Keep Your
Disk Drive in Line

By JOSEPH J. SHAUGHNESSY

Here's a do-it-yourself project that will save you costly repairs due to disk drive misalignment. Knowing how to use a Phillips-head screwdriver is the only prerequisite.

This article provides you with tips that might save you enough to pay for your subscription to *RUN* magazine for many years to come. I wish someone else had written it two years ago. I would have saved about $100 in technician fees for service on my disk drive.

There are several million of you Commodore owners who have the 1540 or 1541 disk drive, and almost every one of you has needed, or will someday need, to have your disk drive realigned. Some of you probably need it right now and may or may not know it. Misalignment is the most common cause of failure in this disk drive.

Most of this article will consist of giving you step-by-step instructions for a do-it-yourself project, realigning the read/write head on your 1540 or 1541 disk drive.

Caution: Because you will be working with an electrical device, there is always the danger of electric shock or injury. Children and others unwilling or unable to follow directions and observe safety precautions

should not attempt this project. Neither *RUN* magazine nor the author will assume liability for damage or injury to yourself or your equipment. Performing this work will also void your warranty, so make sure that you have owned your disk drive for at least 91 days.

The only tool required is a small (size 1) Phillips-head screwdriver. An optional tool is a pair of needle-nose pliers for replacing some of the screws during reassembly. If you want to drill two holes in the bottom of your plastic case, you will also need an electric drill with an appropriate-sized bit (more about this in the reassembly section).

Preliminary Information

First, I'll discuss how programs and files are stored on disk. Each disk has 35 tracks, arranged concentrically, with track number 1 being the outermost and track 35 the innermost. Each track has from 17 to 21 blocks (the inner tracks have fewer blocks). Each block can store 256 bytes (or characters) of data. The middle track is track 18, which is special.

The first block (block 0) of track 18 is used to store the name and I.D. number that you gave the disk, a few other special codes and the BAM (block availability map). The disk drive uses the BAM to determine which blocks are available for storing

data and which blocks have already been used. The remaining blocks (1 to 18) of track 18 are used to store your disk directory.

The disk directory contains the names of your programs and files and also information on the type of file, its length and where the starting point is on the disk. Your actual programs and files are stored on the disk's remaining blocks. (664 blocks are usable on a brand new disk.) Storage of your programs and files begins on tracks 17 and 19 and proceeds both inward and outward from the center track, with 1 and 35 being the last tracks used.

When your disk drive begins to go out of alignment, the first tracks to become unreadable are on these outermost tracks (1 and 35). You'll find that you can load in programs near the beginning of your directory, while programs near the end will load with difficulty, if at all.

Ordinarily, programs near the beginning of the directory are stored near the center of the disk, since they were saved first, and later programs are stored farther out from the center. The last thing you will lose, as the alignment gets worse, is the ability to read the directory.

You can also tell that you are losing alignment when program loads start taking an exceptionally long time, and your red disk drive light flutters and blinks and the drive seems to chug and makes awful sounds (which are caused by the read/write head resetting itself against its stop when the first attempt to read a block is unsuccessful).

On a perfectly aligned disk drive, the red light will come on and remain steady throughout the load, with one major exception. Some companies copy-protect programs by deliberately "bad sectoring" certain blocks on the disk. During or after the program load, these "bad" blocks are checked by the program. If the disk drive can't read the bad block, the program knows that it is probably not dealing with a pirated disk. If it can read the block, the program will usually shut itself down.

It is suspected that the most probable cause of disk-drive misalignment is using commercial software with this "bad sectoring" type of copy protection. The repeated hammering of the read/write head against its stop may eventually knock the drive out of alignment.

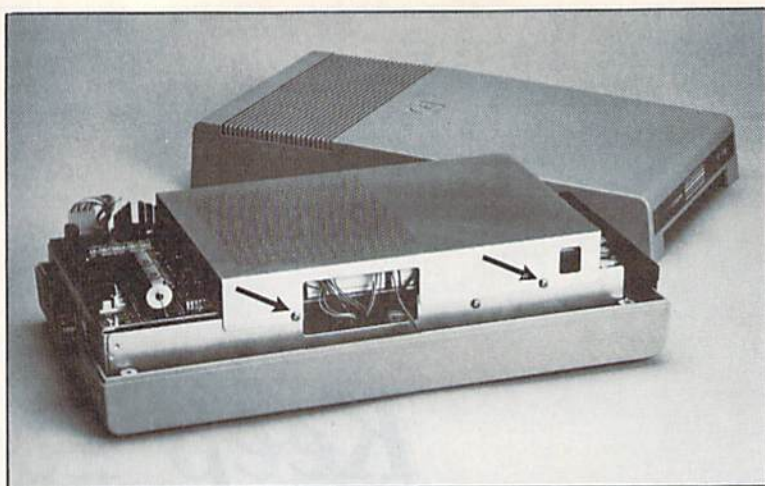Another reason for the red light

Photo 1. Drive with cover removed.

blinking during the loading of commercial software is that some companies load programs in sections, and the red light goes off between these sections. Other possible causes would be transporting your drive to another location, mishandling, long usage or, perhaps, gremlins.

The simplest test for disk-drive misalignment is to run the performance test program (using a disk you don't need anymore) or the short program found later in this article (using any disk—the program won't hurt it). Neither of these programs, however, will check for perfect alignment, since I've had disk drives that I know are not in perfect alignment pass these tests. The best way to test your drive is to use my Safe and Fast Disk Checker program (published last month in *RUN*), which runs both quickly and smoothly (see step #15 in the alignment procedure).

Once you've determined that your disk drive needs realignment, you're ready to advance to the actual alignment procedure.

In brief, you will first check the alignment of track 18 by loading in a long directory. You'll next check the alignment of the outermost and innermost tracks by running the short program in this article. Finally, you will check every track and sector for perfect alignment by running my Safe and Fast Disk Checker program.

We are now ready to begin. *Please* think and practice safety while doing this!

Disassembly Instructions

1. Turn off the disk drive power switch and disconnect all cables from the rear of the disk drive.

2. Place the drive upside down on a flat surface and remove the four Phillips-head screws.

3. Gently lift the disk drive off of the top cover and place right side up on a flat surface. Put aside the top plastic cover until reassembly time.

4. Photo 1 shows the top metal cover, which is held in place by two Phillips-head screws. Remove these screws and the top metal cover.

5. The green power light located on the lower front of the drive's plastic case is connected to the now-exposed circuit board by two wires and a plug. Note the orientation of this plug and remove it. This will disconnect the green power light.

6. Replace the top metal cover over the circuit board using two Phillips-head screws.

7. Remove the disk drive from the lower plastic case by removing the six screws and lifting it out.

8. Place the disk drive upside down on a flat surface next to your computer. At this point, you should notice the stepper motor and the two screws that hold it in position (Photos 2 and 3). These screws pass through slotted holes in the stepper motor mounting, thereby allowing the stepper motor to be rotated by a small amount when these screws are loosened.

9. Plug the connecting cord from the computer into the disk drive. Plug in the power cord to the disk drive. *Warning*: from this point on, *do not* touch any of the exposed electrical components in the rear of the disk drive. It is all right to touch the power switch to turn the drive off and on, but don't touch anything else back there. It is also all right to touch
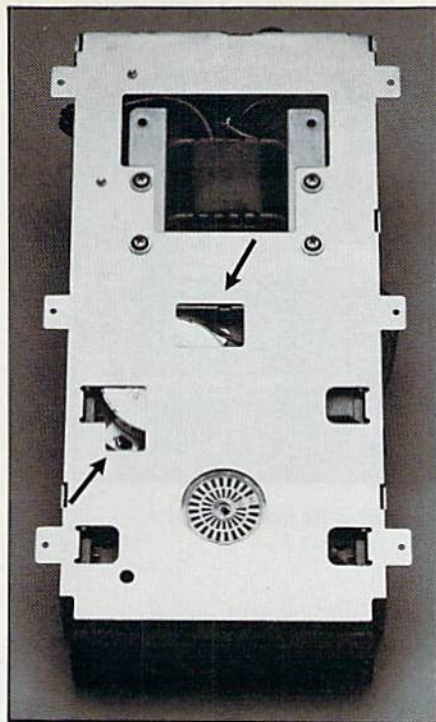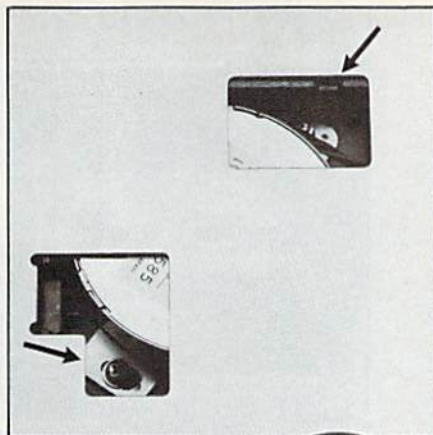
Photo 2. Location of stepper motor.

Photo 3. Close-up of stepper motor.

the protective metal case that is built around your disk drive.

If, for any reason, you were to get a shock from your metal case, immediately unplug the disk drive and take it in for professional service—you have a dangerous short circuit and more problems than just misalignment. (I have never heard of this happening, but anything is possible. It is not required in the alignment process to touch any of the electrical devices in the rear of the disk drive, so why take chances? Stay away!)

Alignment Procedure

1. Turn on your disk drive, TV or monitor and your computer. Note that your green power-on light for the disk drive will not work, since it is disconnected.

2. Type in POKE 53281,1 {return}. Next, hold down the CTRL key and push the 1 key. This will give you black characters on a white screen. (This step is optional, but I like it.)

3. Hold down the shift key and push the CLR/home key. This clears the screen and leaves your cursor in the upper-left corner.

4. Place a disk in the drive. Note that you will have to put the disk in upside down (disk notch to the right), since your drive is upside down. Preferably, the disk you select should have a long directory (lots of programs) in order to make it more dif-

ficult for the disk drive to load the directory.

5. You will now begin typing in instructions and a short program that will make life simpler while aligning the disk drive. Do not get ahead of me on this, since any deviation from the following instructions will mean extra typing and work for you.

6. Type in LOAD "$",8 {return}. The disk drive light will come on and the message Searching For $ will appear. Next will appear the Loading message or, if your drive is badly out of alignment, you will get the File Not Found message. Then the Ready message will appear, along with the blinking cursor.

In some cases, the disk drive will find the directory ($) and attempt to load it, unsuccessfully. In this case, your disk drive may "hang up" (your cursor does not come back to the screen). For this condition, turn your computer off, then on again, thereby resetting it, and try a different disk.

7. During the directory load, observe your drive's red light. If it comes on and remains steady, with no flickering or blinking, then proceed to step 9. If it flutters and pauses or if you get the File Not Found message, continue on to step 8.

8. You must get the disk drive sufficiently operational to read the disk directory. First, press the CLR/home key (without the shift key). Your cursor will now be flashing in the upper-left corner, on the "L" of LOAD"$",8.

With your Phillips-head screwdriver, *loosen* (not remove) the two screws on the stepper motor (they may be hard to unscrew the first time). It is not necessary to turn off the disk drive or remove the disk during this procedure.

Rotate the stepper motor about ¹⁄₁₆ of an inch in either direction. Retighten the screws until they are snug. Hit the return key on your computer. The directory will again attempt to load. Repeat step 7.

If the directory still will not load properly, rotate the stepper motor in the other direction and try again. You may have to readjust several times in order to get a good load of the directory. If, no matter where you adjust the stepper motor position within the range of the slotted holes, you cannot get a good directory load, go to the section in this article entitled "Other Troubleshooting Tips."

9. At this point, you should have had a good directory load. This indicates that track 18 is sufficiently in alignment and can be read by the disk drive. This is the easiest track to align and seems to have a wider tolerance for alignment. Tracks 1 and 35 are a little more critical.

Returning to the screen display, after loading the directory, the cursor should be flashing under the Ready message. Do not list the directory! Type in the New command and press the return key. The Ready message will again appear, with the cursor flashing underneath.

10. Next, type in the following short program beneath the latest Ready message, using carriage returns at the end of each program line.

```
10 OPEN 15,8,15:OPEN 5,8,5,"#"
20 PRINT#15,"U1:"5;0;1;1:GOSUB 60
30 PRINT#15,"U1:"5;0;35;1:GOSUB 60
40 CLOSE 5:CLOSE 15
50 END
60 INPUT#15,A,A$,B,C:PRINT A;A$;B;C
70 RETURN
```

Immediately after line 70, type RUN and hit the return key.

11. The short program you have just entered will begin executing and will check to see if block 1 of tracks 1 and 35 are readable. Two messages will appear under your last Run command. If the disk drive is in fairly good alignment, both messages will say 0 OK 0 0 and you can jump to step 14. If not, you will get an error message, such as 21 READ ERROR 1 1 or 27 READ ERROR 35 1 or something similar. The last two numbers in the error message refer to the track and block that was unreadable.

12. If you received an error message in step 11, you must further "tune" your disk-drive alignment. Loosen the two stepper-motor screws and rotate the stepper motor by a

very small amount, in one direction. Retighten the screws.

On your second or third time through this step, you may be rotating the stepper motor by a small amount in the opposite direction. You are looking for that "just right" position and will find it by trial and error.

13. Here is where you are rewarded for following directions. You don't have to type everything in again on the retest. First, push the CLR/home key (do not use shift), then hit the return key. Since your cursor was once again on the "L" of LOAD "$",8, the directory will begin loading. Once again, observe your red light during the program load, as in step 7. If everything is all right, proceed. Otherwise, readjust the stepper motor in the opposite direction and try again.

After the load, your cursor will be flashing on the "N" of NEW. Hit the return key again. Now your cursor will be blinking on the "1" of program line 10. Press the return key eight more times and your short program will be reentered in the computer and will begin running. You must reenter the program this way, because every time you load in the directory, you write over whatever else might be in the computer's memory. (The format of this screen makes it easy to keep testing the disk drive without a lot of typing.)

Once again, you will get two messages. (The new messages will write over the old ones, but there's no harm in that; if it bothers you, use your cursor controls and the space bar to erase the old messages prior to hitting the CLR/home key.) Repeat steps 11, 12 and 13 as often as necessary, until, by trial and error, you get two messages that say 0 OK 0 0.

14. Basically, you have fiddled with the orientation of the stepper motor until the disk drive loads well enough for you to be able to read both tracks 1 and 35. At this point, your disk drive is in fair, but probably not optimal, alignment. There is one final "supertuning" check for optimal results.

15. As I mentioned earlier, my Safe and Fast Disk Checker program is in last month's *RUN*. Originally, this program was only meant to check for bad sections on your disk. However, in developing this article and the procedures herein, I found that this program was an invaluable alignment tool. In just a few minutes, the S & F
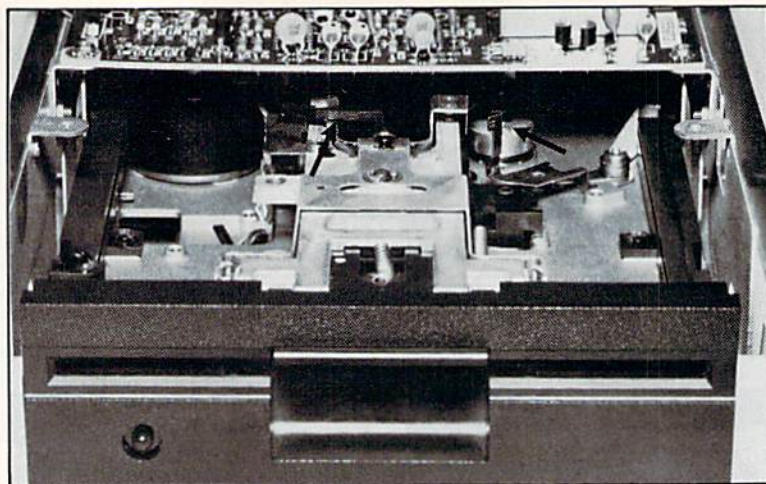

Photo 4. Front-top view of the drive, showing the location of the read/write head and the capstan.

Disk Checker checks every single track and block on the disk, whereas the program in step 10 above checks only the first block of tracks 1 and 35.

The final step in your alignment procedure is to load in the S & F Disk Checker and run it. Since you are working with a disk drive that may not be in perfect alignment, cover the disk's write-protect notch with a piece of tape. If your drive is in perfect alignment, the S & F Disk Checker program will run both quickly and at a uniform rate of speed.

If the rate of checking slows down or falters, or if the disk drive must reset itself, it is not perfectly aligned. Do not turn off your computer or disk drive. After the S & F Disk Checker program stops (or you stop it by hitting the run/stop and restore keys), once again loosen the stepper-motor screws and readjust the stepper motor by rotating it a very tiny amount. Retighten the screws and run the S & F Disk Checker program again.

Continue this final adjustment process until the program runs all the way through without pausing or slowing down. Then run the program with several different disks to make sure that you can read them all. Some of your latest disks may have been formatted when your disk drive was in the process of going out of alignment; these disks may be difficult to read. Salvage what you can from them and put their contents on other disks.

As a final test, I run the S & F Disk Checker program on the test/demo disk that came with my Commodore drive, since I'm fairly sure this disk was prepared on a properly aligned drive.

From my experience, there is only one "perfect-alignment" position for the stepper motor. The disk can still be read if the motor position is slightly to either side of "perfect," but the drive hesitates and pauses. The S & F Disk Checker will help you go from this workable position to the perfect position.

Other Troubleshooting Tips

Photo 4 shows the top of the mechanical portion of the disk drive from the front. Sometimes, no matter what you do with rotating the stepper motor, you are unable to get a directory to load. I know of three possible solutions, and there may be more:

1. Electronic failure. This is beyond the scope of this article. Take your disk drive in for repair.

2. The left arrow in Photo 4 points to a black lever, which is attached to a pressure pad holding the disk against the read/write head after the disk is inserted. If you lift this lever just slightly, you will see the pressure pad and the read/write head underneath. I know of a few cases where this black lever has become stuck while people have been working with the stepper motor. A few jiggles should free it up.

3. The right arrow in Photo 4 points to the cylinder-shaped capstan, which is mounted on the shaft of the stepper motor. The rotation of this capstan, with the motion transferred through a strap and pulley arrangement, is what moves the read/write head over the disk during use.

Directly above this capstan is a small trapezoid-shaped flat plate, which is held in place by one Phillips-

head screw. That flat plate is the stop for the capstan's rotation. This stop occasionally will be knocked askew and must be repositioned. To get at the stop plate and its holding screw, it is necessary to remove the top circuit board. If you try this, remember to have the disk drive unplugged (no power), and remember where all the wires go for reassembly.

Reassembly Instructions

1. Turn off the disk drive and remove all cables from its rear.

2. One helpful hint at this point. I drilled two ⅞-inch diameter holes in the bottom of my disk drive's plastic case, so I would never again have to disassemble the drive to get at the adjusting screws for the stepper motor. Now I just turn the disk drive over and begin the realignment, with no disassembly required.

3. Make sure that the stepper-motor screws are *tight*!

4. Place the disk drive in its lower case and install the six screws. I find that the needle-nosed pliers are helpful in placing these screws in their holes.

5. Remove the top metal cover and plug in the green power light. Remember which way the plug faces.

6. Replace the top metal cover.

7. Replace the top plastic cover with the four screws.

8. Reconnect the cables in the back of the disk drive.

I hope you have enjoyed this article and will find it useful.

The Safe and Fast Disk Checker for the Commodore 64 is available from me, in both the original Basic version and in a compiled version (twice as fast). For VIC-20 owners, I have a functional but simplified version, which can also be used in the alignment process.

I will provide all three versions on the same disk, with mailer and postage included, if you'll send me your name, address and $8. ⓡ

Joseph J. Shaughnessy is a professional engineer who works with Reynolds, Smith & Hills, Inc., in Jacksonville, Florida. Address correspondence to him at 8438 Lynda Sue Lane W., Jacksonville, FL 32217.