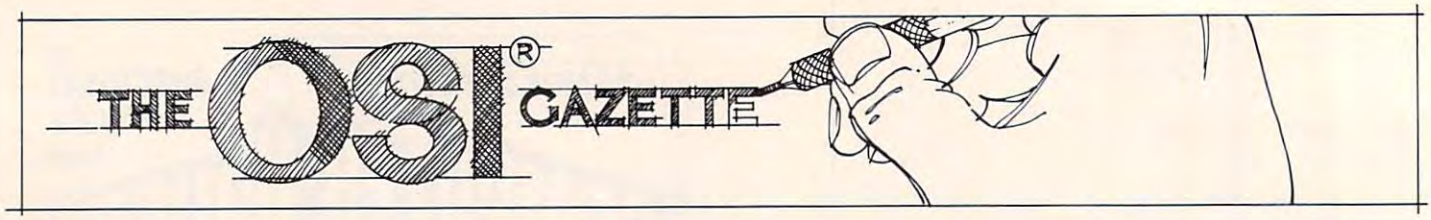


## Part II:

# A Small Operating System: OS65D, The Disk Routines

T. R. Berger
Coon Rapids, MN

*Editor's Note: Part I appeared last month. Here, the author presents a map of the disk routines. — RTM*

Let's turn to track zero. Exactly one ms. after the index hole a two byte address is recorded on the disk in high byte-low order. This address is read by the ROM on boot. It is the start address for loading track zero into memory. Next comes the number of pages in track zero. Finally, that many pages of data are written on the track. There are no track start or stop markings. After track zero is loaded, the computer always jumps to $2200. Hopefully, track zero has been loaded in that vicinity. It would appear that OSI did not think the track zero format over very carefully.

### Subroutine Descriptions

Most of the disk routines are self-explanatory. Because these routines are far more involved than those in the kernel, many more flow charts are needed. Let's run through the memory map in order, commenting on special properties of certain subroutines.

The timing routines at $2678, $267A, and $26A2 are independent of the system clock. The wait time in the routines at $2700, $289F, and $28A4 should be divided by *T* if the system clock is T MHZ.

OS65D does not use binary track numbers, but BASIC does. Thus BASIC uses $26A6, but OS65D enters this routine at $26BC with the BCD track number in the accumulator. With a binary track number in the accumulator, this routine may be entered at $26A9. It will move the disk head over the correct track after some error checking.

The sequence beginning at $2728 may be viewed as the standard startup to read or write a track or sector. It puts the head on the disk, finds the index hole, then initializes the disk data ACIA.

The EXAMINE command uses $2739 to load the entire contents of a track into memory without regard to error checking, track formatting, or sectoring. This type of command is only possible with the asynchronous data format used by OSI. If you crash a track, this command can prove invaluable in retrieving what may remain. I view this routine as a utility. It should reside on the disk and not in memory, unless needed. The initialize routine at $2768 used on a full disk falls in the same category. Such programs as these should be transient, i.e. only called when needed.

The major "Save a Sector" routine begins at $27D7. It uses the data in $265E-$2661. Most of OS65D's disk data is stored in page zero. Because Zpage is swapped out when BASIC comes in, the most important data is repeated in $265C-$2662. BASIC passes its values to these latter locations. LOAD and SAVE routines must then move this data to Zpage. Since OS65D can put information directly into Zpage, it puts the save vector into $FE, $FF directly, entering the Save routine at $27E1. Except when SAVE or CALL are used, all saving is done in Sector one for 12 ($OC) pages on 8" floppies and for eight pages on minifloppies. After a write, the sector is reread and compared with memory. If the comparison fails, the sector is reread again. This may occur up to four times. If comparison still fails, another attempt is made to write the sector. If comparison fails after four rereads again, the operation is aborted with Error #2. To my recollection, I've never seen Error #2 occur. It might happen on an old worn disk, on a midnight special, or with a very dirty head.

The major "Read a Sector" routine is $295D. It uses data in $265-E-$2662. Again OS65D may enter this routine at $2967 if the load vector at $FE, $FF has been set. This program tries to read a sector seven times. The only error check (other than sector seek errors which abort immediately) is a parity check for each byte. If, after seven tries, a read still fails, then the head is moved down then up one track. This whole process may be repeated up to four times before Error #1 is reported. This error also seems to be very rare.

Both read and save routines use the sector seeking routine at $28C4 which, in turn, calls $2998.

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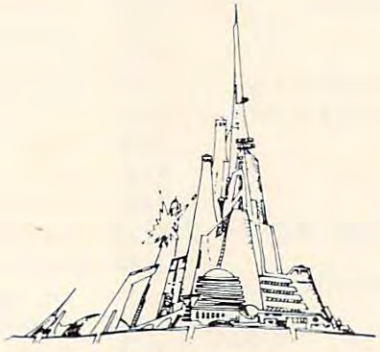

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OSI COLOR-80

Further, they both use a dual purpose routine at $2905. If the accumulator is zero on entry, this routine reads to memory. If it is nonzero, then the routine compares with memory. The actual read and compare loops within this routine are separate. With 8" floppies and a 1 MHZ clock, the 6502 is not fast enough to get from one disk byte to the next if the read and compare loops are combined into one. As it stands, the compare loop just barely returns in time for the next comparison. With a 2 MHZ clock there is plenty of time.

I view the sector directory routines at $29F3 and $2A41 as utilities. They do not need to be resident in memory.

Machine language routines may access the disk directly. For example, to write a sector, locations $265E-$2662 should be assigned correct values. The following segment of code will write a sector to the disk.

```
10 JSR $26A6 ;Move head to track
20 JSR $2754 ;Engage head, find start of track
30 JSR $27D7 ;Write sector
40 JSR $2761 ;Disengage head
50 RTS
```

If the write address is already in $FE, $FF then $27D7 may be entered at $27E1. In this case, lines 20-40 may be replaced by JSR $2CA7, a kernel routine.

To read a sector, again assign correct values to $265E-$2662 then perform the following.

```
10 JSR $26A6 ;Move head to track
20 JSR $2754 ;Engage head, find start of track
30 JSR $295D ;Read sector
40 JSR $2761 ;Disengage head
50 RTS
```

If the read address is already in $FE, $FF then $295D may be entered at $2967. In this case, lines 20-40 may be replaced by the kernel routine:

```
JSR $2B1A
```

When we discuss the I/O section of OS65D we will see additional ways to read from and write to the disk.

**References:**

1. Jefferson Harman, "IBM Compatible Disk Drives", Byte October 1979, p. 100
2. Ira Rampil, "A Floppy Disk Tutorial", Byte December 1977, p. 24
3. Les Solomon, "BASICS of Computer Disk Systems", Popular Electronics November 1980, p. 53

---

**MAP – OS65D DISK HANDLER**

**DISK-MEMORY DATA**

| | |
|---|---|
| 265C | DRIVE NUMBER |
| 265D | CURRENT BCD TRACK NUMBER |
| 265E | SECTOR NUMBER |
| 265F | PAGE LENGTH OF SECTOR |
| 2660 | LOW BYTE LOAD/SAVE VECTOR |
| 2661 | HIGH BYTE LOAD/SAVE VECTOR |
| 2662 | BINARY TRACK NUMBER |

**DISK-Z PAGE**

| | |
|---|---|
| E5 | LAST TRACK OF FILE BEING HANDLED |
| F6 | NUMBER OF RETRIES ON WRITE |
| F7 | NUMBER OF HEAD MOVE RETRIES ON READ |
| F8 | NUMBER OR READ RETRIES BEFORE HEAD MOVE |
| F9 | SECTOR COUNT |
| FA | TARGET TRACK NUMBER ON SEEK |
| FB | SECTOR NUMBER READ ON DISK |
| FC | STACK POINTER (IN $29F3) |
| FD | SECTOR PAGE COUNT (IN $27D7) |
| FE | SYSTEM POINTER. USED AS |
| FF | LOAD AND SAVE VECTOR BY DISK |

---

**Subroutines – OS65D Disk Handler**

| | |
|---|---|
| 2663 | Home the Disk. Move the disk head to track 0. |
| 2678 | Wait 12 ms. |
| 267A | Wait X ms. |
| 2683 | Step up one track toward track 76. |
| 268A | Step down one track toward track 0. |
| 26A2 | Wait 8 ms. |
| 26A6 | Fetch binary track number from 2662 then: |
| 26A9 | Convert track number to BCD then: |
| 26BC | Check for track 0-76 BCD, check for drive ready, move disk head to track, adjust head current, and if an error occurs, abort and send an error message via 2A4B. |
| 2700 | Wait 20Y + 7 microseconds (1 MHZ clock). |
| 2708 | Adjust head current. |
| 271D | Find trailing edge of index hole. |
| 2728 | Engage head then: |
| 272B | Find index hole then: |
| 272E | Initialize disk ACIA. |
| 2739 | Engage head, read from index hole full around to index hole, then quit. |
| 2754 | Head down. |
| 2761 | Head up. |
| 2768 | Initialize full disk. |
| 277D | Initialize one track. |
| 27C2 | Send a byte to the disk. |
| 27CD | Fetch a byte from the disk. |
| 27D7 | Fetch sector save vectors then: |
| 27E1 | Save a sector. |
| 289F | Wait 800($FA) microseconds. |
| 28A4 | Wait 100Y microseconds. |
| 28B0 | Fetch a byte from the disk. Abort with an error message if over the index hole. |
| 28C4 | Find the end of the sector preceding the one in 265E. |
| 2905 | Read a sector to or compare a sector with memory. |
| 295D | Fetch disk read vector then: |
| 2967 | Read and reread a sector to memory, quit if successful or the full number of retries are exhausted. |
| 2998 | Find the end of the present sector. |
| 29C6 | Select the drive in 265C then: |
| 29DA | Check if the drive is ready. |
| 29EB | 8 drive select data bytes. |
| 29F3 | Output a sector directory. |
| 2A41 | Output subroutine for 29F3. |

# A Correction For Progressive Computing Chess 1.9


Dave Leskin
Calgary, Canada


Progressive Computing, based in Windsor Ontario, is an excellent source of OSI software with prompt and courteous service; however, there is a major error in their tape version of "Chess 1.9". This error is found in the opening tables. If you try the following sequence of moves you can determine if your copy of "Chess 1.9" has this error too. Note that the last move by the computer is illegal. Microchess notation in brackets.

| | Computer (White) | Human (Black) |
|---|---|---|
| 1 | P-K4 (13-33) | P-K4 (63-43) |
| 2 | N-KB3 (01-22) | N-QB3 (76-55) |
| 3 | B-QN5 (02-46) | N-KB3 (71-52) |
| 4 | B-KN5 (05-41) ??? | |

As you see the "B-KN5" jumps right over the Queen Pawn at 14. To solve this problem I changed the program so that the Queen Knight was moved from 06 to 25 instead. This results in a "Four Knights Game" which is a common opening used by many players. Just follow the steps listed below to effect the change.

### The Changes

**1.** Load "Chess 1.9"

**2.** Press "D" to enter monitor once the board appears.

**3.** Press ".0B34"

**4.** Press "/" to enter the data mode

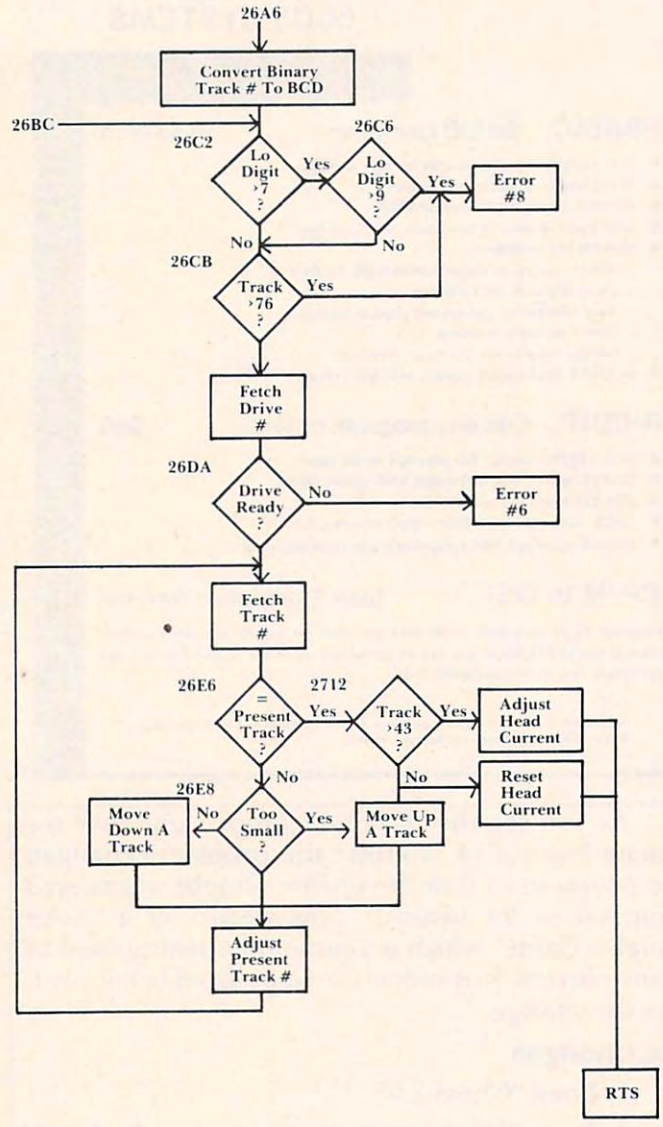
**5.** Press "25" which refers to the square that the piece will be moved to

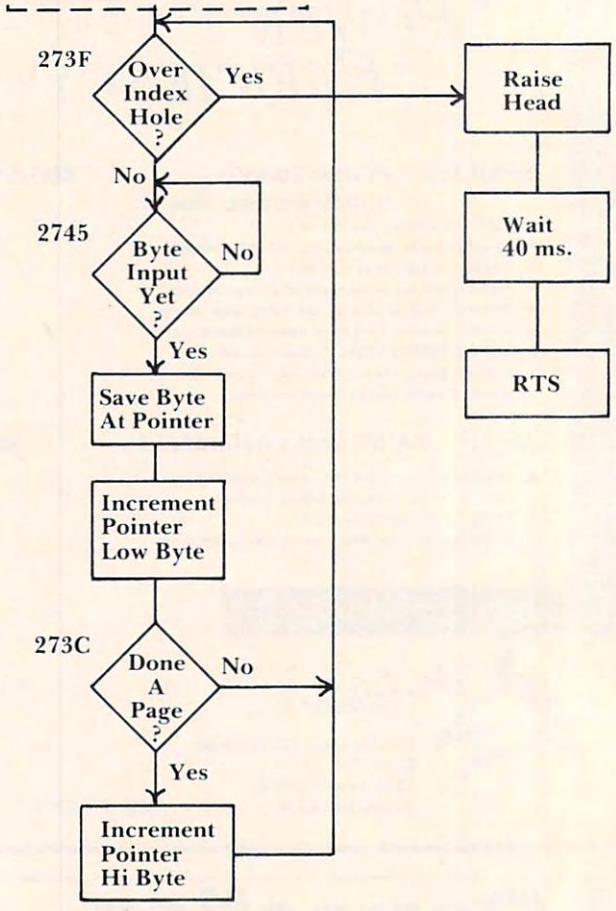
**6.** Press the "RETURN" key

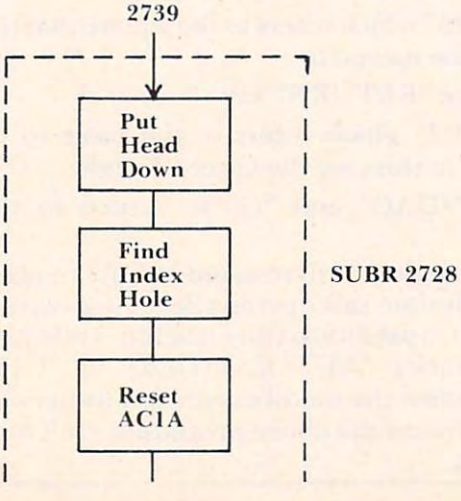
**7.** Press "07" which refers to the piece to be moved — in this case the Queen Knight

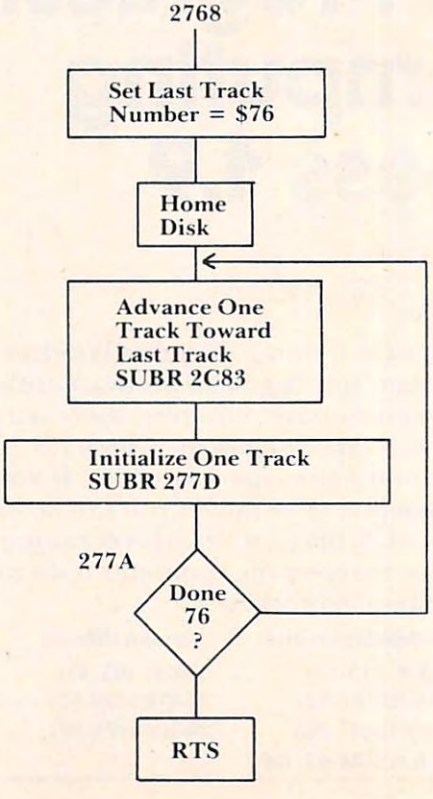
**8.** Press ".03AC" and "G" to return to the program

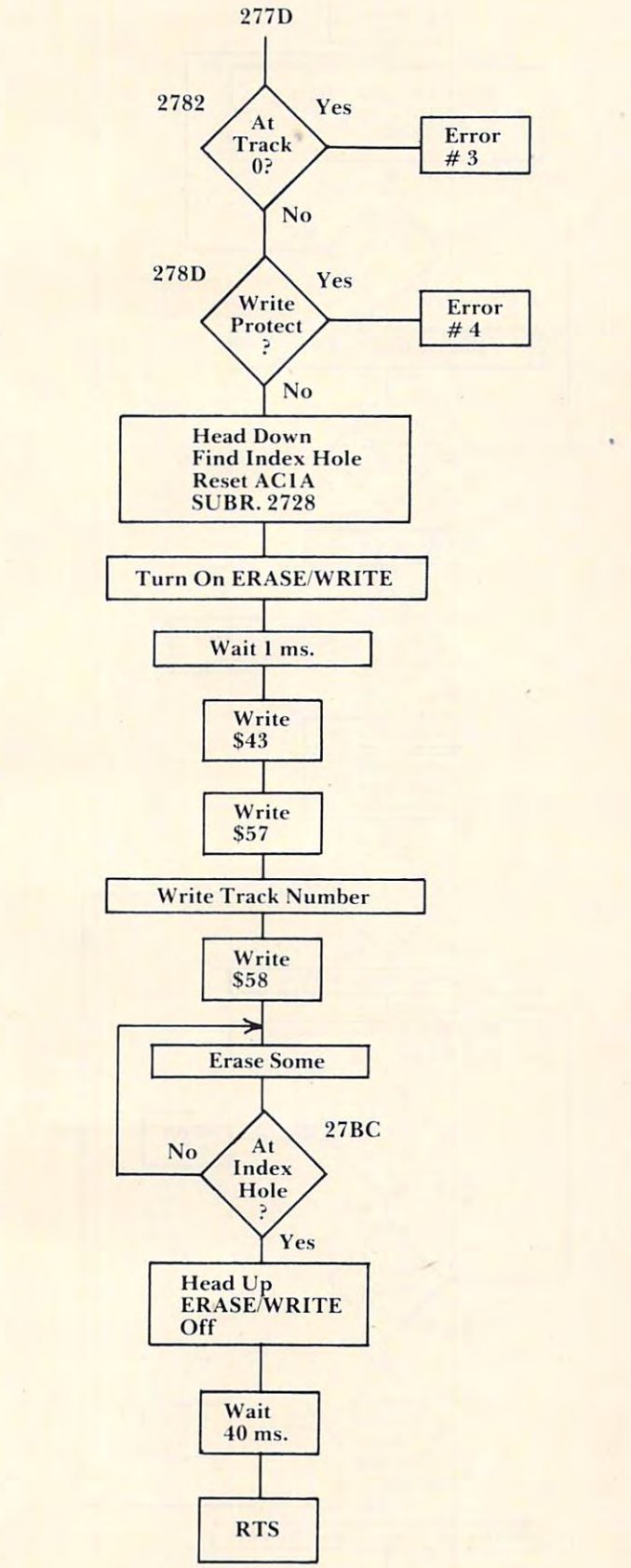
Now the program will respond N-QB3 in place of B-KN5 each time this opening sequence occurs. If you have the capability to store machine code programs (Aardvark's "AUTOLOADER" or "C1E" ROM) then record the modified version (otherwise you'll have to follow the above procedure each time you power up). ©

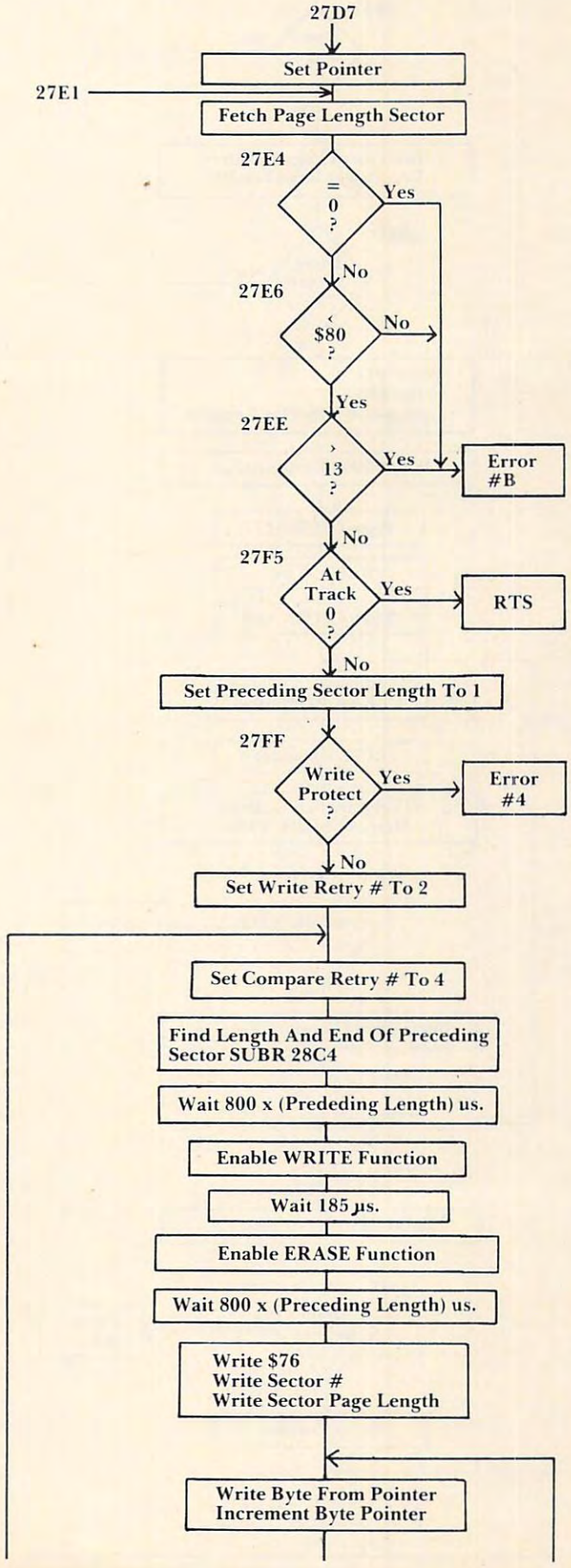

26A6
Convert Binary Track # To BCD
26BC
26C2
Lo Digit >7 ?
Yes
26C6
Lo Digit >9 ?
Yes
Error #8
No
No
26CB
Track >76 ?
Yes
Fetch Drive #
26DA
Drive Ready ?
No
Error #6
Fetch Track #
26E6
= Present Track ?
Yes
2712
Track >43 ?
Yes
Adjust Head Current
No
No
Reset Head Current
26E8
Too Small ?
No
Yes
Move Down A Track
Move Up A Track
Adjust Present Track #
RTS

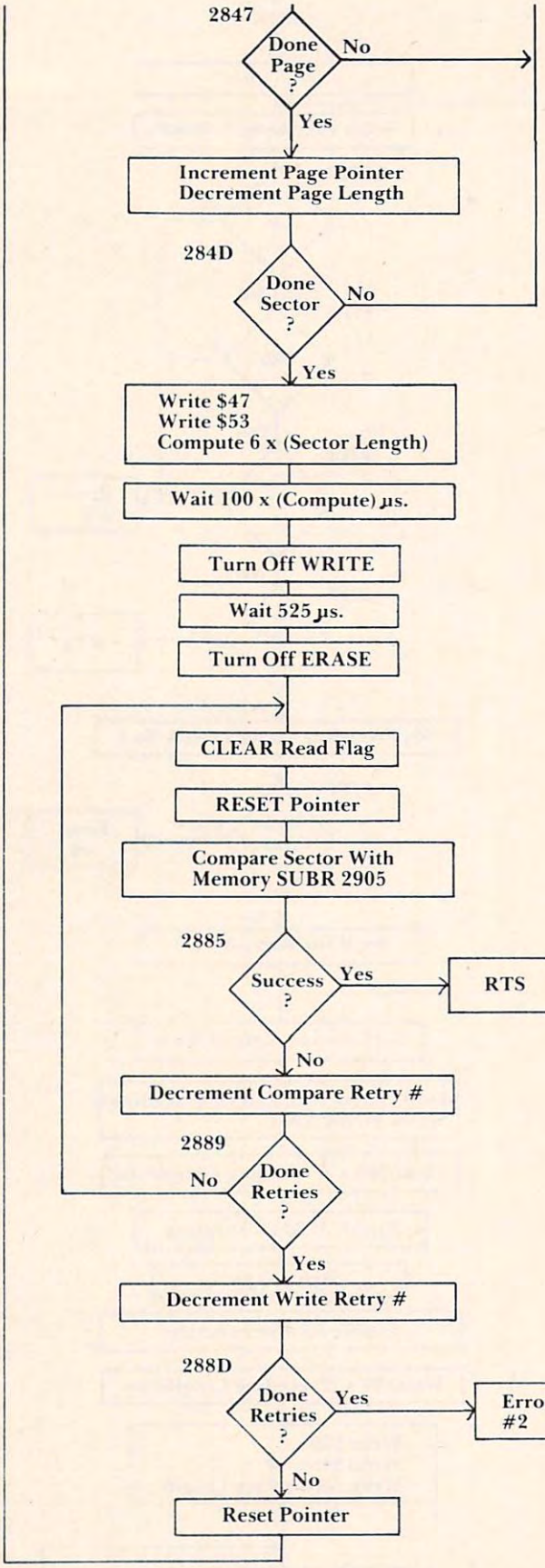

273F
Over Index Hole ?
Yes
Raise Head
Wait 40 ms.
RTS
No
2745
Byte Input Yet ?
No
Yes
Save Byte At Pointer
Increment Pointer Low Byte
273C
Done A Page ?
No
Yes
Increment Pointer Hi Byte

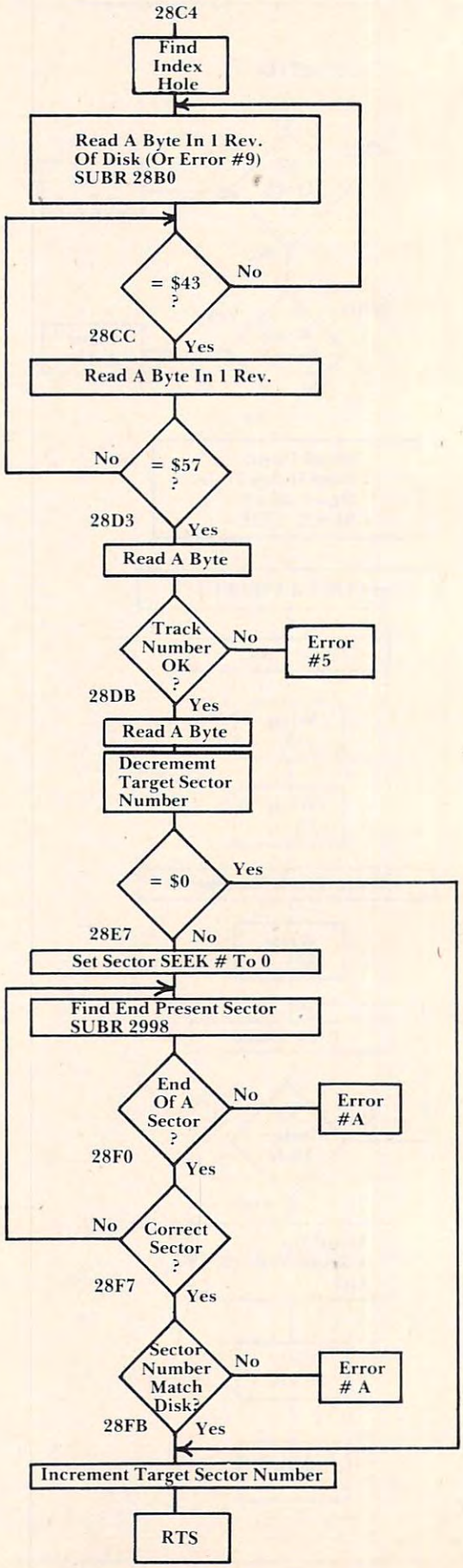

2739
Put Head Down
Find Index Hole
Reset AC1A
SUBR 2728

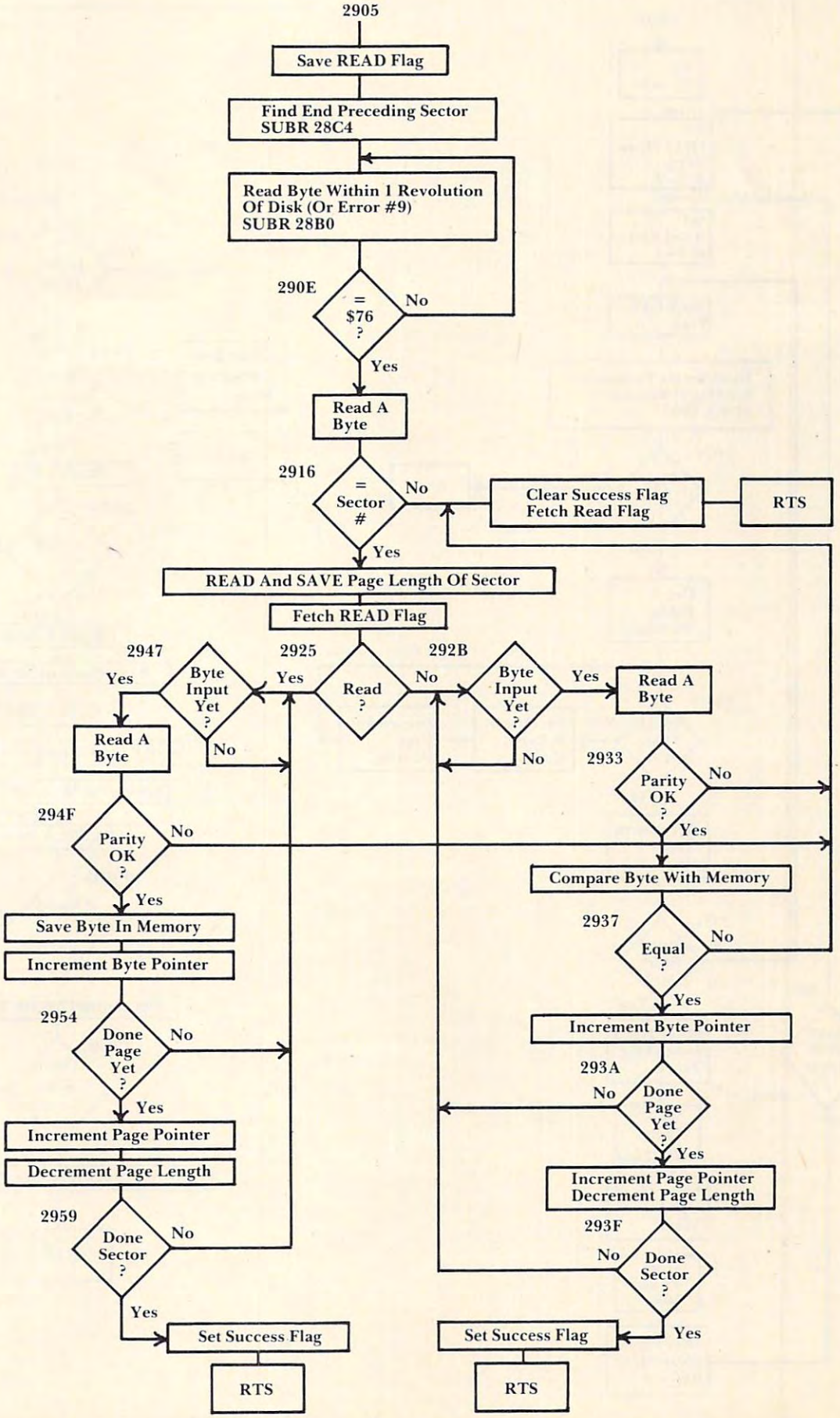

2768
Set Last Track Number = $76
Home Disk
Advance One Track Toward Last Track SUBR 2C83
Initialize One Track SUBR 277D
277A
Done 76 ?
RTS

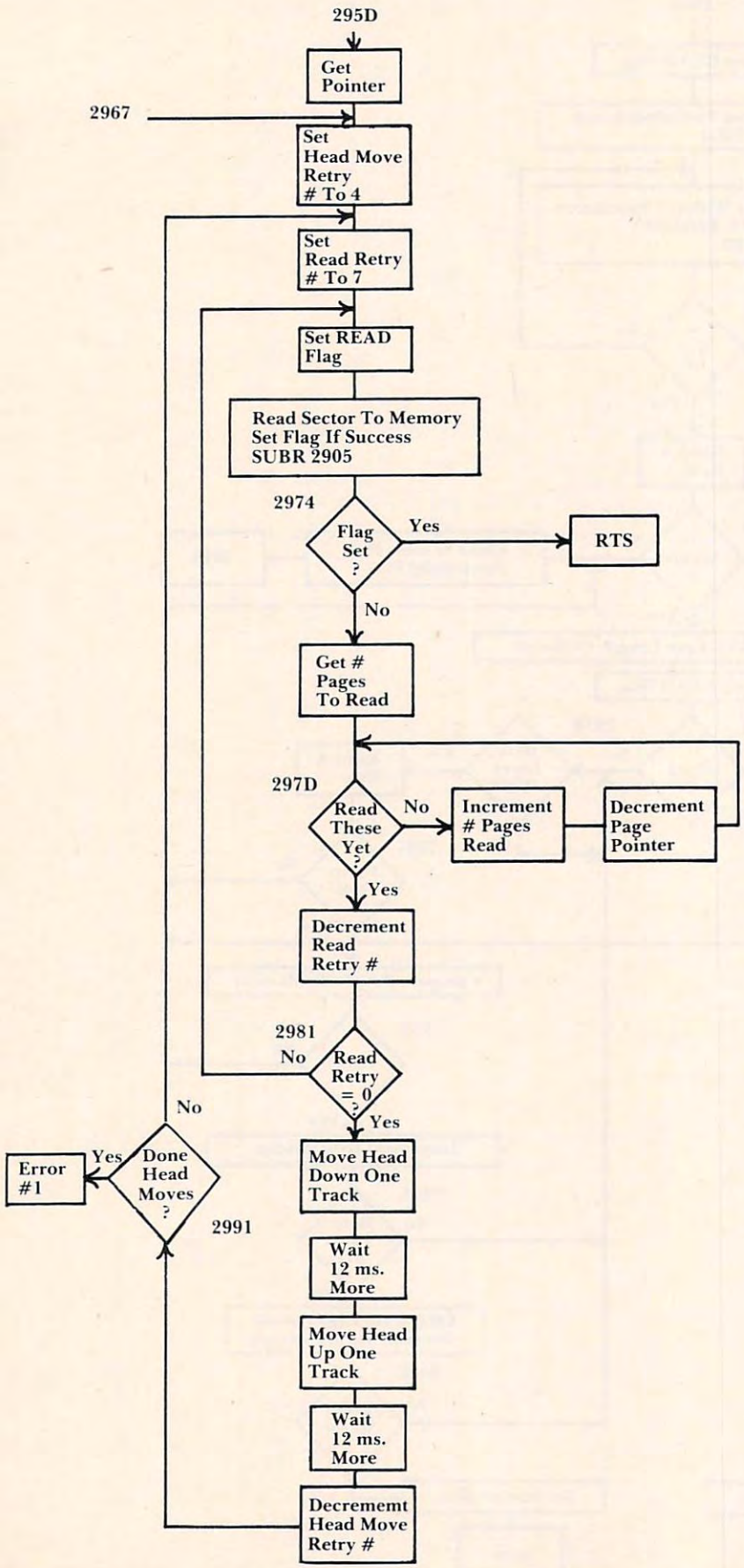

277D
2782
At Track 0?
Yes
Error # 3
No
278D
Write Protect ?
Yes
Error # 4
No
Head Down
Find Index Hole
Reset AC1A
SUBR. 2728
Turn On ERASE/WRITE
Wait 1 ms.
Write $43
Write $57
Write Track Number
Write $58
Erase Some
27BC
No
At Index Hole ?
Yes
Head Up
ERASE/WRITE Off
Wait 40 ms.
RTS

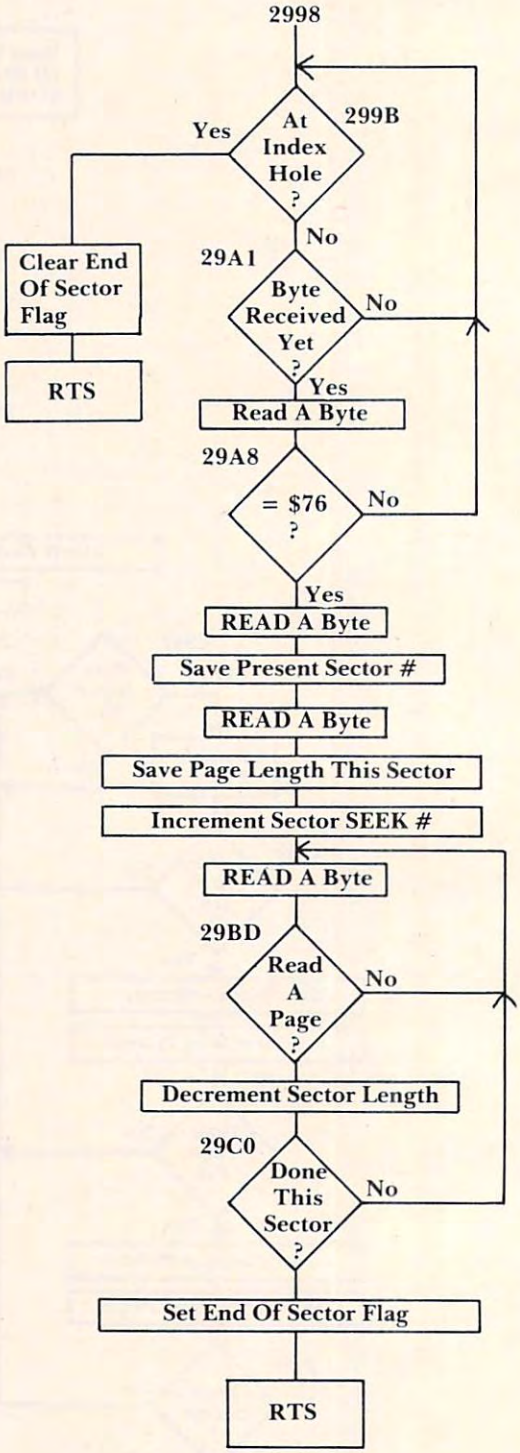

27D7
Set Pointer
27E1
Fetch Page Length Sector
27E4
= 0 ?
Yes
No
27E6
< $80 ?
No
Yes
27EE
> 13 ?
Yes
Error #B
No
27F5
At Track 0 ?
Yes
RTS
No
Set Preceding Sector Length To 1
27FF
Write Protect ?
Yes
Error #4
No
Set Write Retry # To 2
Set Compare Retry # To 4
Find Length And End Of Preceding Sector SUBR 28C4
Wait 800 x (Prededing Length) us.
Enable WRITE Function
Wait 185 µs.
Enable ERASE Function
Wait 800 x (Preceding Length) us.
Write $76
Write Sector #
Write Sector Page Length
Write Byte From Pointer
Increment Byte Pointer

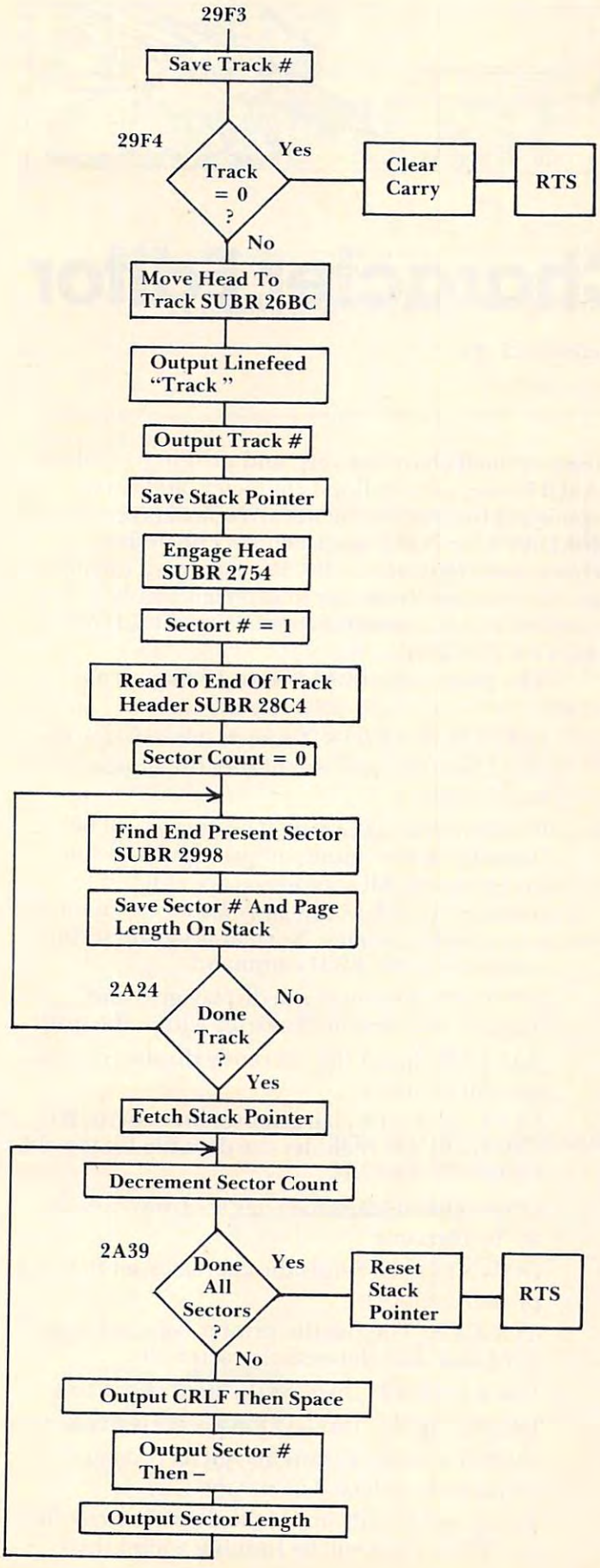

2847
Done Page ?
No
Yes
Increment Page Pointer
Decrement Page Length
284D
Done Sector ?
No
Yes
Write $47
Write $53
Compute 6 x (Sector Length)
Wait 100 x (Compute) µs.
Turn Off WRITE
Wait 525 µs.
Turn Off ERASE
CLEAR Read Flag
RESET Pointer
Compare Sector With Memory SUBR 2905
2885
Success ?
Yes
RTS
No
Decrement Compare Retry #
2889
Done Retries ?
No
Yes
Decrement Write Retry #
288D
Done Retries ?
Yes
Error #2
No
Reset Pointer

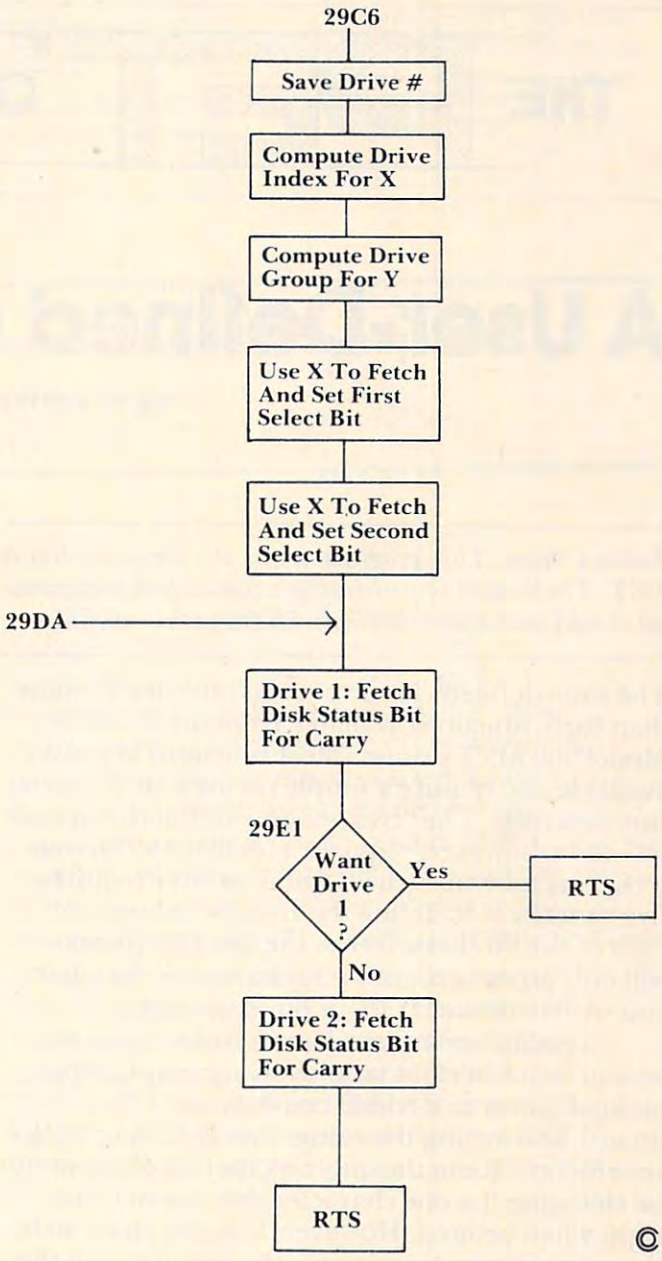

28C4
Find Index Hole
Read A Byte In 1 Rev. Of Disk (Or Error #9) SUBR 28B0
= $43 ?
No
28CC
Yes
Read A Byte In 1 Rev.
No
= $57 ?
28D3
Yes
Read A Byte
Track Number OK ?
No
Error #5
28DB
Yes
Read A Byte
Decrememt Target Sector Number
= $0
Yes
28E7
No
Set Sector SEEK # To 0
Find End Present Sector SUBR 2998
End Of A Sector ?
No
Error #A
28F0
Yes
No
Correct Sector ?
28F7
Yes
Sector Number Match Disk?
No
Error # A
28FB
Yes
Increment Target Sector Number
RTS


2905
Save READ Flag
Find End Preceding Sector
SUBR 28C4
Read Byte Within 1 Revolution
Of Disk (Or Error #9)
SUBR 28B0
290E
= $76 ?
No
Yes
Read A Byte
2916
= Sector #
No
Clear Success Flag
Fetch Read Flag
RTS
Yes
READ And SAVE Page Length Of Sector
Fetch READ Flag
2947
Byte Input Yet ?
Yes
No
2925
Read ?
Yes
292B
No
Byte Input Yet ?
Yes
No
Read A Byte
Read A Byte
2933
Parity OK ?
No
Yes
294F
Parity OK ?
No
Yes
Compare Byte With Memory
2937
Equal ?
No
Yes
Save Byte In Memory
Increment Byte Pointer
Increment Byte Pointer
2954
Done Page Yet ?
No
Yes
293A
No
Done Page Yet ?
Yes
Increment Page Pointer
Decrement Page Length
Increment Page Pointer
Decrement Page Length
2959
Done Sector ?
No
Yes
293F
No
Done Sector ?
Yes
Set Success Flag
RTS
Set Success Flag
RTS


295D
Get Pointer
2967
Set Head Move Retry # To 4
Set Read Retry # To 7
Set READ Flag
Read Sector To Memory Set Flag If Success SUBR 2905
2974
Flag Set ?
Yes
RTS
No
Get # Pages To Read
297D
Read These Yet ?
No
Increment # Pages Read
Decrement Page Pointer
Yes
Decrement Read Retry #
2981
No
Read Retry = 0 ?
Yes
No
Done Head Moves ?
Yes
Error #1
2991
Move Head Down One Track
Wait 12 ms. More
Move Head Up One Track
Wait 12 ms. More
Decrememt Head Move Retry #


2998
299B
At Index Hole ?
Yes
No
Clear End Of Sector Flag
RTS
29A1
Byte Received Yet ?
No
Yes
Read A Byte
29A8
= $76 ?
No
Yes
READ A Byte
Save Present Sector #
READ A Byte
Save Page Length This Sector
Increment Sector SEEK #
READ A Byte
29BD
Read A Page ?
No
Decrement Sector Length
29C0
Done This Sector ?
No
Set End Of Sector Flag
RTS


29F3
Save Track #
29F4
Track = 0 ?
Yes
Clear Carry
RTS
No
Move Head To Track SUBR 26BC
Output Linefeed "Track "
Output Track #
Save Stack Pointer
Engage Head SUBR 2754
Sectort # = 1
Read To End Of Track Header SUBR 28C4
Sector Count = 0
Find End Present Sector SUBR 2998
Save Sector # And Page Length On Stack
2A24
Done Track ?
No
Yes
Fetch Stack Pointer
Decrement Sector Count
2A39
Done All Sectors ?
Yes
Reset Stack Pointer
RTS
No
Output CRLF Then Space
Output Sector # Then –
Output Sector Length


29C6
Save Drive #
Compute Drive Index For X
Compute Drive Group For Y
Use X To Fetch And Set First Select Bit
Use X To Fetch And Set Second Select Bit
29DA
Drive 1: Fetch Disk Status Bit For Carry
29E1
Want Drive 1 ?
Yes
RTS
No
Drive 2: Fetch Disk Status Bit For Carry
RTS