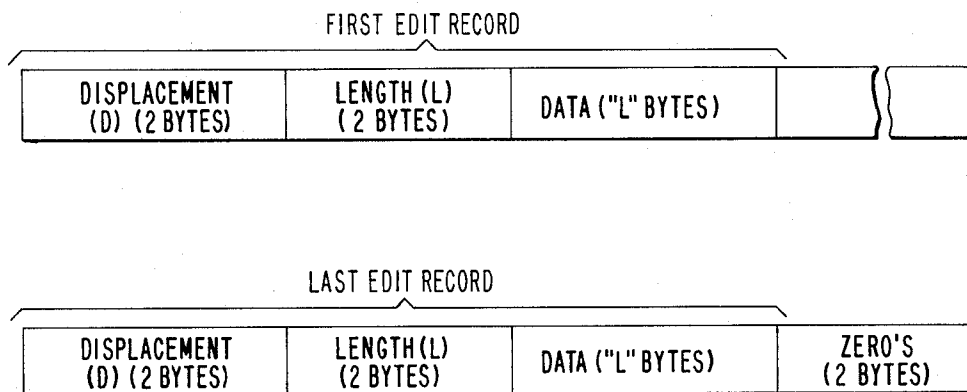


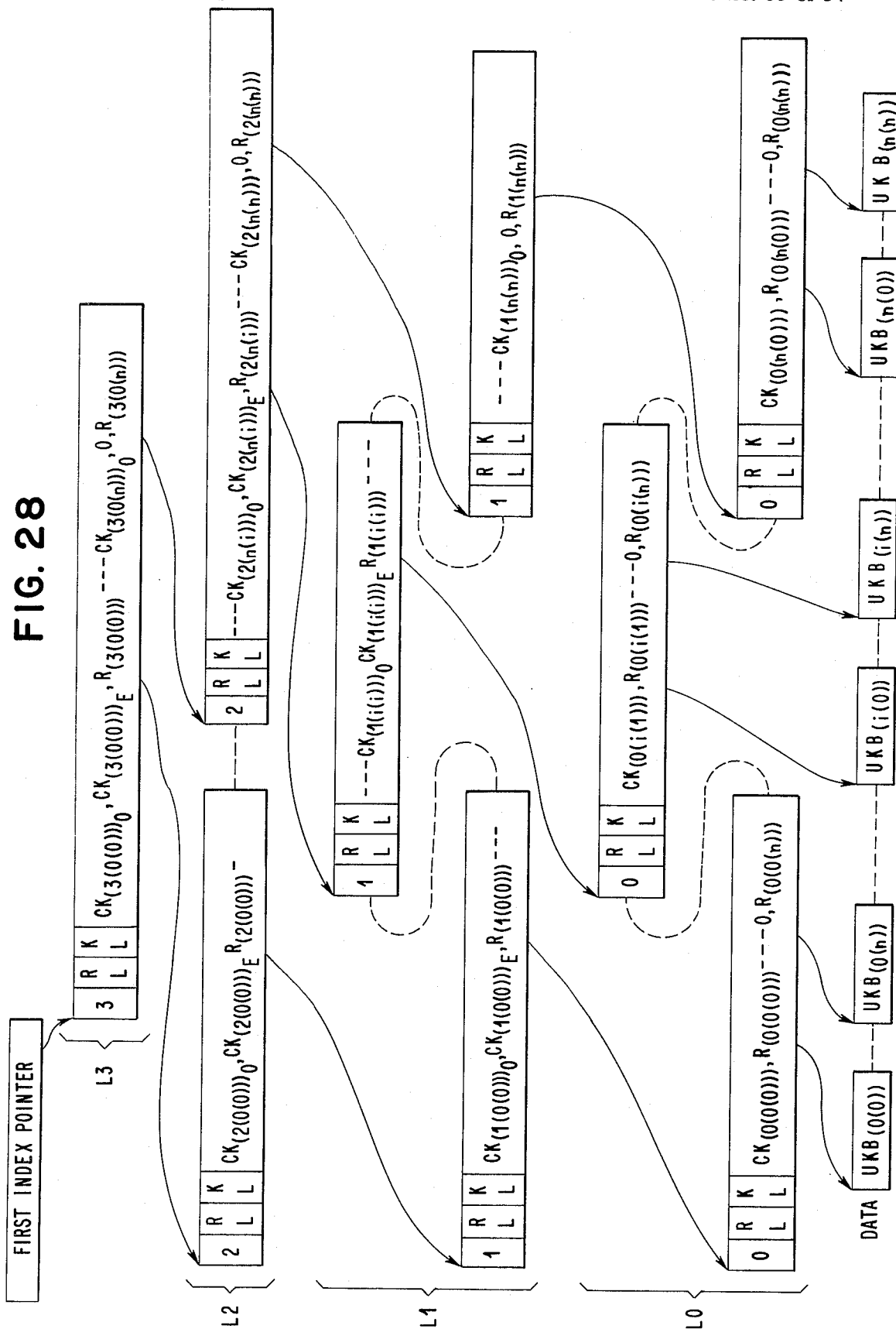
FIG.26 POSITION CONTROL REGISTER FORMAT

(1 BYTE)	(3 BYTES)
P_{i-2}	BUFFER ADDRESS OF P_{i-2}
P_{i-1}	BUFFER ADDRESS OF P_{i-1}
P_i	BUFFER ADDRESS OF P_i
P_{i+1}	BUFFER ADDRESS OF P_{i+1}

FIG.27 COUNTER REGISTER

0	1	2	3	4	5
EQU CTR	P CTR	PTR CTR	TABLE CTR	L CTR	IB CTR

FIG. 28



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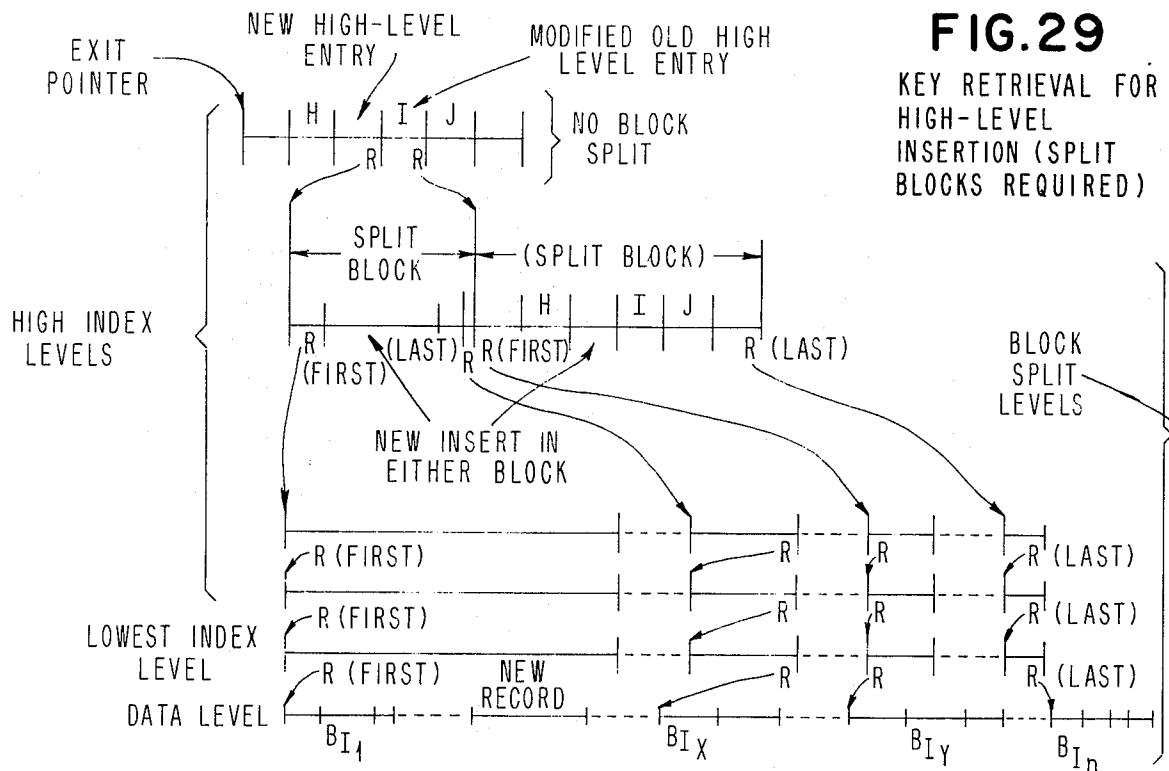


FIG. 30

KEY RETRIEVAL FOR
LOW LEVEL INSERTION
(NO BLOCK SPLIT
REQUIRED)

