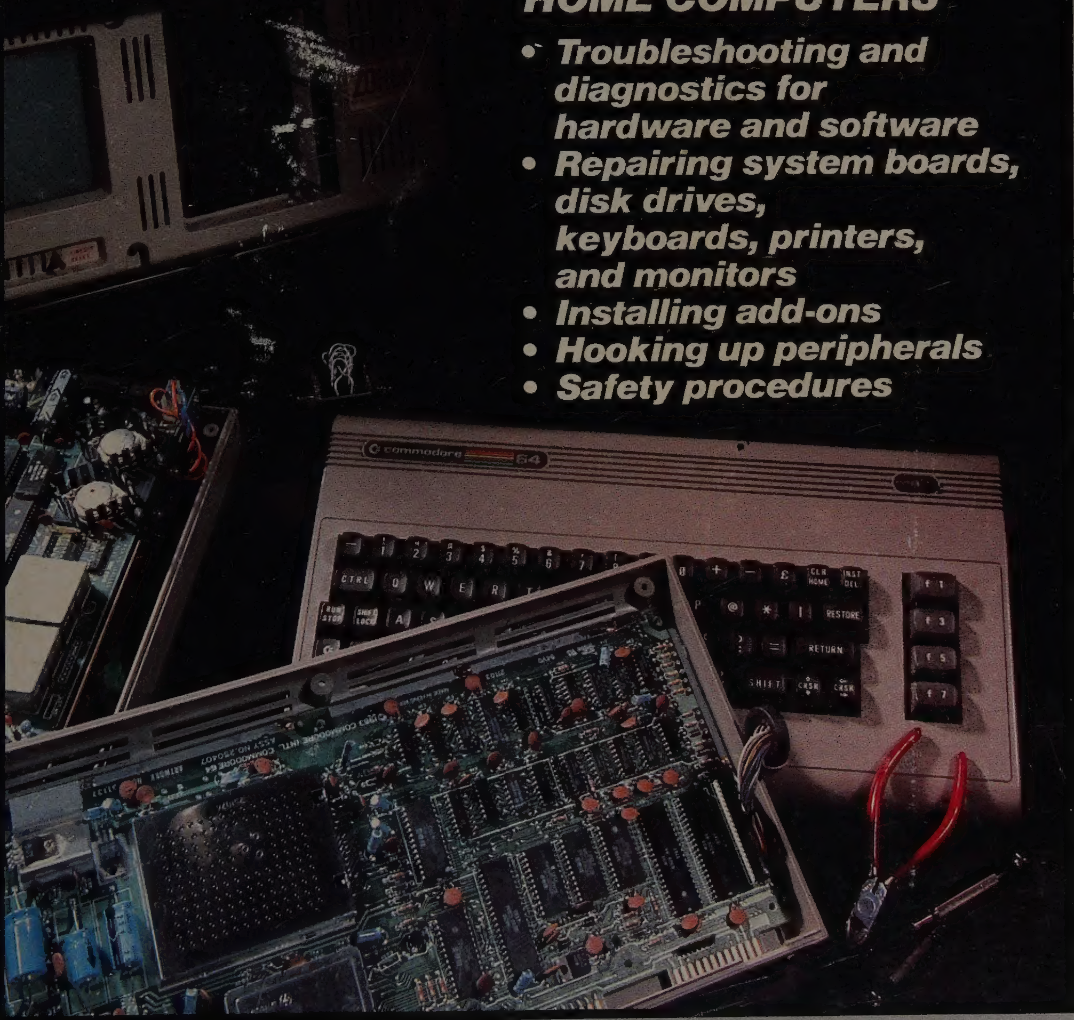
CHILTON'S GUIDE TO SMALL COMPUTER REPAIR and MAINTENANCE

Gene B. Williams

ALL MAJOR HOME COMPUTERS

- *Troubleshooting and diagnostics for hardware and software*
- *Repairing system boards, disk drives, keyboards, printers, and monitors*
- *Installing add-ons*
- *Hooking up peripherals*
- *Safety procedures*



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To BEN AVECHUCO,
without whom this book might have been possible
but not nearly as much fun

Contents

Preface

It has been quite a few years since I bought my first computer. At the time, I was facing a tight deadline, and the computer was supposed to help bail me out. The computer was checked out before I packed it into my car and brought it to the office. Back in the office, it was plugged in and booted up with the program. Nothing! The screen was blank.

I called the seller to explain the problem. He said that he couldn't be out until the following Wednesday. So much for my deadline. The only solution was to try a diagnosis by phone.

He told me to open the case. I was convinced that the second I did that, the machine would be ruined for all time. A look inside confirmed my fears. There were what seemed to be several hundred memory boards along with enough mysterious components to launch the next deep space probe. I had about as much desire to touch the insides of the machine as I have to jump out of a moving car.

Under the dealer's direction, each board was pulled, cleaned, and inserted back into the system board. What should have been a 30-second job took 30 minutes. I was so sure that every movement would break something important that I did everything *very* slowly.

I tried to get the computer to operate again, thinking that a reset might cure the trouble. Absolutely nothing! The dealer repeated, "I really can't make it there before Wednesday. Oh, by the way, have you checked the contrast control? Maybe you bumped it."

"Contrast control? What contrast control?"

"It's on the left, beneath the keyboard."

I reached under and felt a little wheel. "You mean that little wheel thingy?"

Suddenly the screen came to life with all the signs and symbols it was supposed to display. The problem was solved, and I met the deadline.

As the months went by, I ran into other problems. I went through the same feelings of helplessness each time. A computer is an extremely complicated piece of machinery, isn't it? To repair one, doesn't it require years of training and experience plus a room full of special tools and test equipment?

Most of my problems turned out to be minor. Repair was usually handled with tools no more complex than a screwdriver. A few times I had to get "technical" and use an ordinary voltmeter.

Then I became involved with other computers. The knowledge I'd gained with my first computer carried over. From conversations with other computer owners, I found out that most not only knew very little about their machines but were practically terrified of them.

As a result, this handbook and guide was developed for owners and users of virtually any home computer. It will help you in taking care of the most common failures in a personal computer system and is purposely designed so that the most complicated piece of equipment needed is a VOM.

With rare exception, the average person *can* do it. A computer is nothing all that grand and mysterious. It's just a machine—sophisticated, perhaps, but a machine all the same. There are only so many reasons why a machine fails to work.

The purpose of this book is to save you *at least* ten times the cost of the book. More important to some, it will save you a great deal of time, both in waiting for the technician and in driving to and from the shop. If you're standing in a bookstore reading this, *buy* this book! If you've already bought it, congratulations! You won't regret it.

Although each model is different from the others, most of the steps are identical for all models. When there is a difference, it is noted in the text, photos, and drawings.

My thanks go to those people who were helpful in putting this book together for you. John Kwiecien handled most of the art in this book. A tremendous amount of technical input was provided by the users of *The Establishment* and *The Silent Side*, two BBSs in the Phoenix/Mesa area.

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Introduction

Not all that many years ago, the world of computing was more or less confined to big business. The average person couldn't hope to afford a computer. Special schooling was needed to operate one. Then along came the idea that computing need not be difficult or mysterious, followed immediately by the advent of home computers.

The popularity of home computers is due largely to the fact that they are becoming easier to operate. Not many years ago, the person who had a home computer was thought to be a genius (or a "nut"). There were very few commercial programs available, which meant that the owner of a home computer had to have a solid knowledge of programming. All that has changed now.

Ask any ten people today. Several will own a computer. More yet will be in the category, "We're thinking about it." Nine out of ten are likely to have some kind of computer around—a pocket calculator, if nothing else.

Almost anyone can operate a computer. You might enjoy your computer more if you learn some programming, but all you really need are preprogrammed diskettes. Push one in, press a few keys, and you're ready to go.

Meanwhile, the cost for technical work—repair, installing add-ons, etc.—has jumped. Charges of $60 per hour or more for labor alone are common. Some shops charge as much as $150 minimum just to *look* at a malfunctioning machine. For the lower priced computers, it's not unusual for the repair bill to be higher than the cost of a new computer.

Average downtime for such a repair is three days. Having the machine tied up for a week or more isn't unusual. If the computer owner needs the technician to come to his or her home or place of business, all costs increase.

To avoid the high costs of repair, some owners purchase a repair contract. The normal charge for such a contract is between 5% and 10% of the purchase price per year. A fee of 20% isn't unheard of. Several sources say to expect repair costs to be at least 1% of the system purchase price *per month* without such a contract.

To make things even more depressing, it has been said that 95% of all repairs and other technical work could be taken care of by the computer owner without special tools or technical background. About one-third of all the repairs require nothing more complicated than your fingers. When tools *are* needed, it's rare that you'll need anything but simple ordinary tools you probably have already. (See "Tools Needed" toward the end of this Introduction.) There is often no need for you to spend those hundreds of dollars or to wait a week (or even a day) while the repair is being done nor even the time you'd spend going to and from the shop.

ADVANTAGES OF THIS BOOK

The purpose of this book is to show you just how easy it is to diagnose and repair most computer malfunctions. It will also show you how easy it is to maintain a system to reduce repairs. You don't need a knowledge of electronics. It helps, but you can handle many normal repairs without it.

Chapter 1 acquaints you with the rules of the game. Its purpose is to show you what can cause trouble or damage, both to you and to the computer. Danger spots are revealed to prevent you from getting a shock. Cautions and precautions are given to keep you from making costly mistakes. If you read this chapter thoroughly and use the information in it, you are highly unlikely to run into trouble while working on your computer.

Chapter 2 shows you how to diagnose malfunctions and how to get your computer to diagnose itself. (A computer is a powerful tool, if you let it be one.) Additional tips are provided in this chapter on how to track down a problem. Chapters 3, 4, 5, and 6 take you deeper into the specific problem areas.

Proper maintenance can reduce repair costs dramatically. Chapter 7 tells you how to reduce problems and repair costs by prevention. After you've read this chapter, you'll know what to do and what not to do. Knowing how to do many of the little tasks to keep your computer happy and healthy can save you a great deal of time, expense, and frustration.

Unless you knew ahead of time exactly what you needed in a computer system, there will come a time when you want to add something to your computer. It might be a second printer, a phone modem, or some modification to the hardware to make the computer even more versatile than it already is. Whatever you care to add, you'll find the help you need in Chapter 8.

By following the steps in Chapter 2, you'll have a good idea as to what the malfunction is. For those jobs you don't want to handle yourself (or can't), at the very least you'll have a good idea of what has gone wrong. This in turn will help to reduce the repair costs and will greatly reduce the risk of paying for unnecessary repairs. Chapter 9 gives you some additional tips to help you find a reliable technician and how to deal with this person. Chapter 10 provides a trouble-shooting guide.

Even if you have no background in electronics, you can still handle most repairs and maintenance. However, the more you know, the easier it will be. Check with your local library for books on basic and advanced electronics. Your goal isn't to become an electronics whiz but just to have a better understanding of what is going on and, consequently, what is going wrong and why.

It is suggested that you read through this entire book before tearing into your computer. Even those sections you don't think you'll need are important. This will help give you an overall idea of what your computer does and how it does it. Don't be in so much of a hurry that you end up causing *more* problems.

Before you start yanking out parts or devices, go through Chapter 2 (Diagnosis) carefully. Imagine that something has gone wrong and the computer will not accept programs. If you just tear into the machine without thinking, you could spend hours trying to find out what is wrong (if you ever find the problem at all). Proper diagnosis will guide you to the source of the malfunction. If the problem is with the drives, why spend time with the video board? The few minutes you spend with this chapter can save you hours of wasted effort.

Once you've done this, you can go to the appropriate chapter for further details. For example, if diagnosis indicates that the problem is with the disk drives, turn to Chapter 4. If the problem seems to be with the power supply, go to Chapter 6.

Use this book correctly and it should save you at least ten times its cost in the first repair. Expenses aren't counted in dollars alone. There is the time involved: time waiting for the technician to come or time wasted in driving to and from the shop. If you're one of the many who live a considerable distance from the shop, you could spend an entire day driving to and from the shop and waiting to have the technician look at your computer. Then there is downtime, when your valuable computer is useless.

You bought your computer to save time. Why use up what you've saved in waiting hours or days only to find out that you could have fixed the trouble yourself in a few seconds?

An added benefit will be that you will understand your system better. You'll know what can go wrong. You'll learn how to fix the most common problems and even how to prevent troubles.

TOOLS NEEDED

Quite often, you can successfully troubleshoot and repair your computer with nothing more than a few basic tools (Figure I-1). An ordinary VOM will help you perform various tests to spot the exact cause of the trouble. With this book as a guide, you have just about everything you need.

Unlike so many machines of "modern" manufacture, most home computers require no special or expensive tools. Chances are, you already have all the tools you need. If you don't, the cash outlay to equip yourself will be small.

1. Screwdrivers—Using nothing more than a standard screwdriver and small-headed and medium-headed Phillips (with insulated handles to protect yourself), you can just about completely disassem-

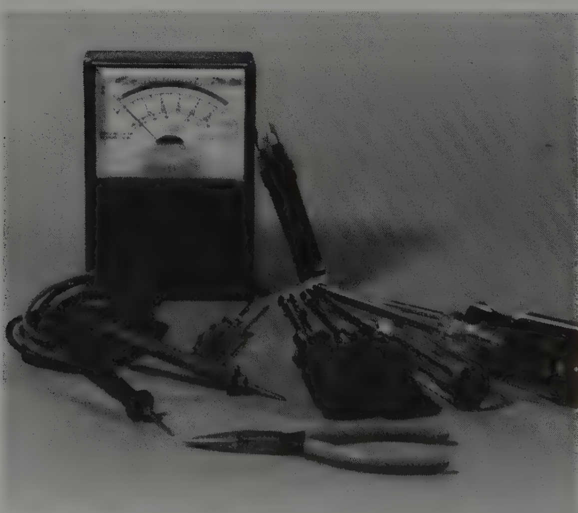


FIG. I-1 Tools you'll need: screwdrivers, needlenose pliers, nut driver set, VOM, IC tool, and hex wrenches.

ble most home computers. Don't try to remove a Phillips head screw with a blade screwdriver. The blade of a standard screwdriver should fit properly into the slot of the screw.

A special kind of screwdriver called a Torx screwdriver (Figure I-2) is designed to handle a screw somewhat like a Phillips but with a six-pointed star. This kind of screw is virtually immune to stripping and, as such, is coming into more common use.

2. Needlenose pliers—You'll rarely need regular pliers. However, having a needlenose at hand makes retrieving dropped parts easier. They also help to remove parts that are being desoldered.

3. Nut drivers—These are like fixed socket wrenches. When screws give you the choice of using a screwdriver or nut driver, the nut driver often makes removal and replacement of the bolts, nuts, and screws easier, faster, and safer. They are handy when working on certain peripherals, such as printers.

4. Multimeter—To test for voltages, to measure component values, and to check for continuity, you will need a fair quality multimeter. It doesn't have to be a fancy digital multimeter (Figure I-3). Voltages measured will be in the 5-volt and 12-volt DC ranges and 120 AC. It should also be capable of measuring resistance (in ohms). Accuracy *is* important, especially when measuring voltages. If you're not familiar with the use of a multimeter, practice using it before probing inside the computer. For example, take readings of the various outlets in your home to check for AC voltage. Use the meter to check some batteries (DC voltage). If you have some old resistors lying around, check these for correct resistance. It doesn't take long to learn how to use it efficiently, accurately, and safely.

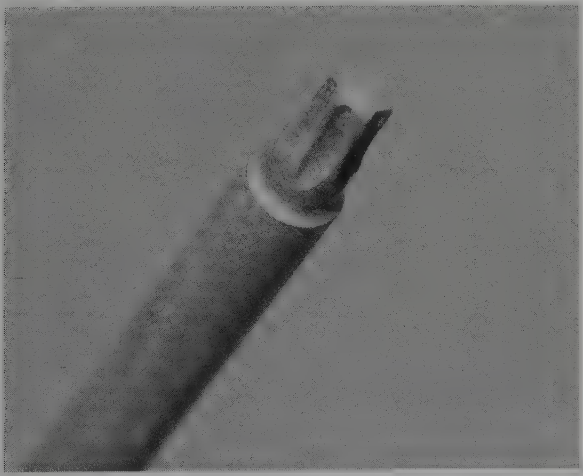


FIG. I-2 A Torx head screwdriver.

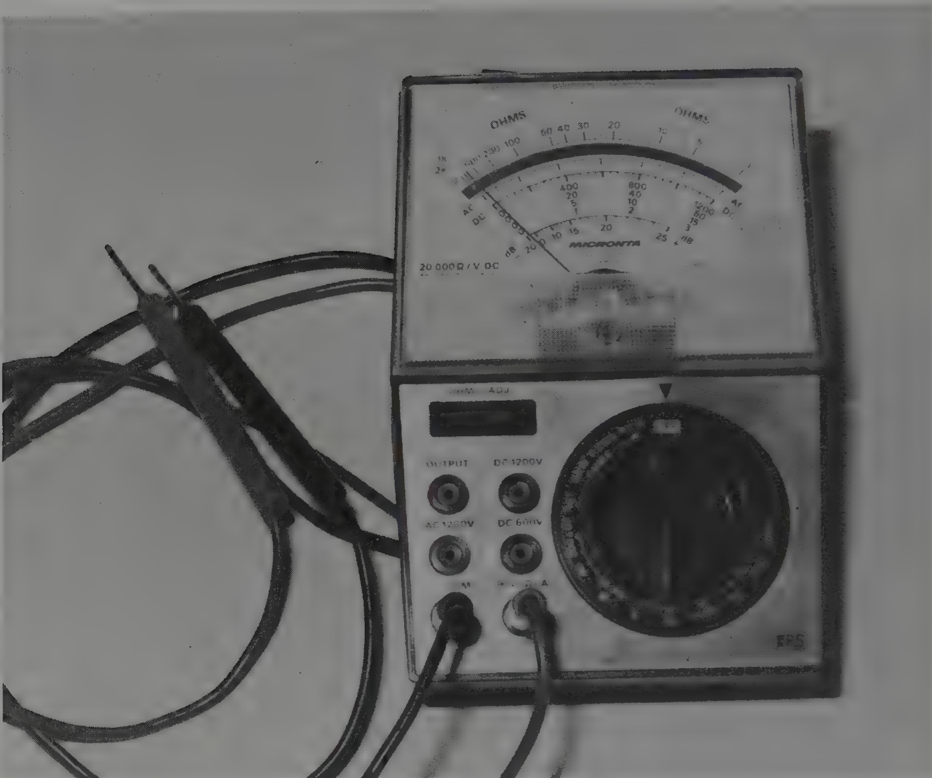


FIG. I-3 The multimeter doesn't have to be fancy.

5. IC tool—Some of the integrated circuits (ICs) on the expansion boards in your computer are plugged into sockets. Replacement of these is a simple job but a risky one if you try to do it with your fingers alone. The many prongs of the IC are easily damaged, and it is during removal that most of the damage to the prongs occurs. An IC extractor is used to remove the chip from its socket safely.

6. Hex wrench set—Some of the screws, such as those that hold the drives in place, have hexagonal heads. To remove these devices, you'll have to have a set of hex wrenches (sometimes called Allen wrenches).

OPTIONAL TOOLS

With the screwdrivers, nut drivers, and the multimeter, you'll be able to take care of almost any problem. Other tools, such as those listed below (Figure I-4), are merely to make the job easier.

1. Digital soldering tool—If you intend to change single components, you will have to have a high-quality soldering gun, one

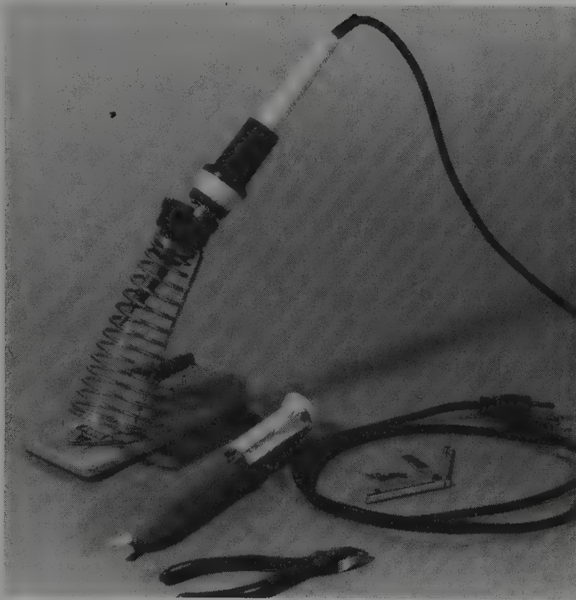


FIG. I-4 Optional tools: soldering and desoldering tools, wire cutters, knife, and alignment tools.

designed specifically for digital circuits. (If you will not be replacing soldered components, you won't need this tool. You can put off the investment—about $50—until you need it.) The tool should have a rating of no higher than 40 watts. If possible, the tip should be grounded to avoid electrical damage to delicate components.

2. Desoldering tool—This is a fancy name for a heat-resistant syringe. Its function is to suck away solder from a heated joint. (Some people call this tool a "solder sucker.") Without it, removing components is possible but difficult.

3. Wire cutter—New components often have metal leads that are too long. This means that they must be clipped to the proper length. A wire clipper handles this job correctly and efficiently. Some pliers have built-in clippers. These may be suitable for cutting wire but are not meant to trim the leads of components that are soldered in place.

4. Knife—A small, sharp knife can be used for many jobs. Used correctly, it can be a valuable tool.

5. Alignment tools—It's rare that the video board will need to be realigned, and it's far better to leave this job to a professional. However, if you wish to handle it yourself, a set of plastic alignment tools is essential. The only ones that will work are those that are all plastic. Do not use alignment tools that have metal tips. These cause subtle changes in the flow of current in certain adjustable components that makes alignment impossible.

Table I-1 lists the tools described in the above paragraphs. "RS"

TABLE I–1. Required and Optional Tools

Part	*Part Number*	*Approx Cost*
Screwdriver (blade)	Any	$2.50-6.00
Screwdriver (Phillips)	Any	$2.50-6.00
Multimeter (VOM)	RS 22-201	$19.95
IC extractor/installer	RS 276-1574	$6.95
Needlenose pliers	Any	$5.00-10.00
Nut drivers	RS 64-1800	$4.99
Hex wrench set	RS 64-1849	$1.99
Soldering tool (Weller)	TC201 & TC202	$79.95
Desoldering tool	RS 64-2085	$8.79
Wire cutter	RS 64-1841	$3.79
Knife	Any	Varies
Alignment tools	RS 64-2220	$2.99
Cleaner/degreaser	RS 64-2322	$1.99

denotes that the part is available at Radio Shack at a competitive price. Anything equivalent will work as well. *Do* pay attention to the quality of the tools. Some have a thin metal plating that can flake off. These flakes can get down inside the computer and cause a variety of serious problems.

You may also find that an assembled tool kit, such as the one available from Heath Company (part number GHP-1270, $39.95), will suit your needs. Radio Shack carries a smaller but adequate tool set for $14.95 (part number 64-2801). This set lacks a Phillips head screwdriver and hex wrenches, however.

Note: Most of the tools do not have to be specifically for electronics. For example, the screwdriver or pliers you use to work on the car will do just fine (as long as they are *clean!*).

Chapter 1

Best Results/Minimal Time

Have you ever watched a child take apart a toy? The usual way is for pieces to go flying in all directions without any order or planning. Parts that don't come off easily are broken off. Some roll under the couch; others get stepped on; some just disappear.

When it comes to reassembling the toy, the child rarely has the slightest idea of what to do or how to do it. That's when the child brings it to mommy or daddy with big, wet eyes and says, "My toy broke. Fix it for me."

A fair number of computer repair jobs come as a direct result of an adult "child" getting inside his or her electronic "toy" to find out how it works or in an attempt to repair some malfunction. Quite often what started out as a minor problem turns into something expensive.

Sure, you can save yourself hundreds of dollars per year by doing your own repairs and maintenance and by installing any add-on equipment yourself. Approach it incorrectly, however, and your mistakes can end up costing many times what the repair should have cost to begin with. Sometimes in ways you didn't expect.

YOUR SAFETY

Nothing is more important than your safety. If you do something that destroys a circuit in the computer, that circuit can be replaced. Even if repair of the malfunction costs several hundred dollars, you can take out a loan if need be and get it paid off over a period of years. If you let something happen to you—well, there is no such thing as taking out a loan for more life at any interest rate.

There are actually very few danger spots in your computer. Even while in operation, the voltage inside the computer (past the power supply and excluding the CRT monitor) is either 5 volts or 12 volts, both DC (direct current). The amount of current flowing through most of the circuit is so tiny that you wouldn't even feel it.

The direct current used in the operation of most digital circuits isn't at all dangerous to a human being. However, there are certain places where the voltage and current *aren't* safe. These spots are usually where AC (alternating current) power comes into the device. Touch one of these places and you're in for a bad time.

If the danger spots are not already exposed, they will be when you open the power supply. The most dangerous spots are the fuse block and where the 120-volt power cord comes into the power supply. Look and move carefully. It's all too easy to come into contact with 120 live (and deadly) AC volts.

Whether a computer uses an internal or external CRT monitor, 13,000 volts or more are needed for the CRT to operate with a color monitor requiring even more. Although the current is quite low, the combination of current and voltage is potentially deadly, especially since the CRT has a tendency to store up this charge, which means the dangerous charge will still be present in an unplugged machine! (In portable computers that use LCD technology for a screen, high voltage going to the monitor won't be a danger.)

This charge can be drained off by shorting the high voltage lead to ground, which reduces the danger (Figure 1-1). However, it is best to leave any fiddling or testing of the CRT to someone who knows how to safely handle the high voltages. In short—*stay away!*

EFFECTS OF CURRENT

The line coming into the power supply of your computer, and into most peripherals, is 120 volts AC. The amperage can be as high as the physical limits of the wire and the circuit breaker or fuse. Usually this means that the line is 120 volts with a current of at least 15 amps steady plus a surge limit in the hundreds of amps. This is enough power to melt a metal rod and more than enough power to kill.

Tests were done by the U.S. Navy to learn the effects of alternating current with a frequency of 60 cycles per second (cps). (The measure of frequency is sometimes made in hertz, with one hertz being the same as one cps.) It was found that a tiny trickle of just 1 milliamp (.001 amps or one one-thousandth of an amp) would produce a shock that could be felt. A current of 10 milliamps (.01 amps or one one-hundredth of an amp) would cause the muscles to become paralyzed,

FIG. 1-1 Discharging the CRT.

making it impossible for the person to let go of the source of the shock. In fact, the spasms caused by this amount of current can cause the person to grip the source more tightly. At 100 milliamps (one-tenth of an amp), the shock is usually fatal if it continues for more than a second.

As you can see, it doesn't take much current to bring on a severe hazard. If you carelessly touch a hot spot, you will become a part of the power circuit. For a short time (until the fuse or circuit breaker pops), the current flows unhampered. You risk having a surge of perhaps 100 amps flow through your body, which is more than 1,000 times as much as is needed to be fatal.

DANGER SPOTS

Anywhere there is AC power presents a risk to you. Most of these spots are obvious and are easy to avoid. The danger begins with the wall outlet (or the circuit box if you ever get to fooling around there). It moves up through the wires and into the power switches.

The wires come into the equipment and are usually connected in such a way as to make it difficult to touch the contacts. However, you might touch them accidentally if you're not careful. Repair of the power supply is normally handled by replacement of the entire unit.

The Most Dangerous Spots

1. *Wall outlet*
2. *Power cord*
3. *Power switches*
4. *Power supply*
5. *CRT (monitor)*
6. *Filter capacitor*
7. *Printer and mechanical parts*

You should not attempt to repair it. This is especially true for those computers that use a "switching" power supply.

Past the switch and within the power supply are small "cans." These are the capacitors. One of their functions is to help change the incoming AC to the needed DC. The AC comes into the power supply, where it is changed by a transformer in value to the 5 volts and 12 volts needed. The filter capacitor helps smooth out the flow. To do this, it stores up current as it comes in and then lets it flow out again in a steady stream.

Even after the computer is shut off, and even with the power cord pulled from the outlet, the capacitors can have a hefty charge inside. Theoretically, they should drain themselves of all charge in a matter of seconds. Normally, there is no danger, but if something should go wrong with the circuitry, you won't know it until you touch the capacitor contacts—at which point you'll find out all too quickly.

The power supply and most peripherals have power going directly to the switches. (With the computer, it passes through an AC filter and a fuse, but it is still hot at the switch.) It's a common misconception that a switch is safe when it is in the "off" position. It is *not* safe unless the power cord has been removed from the outlet. If you happen to touch the incoming contacts, it would be the same as if you grabbed the bare power lines or stuck your fingers in the wall socket.

With the switch "off," there is no current flowing through the circuitry or device beyond (assuming that everything is functioning

There is rarely a need to fool with the power supply. Repair is handled by replacing the entire unit.

properly). A fuse cannot do this. It is there for the protection of the circuits inside not for your protection except in a limited sense. If a short circuit occurs, the power supply will begin to draw large amounts of current. In a very short time, this increased flow can cause serious damage. It could also cause a fire. The fuse helps to prevent this from happening.

If the fuse is rated at 2 amps, this simply means that if the current reaches a level higher than this, the fuse wire will melt and current will not flow beyond the fuse. For a fraction of a second, more current *can* flow, however. Worse, if you create a short circuit across the fuse, that fuse will do nothing at all. Your body, the screwdriver, or other tool becomes the new fuse. Normally, this means that you're once again grabbing a bare wire with 120 volts and temporarily unlimited current.

With the power switched to "off," you can safely change the internal fuse, the fuse holder, and other power handling components inside the power supply. (Better yet, shut off the switch and unplug the computer or peripheral.) This again assumes that the switch is operating correctly and that the wires are all connected as they should be. To work on the external fuse, the switch, or the incoming filter, unplug the computer from the wall. Before you begin, take a moment to get out the voltmeter to measure if there is voltage present.

The monitor is another source of high voltage. There is the 120 volts AC coming to its power supply. This is a danger in itself, but the danger doesn't stop here. The monitor is a CRT (cathode ray tube) that works by throwing electrons at the phosphor-coated screen. This requires a considerable charge. The larger the monitor is, the larger the voltage required to form an image. Even a small monochrome monitor will require a few thousand volts. The current (amperage) is low, but this doesn't make the monitor safe.

Computers that have a built-in monitor reduce the risk and increase it at the same time. The dangers are reduced because the monitor is small and requires a relatively small voltage to operate. They are increased because the CRT and its circuitry are right there where you can bump or touch them while working inside the cabinet.

Be extremely careful while working anywhere near the monitor and the related circuits.

The monitor brings yet another danger, and one that has nothing to do with electricity. The screen tube has a vacuum inside and thin glass walls. Striking the tube can cause an implosion. This in turn will cause very sharp slivers of glass to be thrown around. It is suggested that you wear protective goggles when working.

MEASURING VOLTAGE

Although most equipment manufacturers do their best to reduce the risks of accidents, you still have to be careful. There have been cases when electronic equipment, such as peripherals, have been shipped with the power wires connected in the wrong order: a "hot" connected to a spot that should have been "dead." A technician who assumed that everything was as it should be could be in for a shock—literally.

If you are going to be working on the main lines coming into a piece of equipment, the power switches, or anywhere that an AC current might be present, don't take the chance that the spot or contact is dead just because it is supposed to be. Measure the voltage. Better yet, unplug the equipment—and then measure.

Don't trust anything unless you've measured it and know that no current is present. Even then, be careful. This rule applies whenever you're working around something electrical.

Testing for "hot" is easy to learn if you don't already know how. With a voltmeter (Figure 1-2) or other testing device, touch one probe (usually black) to a known ground, such as the metal chassis of the computer. Be sure to hold the probe by the insulated handle *only*. The other probe (usually red) gets touched to the suspected point. Assuming that the meter is functioning properly and that you've put it into the proper testing range, it will tell you if a charge is present and how large that charge is. You can also test for an existing current by touching the two probes across the device, such as touching the two contacts of a switch.

Setting the meter to the correct range is important. If you intend to measure the voltage at the monitor screen, don't have the meter set for 3 volts. (The setting should be in the thousands of volts.) If you're testing for AC, don't have the meter set to test for DC. You're asking for trouble if you just jam the probes inside the computer without first looking to see if the meter is properly set.

RULES OF SAFETY

Working around electricity demands a set of safety rules. The first step is to shut off the power. The main switch will cut the flow to parts farther in. It doesn't protect you completely, though, since the wires between the switch and the wall outlet are still "hot" and because there are certain stored charges inside the computer.

You might think that the best way to protect yourself completely would be to unplug the computer. This is true, with reservations.

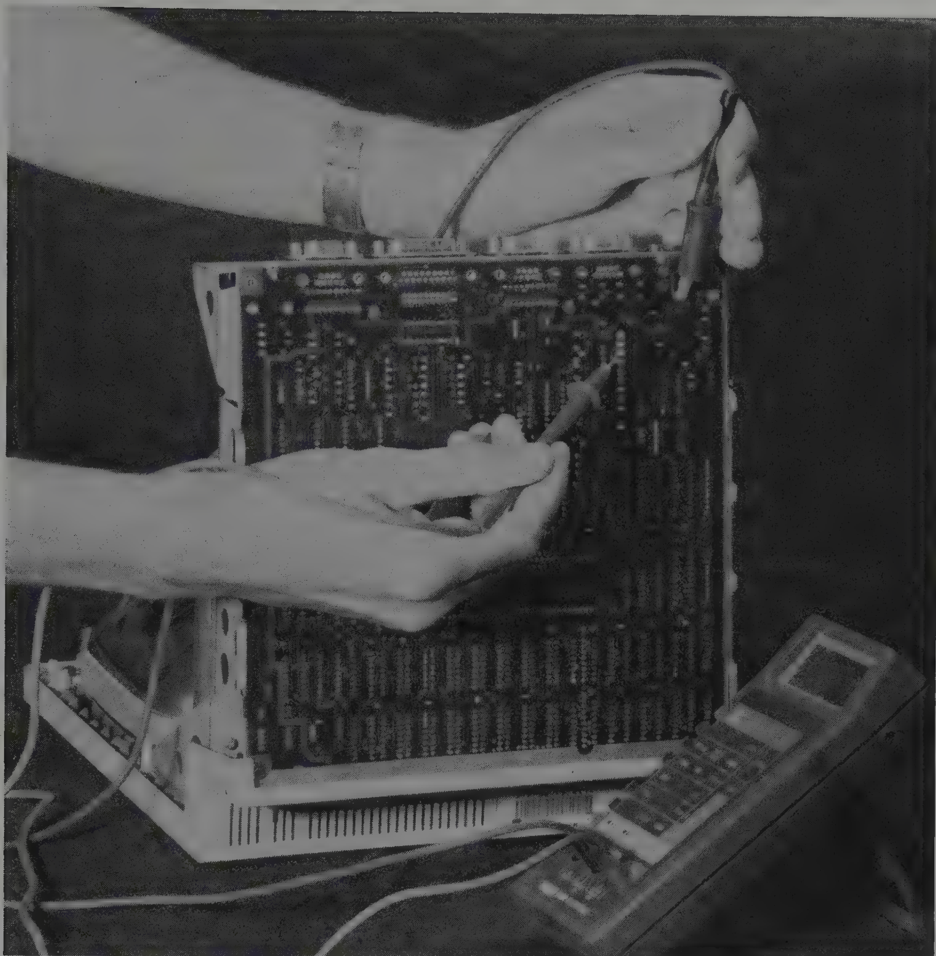


FIG. 1-2 Learn how to use a voltmeter.

Personal Safety Rules

1. *Probe carefully.*
2. *Don't touch conductive surfaces.*
3. *Observe the "one-hand rule."*
4. *Use only insulated tools.*
5. *Beware of jewelry, hair, neckties, and loose clothing.*
6. *Moving parts can be dangerous.*

While pulling the plug does remove the current coming in from the wall outlet, it also removes the safety of a ground wire. This step is more to prevent damage to the computer than to yourself. Whether you unplug the computer or not depends on repair you're doing. (Normally, it's best to unplug.)

With or without the plug, assume that all circuits are live and carry a potentially dangerous current. (The vast majority do not, but if you treat them as if they do, you are unlikely to cause damage to either the computer or to yourself.)

You can't see electricity nor can you tell by sight if a circuit is hot (active). The only immediate indication of power flowing inside the computer is the light on the computer and the soft hum of the cooling fan (if you have one), which is easy to ignore once you become accustomed to it.

By making voltage measurements, you assure that you're not sticking your fingers in places where damage will be done—damage to you or to the computer.

Never probe or poke inside the computer with any part of your body touching a conductive surface. Avoid leaning on the chassis, a metal work bench, or anything made of metal if you are reaching inside. Also take care that your feet aren't touching anything conductive (which includes a damp floor). In short, insulate yourself from your surroundings and from the equipment.

To further protect yourself, use the "one-hand rule." This means, simply, don't reach in with both hands at the same time. Most often, the rule states that one hand should be kept in a pocket. This is to avoid the temptation of breaking the rule. If one hand is in a pocket, you almost have to consciously remove it to reach inside the machine.

The idea behind this rule is to prevent your body from becoming a part of a circuit. If just one hand touches a spot and your body is insulated from all conductive surroundings, the current has nowhere to go. If a second hand touches a hot spot, the current can enter the one hand, pass through your body and out through the other hand.

A corollary to the one-hand rule is to keep the back of the hand toward any potential hot spot. The reason for this is the physical reaction you have to a shock. The muscles contract. If the fingers contract around the source of the shock, it will be much more difficult to break free. However, if the contraction is away from the source, the contraction could actually free you from the shock.

All tools should have insulated handles. Touch the tools only by these handles. It's sometimes tempting to grab a part of the blade of a screwdriver for better control, for example. Don't do it! The insulation is on the handle for a reason.

Many people realize that grabbing a tool by the metal is foolish and then forget that the necklace they are wearing is made of metal. It will conduct current just as well as the shaft of a screwdriver—better if it's made of gold or silver. The same caution applies to other jewelry, such as rings. These won't be as likely to fall onto a dangerous spot, but they can touch it and carry the current into your body.

A dangling necklace might also become entangled in some mechanical part. Inside the computer, the only moving part is the fan for cooling the computer, if you have one. You're unlikely to catch yourself in this. Peripherals are another matter. Printers in particular are loaded with moving parts. Most have a tag inside warning you to remove jewelry and to be careful of long hair. (Having it yanked out by an angry printer is no way to get a haircut.)

There is no such thing as being *too* safe. Just when you think that you've taken every possible precaution, look for something you may have forgotten.

COMPUTER SAFETY

Once you've taken the necessary precautions to protect yourself, you can begin to think about the well being of the computer. As with personal safety, computer safety is basically a matter of common sense. Things such as, "Don't punt the computer across the room no matter how angry you get" and "Don't resort to your hunting rifle just because you're losing at Pac-Man" are obvious (or should be, although you'd be surprised at some of the things people have done to their computers). Other don'ts are just as obvious if you take a moment to think them out.

Computer Safety Rules

1. ***Shut off power.***
2. ***Take notes, make sketches.***
3. ***Don't be in a hurry.***
4. ***Never force anything.***
5. ***Use the proper tools.***
6. ***Avoid short circuits.***
7. ***Check for screws, etc.***
8. ***Beware of static.***

In certain ways, the computer is a surprisingly tough piece of machinery. If it operates for the first week or so, it's unlikely that anything major will go wrong for many, many years (unless *you* cause it). Even if you do make some mistakes in operating or repairing the computer, chances are good that you won't do too much damage.

This doesn't mean that you can be careless. Just as you assume that all circuits are holding deadly charges just waiting to get at you, assume that any mistake will cause the immediate destruction of a $500 circuit. (It *is* possible.)

Again, there is no such thing as being *too* careful.

PHYSICAL DAMAGE

The most common damage done by the do-it-yourselfer is physical. Physical damage is also the least necessary. There is no reason or excuse for it. By being in a hurry, by losing patience, or by being careless, the wrong thing is done at the wrong time and something snaps.

Most of the parts of your computer are tough, but others can be damaged all too easily. Caution is the key at all times, no matter how tough you think something is.

When removing a connection, do so with slow and steady pressure (Figure 1-3). These are supposed to be somewhat tight to maintain a reliable contact. They're not in so tight as to require the strength of both arms and a foot. If it doesn't move, there is usually a logical reason.

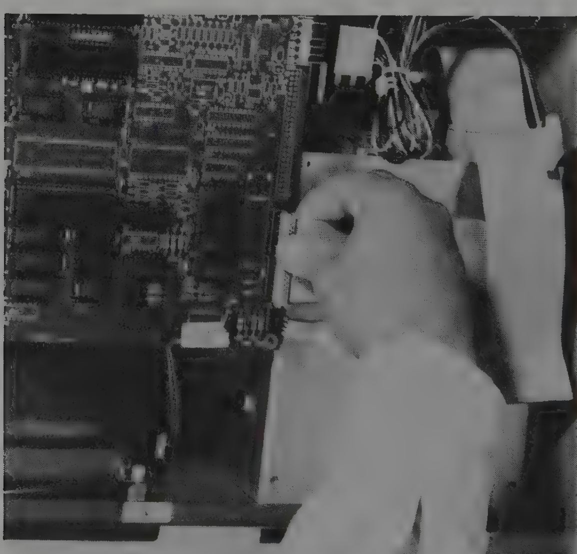


FIG. 1-3 Removing a connector.

One computer operator decided that the signal cable connectors to the disk drives were too difficult to remove. He took the probe of his voltmeter and jammed it into the slots of the cable to widen them. Then he was amazed that the operation of the drives was sporadic, at best. He ended up having to replace the cable at a premium cost.

NEVER force anything. Take the few extra seconds to find out why the board or component won't move easily.

The components inside your computer have anywhere between two and 40 connectors. Each of these leads is prone to physical damage, mostly from bending them too far. The ICs are particularly sensitive (Figure 1-4). The chips have a number of metal prongs projecting from them. More often than not, the prongs on a new IC are in the wrong positions for easy installation. Bending them manually is the usual solution for the computer owner who is installing chips. This

FIG. 1-4 The prongs of an IC are delicate, and the inside can be ruined by static. *Handle with care!*

brings in the danger of bending the prongs too far (or too little) and then having to bend and rebend the prongs.

The prongs are thin, and this bending and rebending creates stress on the metal. The prong may break off. It may also crystalize in such a way that the current flow changes, making a seemingly good chip useless.

USE THE PROPER TOOLS

The solution to this and to related problems is to use the proper tools for the job at hand. Two special tools are available to handle the delicate chips. One is made to put the prongs into the correct places for installation (an "IC installer"). The other is designed to aid in the removal of chips (an "IC extractor"). Both tools are fairly expensive for someone who plans to install or remove just one chip per decade. Both are inexpensive when you consider the cost per ruined chip. If you want to reduce the risk, at least get an IC extractor.

These tools offer an additional safeguard. Some of the chips are extremely sensitive to static. Your body has the tendency to store up static charges. You have probably experienced a tiny shock when touching a doorknob or other metal object after walking across a rug. If the charge was enough for you to feel it, it was probably enough to fry the insides of a delicate chip. A static charge you cannot feel may still be enough to ruin a chip.

The IC extracting and installing tools will help prevent this from happening. You can reduce static buildup by treating the carpets either with a commercial product or with a dilute mixture of water and standard fabric softener. You can also make use of a "static discharge device." This is a device connected to a ground (such as a neutral screw on a wall outlet). You touch a metallic spot with your finger. Any static charge your body might have is drained off safely.

SHORT CIRCUITS AND OHM'S LAW

The second most common type of damage caused during repair is a short circuit. This can happen in several different ways.

The usual way is to touch the metal tip of a tool or probe across two points that are not meant to be connected. Most often, this won't matter. Other times, it will send a circuit off into oblivion with a cloud of smoke.

There is a mathematical relationship between voltage, amperage, and resistance. This is stated by Ohm's Law: $E = I \times R$, where E is the voltage, I is current in amps, and R is resistance in ohms. If you multiply the current times the resistance, you'll know the voltage.

With some basic algebra, you find out $R = E/I$ and $I = E/R$. By sticking some numbers into that last formula, you can see what happens with a short circuit. It simply states that the current flowing is equal to the voltage divided by the resistance.

The voltage remains constant due to the design of the power supply. In most circuits, this will be 5 volts. If the resistance is 10,000 ohms, the current flowing is .0005 amps. A short circuit effectively drops this resistance to near zero, which means that the current will flow to the limit allowed by the power supply (about 2.5 amps). For computer circuits designed to handle just fractions of a milliamp, the effect can be disastrous—like trying to instantly force a few hundred gallons of water through a tiny hose meant to carry just a few ounces.

In the previous section, there was mention of necklaces and other jewelry causing current to flow into your body. While working inside the computer itself, there isn't enough current flow to cause any harm to you. However, the rule about jewelry applies, this time to protect the computer. If that necklace swings down and creates an electronic bridge, *you* may not be able to feel the effect but the computer probably will. Resistance drops to near zero. As a result, current swings in the other direction.

The human body normally has a very high resistance. Unless your hands are wet, touching an active circuit inside is unlikely to cause any damage. (This means a digital circuit, not one of those that carry high voltage or AC.) A ring on your finger or a watch on your wrist is another matter. The metal will act the same as if you had connected a wire from spot to spot.

All these are fairly easy to keep track of. Pay attention to what you're doing and you should have no problems. Other things that can cause shorts are more difficult to notice.

When taking things apart, keep careful track of the various screws, bolts, nuts, and other metallic parts. Take notes. Make drawings if you think they are needed. It's all too easy for a part to fall inside the computer unnoticed, only to cause troubles later on. When you turn on the power, that forgotten chunk of threaded metal becomes a surprisingly efficient conductor.

It is less likely, but still possible, that small bits of metal will fall inside the computer. The average computer owner won't have to worry about these unless a screw has been forced (which could strip off a piece of the thread) or unless the lead of a component has broken off.

PREVENTING ELECTRICAL DAMAGE

To prevent accidental short circuits, flip the switch to cut off the power before removing anything. There is only one reason for the power to be on while working inside the computer and that is for testing, probing, and measuring (and those must be done carefully). For anything else, the power should be off and should remain off. Make shutting down the power your automatic response and applying power what you stop and think about.

Imagine yourself going inside the computer for a simple repair, such as to replace a faulty IC. You forget the "rule" and leave the power on. You're being careful and use an IC extractor but touch the edges of the metal tool to active circuits ("zzzt, zzzt, zzzt"). The faulty chip is pulled and you go to install the new one. You've been careful about reinstallation and know that everything is where it is supposed to be. But nothing works. You scratch your head and say, "Now, how could that have happened?"

This isn't likely to happen. What is important is that it *could* happen. If a board or component is removed while current is flowing through it, the current value often changes. As the value changes in one place, other changes will take place elsewhere. Small changes probably won't cause damage, although they can cause the circuit to "age." Larger sudden changes have effects similar to those of short circuits or static discharge, namely, to destroy the circuit from the inside.

When working inside the computer (with the power off!), pay attention to what you are doing. Look carefully at any connector you are going to remove. Make notes and sketches so you have something for reference. (Keep these notes and sketches handy for future times when you want to get inside the computer.) Before you turn the power on again, look around inside. Are all the connectors back in their proper places? Have you left any screws, nuts, or bits of metal inside?

COMPONENT REPLACEMENT

Most of the time, a component failure will be handled by replacing an entire board. Even professional technicians use this method of repair. Although board replacement may sound expensive, the time involved in tracking down a problem to a single component often ends up costing more than a new board.

Since you probably do not have the equipment that the technician has nor the knowledge to use it, you will probably confine most repairs to board replacement rather than component replacement. (When you handle the repair by replacement, keep in mind that the malfunctioning board or unit has a trade-in value.)

There will be times when you will be able to identify the exact component and will want to replace just this piece. When this is possible, the saving to you is large. Most of the components in your computer cost very little. Diodes, resistors, and capacitors cost just pennies. The ICs are often just a few dollars. Many of the ICs used in the computer can be purchased for under a dollar.

The first step in component replacement is to make certain that the new component is exactly the same as the one it replaces. (If you're uncertain about which parts are which or how to read the component values, pick up a book on basic electronics.)

Some components have polarity. An electrolytic capacitor, such as the filter capacitor in the power supply, has positive and negative leads. Install a new one backward and it could explode! Other components won't react so violently but could cause damage throughout a circuit. Expensive damage. ICs that are not installed correctly can burn up and may take a whole string of other components and circuits with them.

Even when you aren't replacing a component, pay attention to polarity. To do many repairs, you'll be disconnecting cables and other wires. Most of these have special keyed plugs, making it impossible to reconnect them with the wrong polarity. You may run into a few that don't have this intelligent design.

Taking notes and making sketches are important parts of any repair. Get into the habit even when you don't think that you'll need the notes and drawings. There is no need to be a professional artist or writer. What you do is primarily for your own use, a jog to your memory. Assume, though, that others will be using these. (It's possible that you'll have to consult a pro on the repair. The notes you take, and the drawings you make, could save you quite a bit of time and money, regardless of how bad they are.)

SOLDERING

Some components plug into place. Most are soldered. Replacing components that are hard soldered directly to the board demands extra attention and a bit of skill.

Despite what you might think, soldering is an art. It's not the kind of skill you can learn in a few minutes. With circuits as critical as those of a computer, you certainly shouldn't be practicing inside your computer. There are a number of books and pamphlets available on how to solder. *Heath* offers a course in soldering. Before you even consider soldering inside the computer, learn everything you can about it. Then practice, practice, practice.

The soldering iron used for digital circuits (Figure 1-5), such as those in your computer, should be rated at no more than 30 to 40 watts. Anything hotter could easily damage the circuit or the board. Even with the lower-powered iron, anything more than a few seconds of contact is risky. Many components are very heat sensitive. The internal goodies can all too easily be fried. The board may also be damaged permanently. If this happens, you may as well scrap the board and buy a new one.

The soldering iron should be designed specially for digital soldering. These irons are more expensive, but the extra cost is a necessity. They have grounded tips, which prevent damage from any build-up of electrical charge. *DON'T* try to use any old soldering iron or gun for the job.

To remove a component, especially one with many contacts (such as an IC), be sure to use a desoldering tool. This inexpensive device removes the melted solder from the contacts, making it possible to simply pull the old component loose. You can also use a "solder wick." This is a copper braid specially designed to pull the solder from a joint and onto the wick. Move slowly and carefully so as not to cause damage. The more contacts the component has, the trickier it is to remove it.

PREPARING TO WORK

Before you begin any repair, you should have a solid understanding of the correct procedure. Diagnosis and repair is a logical sequence

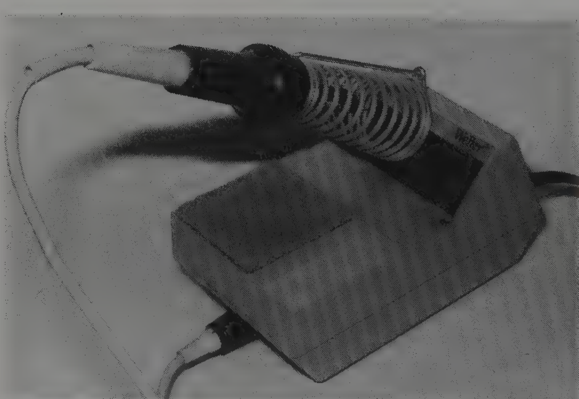


FIG. 1-5 A soldering tool for digital circuits.

of steps. (More on this in Chapter 2.) Learn these steps. Follow them! They'll save you money, time, and a whole lot of trouble.

The first step is so simple that most people ignore it. Make backups of every bit of software. Many books and courses suggest this and mention making *a* copy. Instead, make at least two copies. Having the original plus the two copies helps to protect you in a number of ways.

If you don't know how to make a copy, refer to the "Copy" or appropriate section(s) in your owner's manual. After copying, perform an accuracy test. Run each copy to be sure that it works properly or that it contains the correct data. Testing after copying is a step that should *always* be taken. Without it, you don't know for certain if your copy is a copy or is just a useless diskette.

There are software losses through fire, water, forgetfulness, and so forth. These should always be of concern to you, however unlikely they might seem at the moment. You must also consider loss through the machine.

In one large computer repair house, a certain technician fed in a working disk. There was a problem with the disk drive. The result was that the machine "ate" the diskette. His solution was to feed in a second diskette. The computer destroyed this one as well. So he booted up a third; then a fourth. By the time he figured out that the drive was annihilating the recorded programs, five copies were destroyed.

This may sound silly. A professional *should* know better. The average operator may not. If the problem is intermittent, it would be very easy for even an experienced operator to waste a program or two before realizing what the problem is.

If your machine doesn't accept the original, check it with a copy. If this copy doesn't work, chances are good that something is wrong with the drive. If the malfunction has erased the first two, you have the third to protect yourself.

Protect Yourself

1. ***Make* at least *two backups.***
2. ***Test the backups.***
3. ***Store the original and one backup safely.***

WHERE IS THE PROBLEM?

Computers are extraordinarily reliable. Most people have come to think of machines as being at fault when something goes wrong. In many cases, this is true. When a car suddenly stalls on the freeway, it is usually a machine error. When a television or radio refuses to work, it is usually the fault of the equipment. With a computer, however, the fault is more often with the person running it.

Most of the common machines are designed so that anyone can operate them. There aren't many things for the operator to change or vary. A television, for example, has very few controls. The owner can switch it on, change the channel, and change the contrast and color within limitations. Beyond this, about all the television operator does is to sit back and view.

Operating a computer normally involves pushing a variety of buttons, each of which does a different task. It's like having thousands of controls available instead of just a half dozen. Just as the computer offers more controls, it brings many more opportunities for making mistakes.

Before you tear into your computer, make sure that the fault lies with the computer. Chances are good that the fault is your own or is the fault of the programmer. Most malfunctions are not the fault of the computer.

One of the first questions you should ask yourself is, "Has it *ever* worked?" An untried program may have flaws. Even a known program may have bugs in it. A tried-and-true program may give out after a number of uses. (Diskettes are well manufactured but aren't without error, nor do they last forever.) Then there are those programs that you use every day for their normal functions but that have other capabilities you haven't yet used. When you get around to trying out the other capabilities, you must ask "Has it ever worked?" again.

Important Questions to Ask Yourself

1. ***Has it ever worked?***
2. ***Has that function of the program ever worked?***
3. ***Do other programs work?***
4. ***What is working and what is not?***
5. ***What did I do wrong?***

Your first suspicion should be with yourself (or the operator of the computer). Software documentation is notorious for being poorly written. Do you understand how to work the program? Have you read through the instruction manual completely? Are you trying a new function of the same program?

Second in the line of things to suspect is the software itself. If you have backup copies, try one of these. (If you have been using the program successfully and have tested the copies for all functions, you can eliminate the "Has it ever worked?" question.)

Another test is to boot up a different program. For example, if your word processing program isn't working, try your accounting program or one of the games you have. (Be sure to read the manual for that piece of software if you're not already familiar with its operation.)

If you have checked out any possible operator and software failure, the next step is the visual check. Look for what doesn't look right. Don't start pulling boards and components until you've completed this step. Look for the obvious. Much of the time, you can solve the problem with very little effort.

Perhaps you've dropped a screw or nut and this is shorting one of the internal circuits. Maybe the door to the disk drive is cracked and won't allow the spindle to make proper contact with the diskette (an unfortunately common problem).

Software protection schemes can also cause operating problems. Some half-height drives are strictly 48 TPI (tracks per inch). One protection scheme puts certain information halfway between the tracks. The half-height drive may be incapable of seeking the information here, which in turn means that the program won't load.

Notes should be taken throughout your inspection. Even before you begin your diagnostics, you should have something written down. What is working. What is not? Jot down all the symptoms along with any errors that the computer shows. As you go on with your diagnosis, continue to take notes.

Don't waste your time on parts that are functioning properly. Diagnosis is a process of elimination. If you know for a fact that the drives are accepting programs, that your printer is operating, that the monitor is giving a correct image for what is being sent to it, then eliminate or ignore these sections of the computer. If the problem is that the RAM won't hold data, why waste time taking apart the drive? All you can do is to cause more problems.

Begin with the most obvious and the easy. Work your way to the more complex.

All checks begin with the cabinet closed. Make a note of what is happening or is not happening. Check and recheck for operator error then for software error or for diskette failure. Only then should you think about opening the cabinet. You should have at least a fair idea of what you're looking for before opening the cabinet.

When this step comes along, move slowly and deliberately. With the box open, look around for the obvious. Don't just start tearing into the computer. All you can cause is damage if you're in too much of a hurry.

Where Is the Fault?

1. ***Operator***
2. ***Software***
3. ***Peripherals***
4. ***Disk drives***
5. ***Computer***

PREVENTING PROBLEMS

Chapter 7 deals with maintenance. Home computers are designed and built to require very little maintenance. You can pretty much ignore your machine, almost to the point of abuse, and it will keep going.

But there are still some TLC requirements.

The greatest enemy of the computer is dust. A tiny fleck of dust that your eye can't even see can gouge a diskette to uselessness. Dust combined with humidity can cause short circuits.

Yet dust is everywhere. All you can really do is to reduce the amount that gets into your computer, particularly into the mechanical parts. Some dust on the boards is unlikely to cause any problems. Just a few invisible particles on the disk drive heads can slice the data on a diskette to shreds.

Keep the area around the computer as clean as possible. DO NOT use a feather duster or anything like it. A slightly damp rag will pick up the dust rather than toss it into the air, where it will do even more damage. Store all diskettes and cassettes safely, both inside their jackets and inside a diskette storage box or cassette case.

Computer Enemies

1. *Dust*
2. *Liquid*
3. *Food*
4. *Smoke*
5. *Other contaminants*
6. *Humidity*
7. *Weight or pressure*
8. *Carelessness (i.e.,* YOU)

One item you can eliminate entirely is that of food and drink. Make it a policy never to allow anything spillable within a 20-foot radius of the computer. If you or some other operator wants a cup of coffee, it's time for a break *away* from the computer.

Liquids in particular are dangerous. A spill into the keyboard can require total replacement of the keyboard plus possible repairs inside the computer due to short circuits.

SUMMARY

The do's and don'ts are little more than common sense put into practice. If something seems silly, don't do it. If it seems logical and sensible, think it over before you do it.

A computer is a logical machine. Things don't go wrong for no reason. There is always some reason. Just because you can't see it right away doesn't mean that the reason isn't there. Don't attempt to do anything unless you have some idea as to what you are doing and how to do it. Likewise, don't attempt a repair without the proper equipment. To put it even more simply, "When in doubt, don't."

Some of the problems can be solved immediately, in less time than it takes to call in and wait for a repair. Others may take more time. You'll learn which problems to tackle yourself and which to save for a technician.

In making repairs, keep in mind that the design of the machine demands exact components. If a resistor goes out, the replacement for that resistor must have exactly the same value.

Suspect yourself first. Next, suspect the software and diskettes. After this, begin all checks with the cabinet still closed. Take notes constantly. Make sketches where applicable. Don't trust your memory.

Finally, do read through the entire applicable chapter before you attempt to work on a section of your computer. If you suspect the

The First Steps

1. ***Read the book thoroughly.***
2. ***Read Chapter 1 again for safety tips.***
3. ***Perform diagnosis (Chapter 2).***
4. ***Read applicable repair chapter (3–6).***
5. ***Repair or replace.***
6. ***Consult a professional if needed (Chapter 9).***
7. ***Back in operation again!***

drives, for example, read Chapters 3 and 4 thoroughly before you begin. (Read Chapter 2 even more thoroughly before you do anything!)

Repair and maintenance of a computer is not difficult. People with less intelligence than you have are doing it every day and without making errors. At the same time, people with more intelligence are messing things up faster than they can be repaired almost always because they refuse to follow "the rules."

Chapter 2
Diagnosis: What's Wrong With It?

When something goes wrong with your computer, it's tempting to immediately remove the cover and start poking around. Even if you have some idea as to what has happened (or has not happened), this is probably the worst way to begin. The cure of a problem *always* begins with the cabinet closed and usually with the power off.

Diagnosis is a step-by-step process: one thing at a time. Often you can skip certain steps. When you do, you should know that you're skipping them and why. (This will be because the step has taken care of itself automatically, such as checking to see if the computer is plugged in. Obviously, you don't have to check this if power is getting to the computer.)

The primary diagnostic steps are covered in this chapter. Once you have tracked a problem to a particular system or device by using these steps, you will be guided to the correct section of the book for further diagnosis and for the final repair or replacement.

For example, imagine that your computer refuses to accept a program. The problem could be caused by many things. This chapter will take you through a diagnosis until you have tracked the problem to a single part of the computer system. If the problem is in the software, you would then turn to Chapter 3 for more details. If the preliminary diagnosis indicates that the problem is caused by the disk drives, you would go to Chapter 4.

It's as simple as that. When a problem comes up, begin right here in this chapter (unless you already know for sure what is causing the problem). Diagnosis is little more than a process of isolating the cause of the problem. By using this chapter, you can eliminate many of the things that are not causing the problem. You can then more easily pin down what *is* malfunctioning.

BEFORE OPENING THE CABINET

Most problems and malfunctions can be taken care of without ever taking the computer apart. Many can be spotted and cured without even turning on the power.

There are six steps to take before you open the cabinet: (1) Check for operator error, (2) check for software error, (3) look for the obvious, (4) observe symptoms, (5) take notes and sketches, and (6) use a diagnostics program if you have one.

CHECK FOR OPERATOR ERROR

A computer has remarkably few hardware malfunctions. Despite its appearance, the computer is relatively simple—much less complex than, for example, your television set. If something goes wrong with the television set, the chances are good that the fault lies in the set. After all, there is little chance of operator error. Even the new programmable television sets require little on the part of the operator compared to operating a computer.

The computer works because of what the operator does. It has hundreds of controls generally accessed through the keyboard. The more controls you are required to operate, the more likely you are to mess up somewhere along the way. Then add to this the accidental flubs, such as pressing the wrong key, and you begin to appreciate the differences between operating a computer and operating a television set.

If you are the operator, much of the time you'll know when you make a mistake. If the operator is someone other than yourself, this may not be true. It's possible that as an operator tries to recover from the error, the problem could get worse, making your job of tracking it down more difficult.

Your first BASIC programs are excellent examples of how important operator error can be. Each command has to be just right. A program gives directions to the computer and guides it through the complex electronic maze inside. Give it incorrect directions and the computer will get "lost" (shown by the computer announcing an error).

Don't think that operator error can only occur with "homebrew" programs. Even software that has been professionally written and produced isn't free of suspicion. (See the next section.) A flawless program can present some very strange troubles if you don't understand its functions, characteristics, and quirks.

Does the operator know how to operate the program? Is it a new program or perhaps a new feature of a familiar program? (Has the program or function *ever* worked?) If either is true then it's possible that the "malfunction" is nothing more than a lack of knowledge on the part of the operator.

If you could spend some time in a computer repair shop and listen to some of the malfunctions (and their solutions), you'd come to realize just how many things the operator can do wrong. It has nothing to do with being stupid or even careless. Most of the time, the problem is due to an honest mistake. One operator was never shown how to start the machine, let alone how to run it after it was going. Another had the power cord kicked out by the family dog and couldn't figure out why the computer seemed dead. Still another erased a large amount of valuable data because he thought that the diskettes had to go through format each time before trying to load them.

If it's even remotely possible that the problem is operator error, check it out completely before blaming the computer. Of all computer "malfunctions," about a third are brought about by nothing more than operator error.

CHECK FOR SOFTWARE ERROR

Once you've eliminated the operator as the possible source of error, be sure that the software isn't the cause. This includes both the data on the diskettes or tape and the diskettes or tapes themselves. Both can produce errors that may seem to be machine problems. Of all problems that come in to a repair shop, the vast majority are brought on either by operator error or by software error. In a sense, the software becomes a sort of operator once it's fed into the computer. It tells the computer what to do and how to do it when the human operator pushes the various keys.

New programs and diskettes are especially suspect. Just because the box and plastic wrapper are intact doesn't mean that nothing could have happened to it. In some ways, the magnetic media (tapes or diskettes) is as delicate as a Christmas tree bulb (see Chapter 3). Despite all the care and testing, a flaw could have snuck in during the manufacture, or the diskette could have been damaged in transit. A program on the diskette might have been imperfect to begin with or may have faulty sections. (I have a chess game in which the king cheats whenever he is in trouble.) Newer programs are more open to suspicion than programs that have been around for a long time. After several thousand users run the program through its paces and find the errors, the manufacturer can release an improved version. (The fact that new programs often contain weaknesses of various sorts isn't necessarily the fault of the manufacturer, although there is little excuse for releasing a program and charging for it before the bugs are taken out.)

Making backup copies of all software and data diskettes is a good way to protect yourself from software failure. You should have at least one backup copy of anything that is important to you. Two copies are better yet. Be sure to test the copy before storing it. Then if something goes wrong with the original, you'll have a quick means of recovery. You'll also have a way to test to see if the problem is in the software or in the hardware.

LOOK FOR THE OBVIOUS

A new computer owner took his system home and pushed in the program diskette (just as he'd been shown at the shop) but nothing happened. That same afternoon, he tucked all the equipment in his car and brought it back in. It operated flawlessly, so he took it back home again only to have the system refuse to operate again. Next day, he was back in the shop.

"I just don't understand it," he said. "I know the outlet is good because I plugged a lamp into it. Maybe something got jiggled inside the computer when it was in the car." Again the system operated perfectly while in the shop, with the owner standing there watching. Then he saw the technician reach back to flip off the power. "What's that black switch for?" he asked.

That may sound silly, but it is a true story. Somehow, he managed to get the idea that shoving in the disk automatically kicked in the power. It's such an obvious thing that the salesman hadn't even bothered to show the customer how to apply power to the computer.

This same customer might have been tempted to rip off the cabinet to see what was the matter. It probably would have done no harm. On the other hand, he could have caused actual damage before he realized that all he had to do was flip a switch. (Of course, if he'd bothered to read the manual, there wouldn't have been a problem in the first place.)

Look for the obvious before you do anything else. If the computer

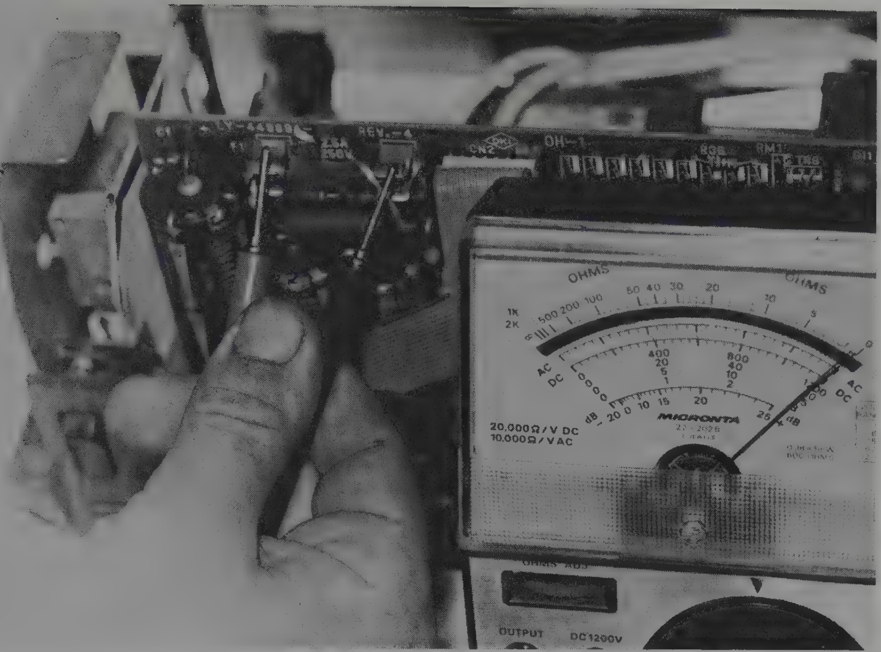


FIG. 2-1 Don't forget to check the fuses.

seems dead, look to see if the plug is still in the outlet and check to make sure that the power switch has been flipped before tearing apart the power supply. Don't forget to check the fuses as the possible cause of no power (Figure 2-1).

It's easy for cables and connectors to become loose even if your computer sits perfectly still (Figure 2-2). You can't always tell if the connector is secure just by looking, either. Push them in to make sure that contact is being made. Since it takes just a few seconds, remove each connector, one at a time, and visually inspect both ends. Then

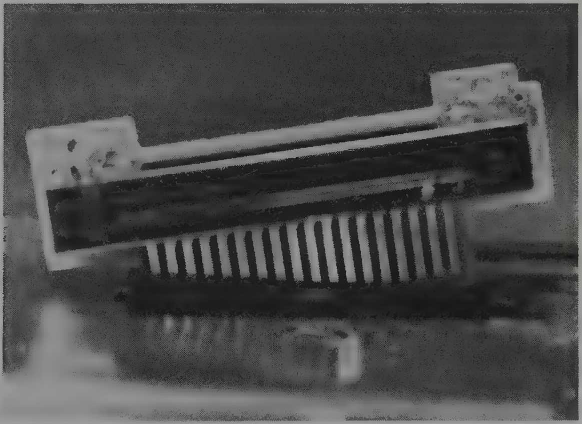


FIG. 2-2 Cables and connectors can loosen and fail to make proper contact.

reconnect. Do this ONLY with the power off as you can cause considerable damage by the sudden surge brought on by a disconnect or connect.

Contrast and other controls on the monitor might have been bumped or accidentally turned so that something seems to be wrong. The more people who touch or move your system, the greater the chance that something has been bumped, nudged, or otherwise messed up by human action.

A program that refuses to load could be caused by something as simple as accidentally inserting the disk or tape cartridge upside down or even putting in the wrong program. A flickering on the screen or recording error could be caused by someone in the next room turning on a vacuum cleaner or an electric mixer.

Recently, I moved into my new home. While talking on a cordless phone, the computer began beeping. Strange garbage popped up on the screen. Nothing I did helped. Then I discovered that in setting up the new office, I had relocated the base of the phone too near the computer. As I talked on the phone, the conversation was being transmitted right into the computer's circuits. I moved the base to another room, and the computer worked like a charm once more.

Then there are problems due to normal wear and tear. What might appear to be a major problem with a disk drive could be nothing more than a broken door (Figure 2-3). (They're usually plastic and all too breakable.)

Even inside the computer, keep your eyes open for the obvious. Expansion boards may not have been pushed all the way into the

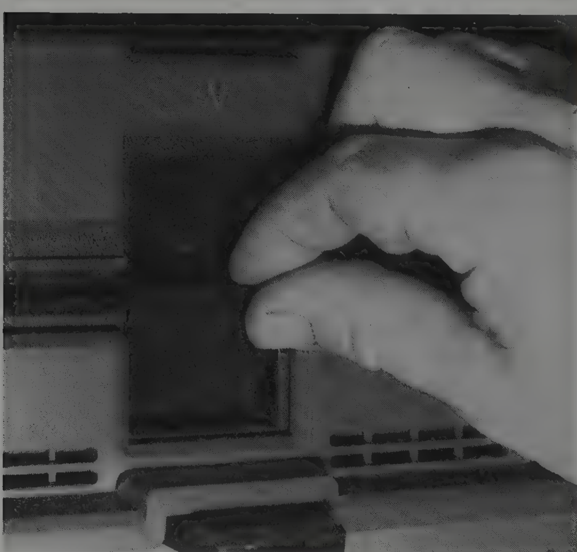


FIG. 2-3 A broken or improperly seated drive door can make it seem as though the drive is malfunctioning.

expansion slots or a cable may have come off. A screw may have fallen, causing a short. Even faulty components are sometimes obviously damaged. A capacitor might be leaking fluid or a resistor might be obviously burned or a soldered connection might be loose.

As you're going through the more detailed steps of diagnosis, keep looking for the obvious. Start with the simple, obvious things and then go to the more complex.

OBSERVE SYMPTOMS

If there is a problem, it will usually show up as soon as you apply power. Observe how the computer comes on while everything is functioning properly.

The normal starting sequence differs for each computer. Some have various beeps to indicate proper operation while others make no sound at all except for the noise from the disk drive or cassette machine. Disk drive LEDs might come on only when a drive is in operation or might stay on constantly.

Make a list of your computer's normal sequence and keep it readily available. Symptoms should include all things that the computer is or is not doing.

Often, the troubleshooting tables that come with new equipment are of very little help because they deal with main symptoms only and not the combination of symptoms needed for a complete diagnosis. For example, the main symptom might be that the computer fails to load programs. By itself, that could mean a power failure, a drive or cassette failure, a software failure, or an internal component failure, etc. But by paying attention to all the symptoms, you make use of the all-important process of elimination until you find out what is causing the trouble.

TAKE NOTES AND MAKE SKETCHES

Throughout the diagnosis process, take lots of notes. What is happening? What is not happening? What symptoms are present? These notes will save you time and money if you have to take the computer to a technician. If you fix the computer yourself, they will act as a guide.

Including sketches is especially important if you are going to be doing any disassembly. Don't trust your memory. It's too easy to forget that screw #17 fits into such-and-such slot.

Plugs and connectors are usually keyed, but if they are not, mark them yourself to keep track of which connector goes where.

USE A DIAGNOSTICS PROGRAM

The purpose of a diagnostics program is to help you spot problems and run periodic checks, enabling you to track down the most common failures within your system. Because not all diagnostics programs are of value, it is important to have a demonstration of the program before you buy it.

The three most common routines within a diagnostics program test the disk drives, the ROM, and the RAM; a few also test the CPU and other components. Disk drive routines are further divided into checks on drive speed, read/write stability, and clamping (the correct alignment of the spindle as it clamps down on the diskette) while a few also test the head movement and the alignment of the read/write head(s).

Unless the program is designed specifically for your computer, the ROM test may be invalid. RAM tests operate by sending a signal to the RAM chips, which read back the signal to see if it has changed. If it has, then data stored in the chips will also change.

A single pass will spot dramatic failures, but will not detect intermittent or complex problems, so a minimum of 30 test passes are required. Diagnostics routines should be used on a regular basis as well as whenever you've made any change in the system, anytime you've moved the system, or whenever the system has been idle for an extended period of time.

BUILT-IN SELF TESTS

Not many computers make use of the relatively new concept of a quick self test to check the integrity of the system. Of those that do, most are activated by the user and are not automatic.

Since most self tests do nothing but quick checks, it's not wise to rely on them completely. Even so, a quick check is better than none at all.

THE PROCESS OF ELIMINATION

In the process of elimination, always try to begin with the easiest things. Since it is easier to check the external, begin there.

If all cable connections seem sound and still nothing happens, it's time to check the incoming power. Checking for power in an outlet is easy. The easiest method is to plug something else into the socket, such as a lamp. If the lamp lights, you know that there is power coming in through the outlet. It won't tell you much more than this, though.

Using a meter is a more accurate gauge (Figure 2-4). (Set the meter to read in the 120-volt AC range!) It will tell you more than just if power is coming in. Power companies are famous for producing "dirty" power. It has periodic drops and surges. The problem is compounded during peak power times. In the middle of a hot summer afternoon, for example, the power company may be having a hard time keeping up with the demand placed on the lines by the thousands of air conditioners going. Line voltage is bound to drop.

The power supply of your computer will usually tolerate any voltage between 105 and 135 volts. Beyond that, many power supplies have a built-in safety circuit that will shut everything down. Because incoming power may at times vary above or below the limitations, a lamp may work just fine yet your computer will refuse to function. Using a meter to check the outlet voltage is more certain.

If you have a cooling fan installed, this can be an automatic clue if it is wired directly to the incoming 110V line. If the fan is running,

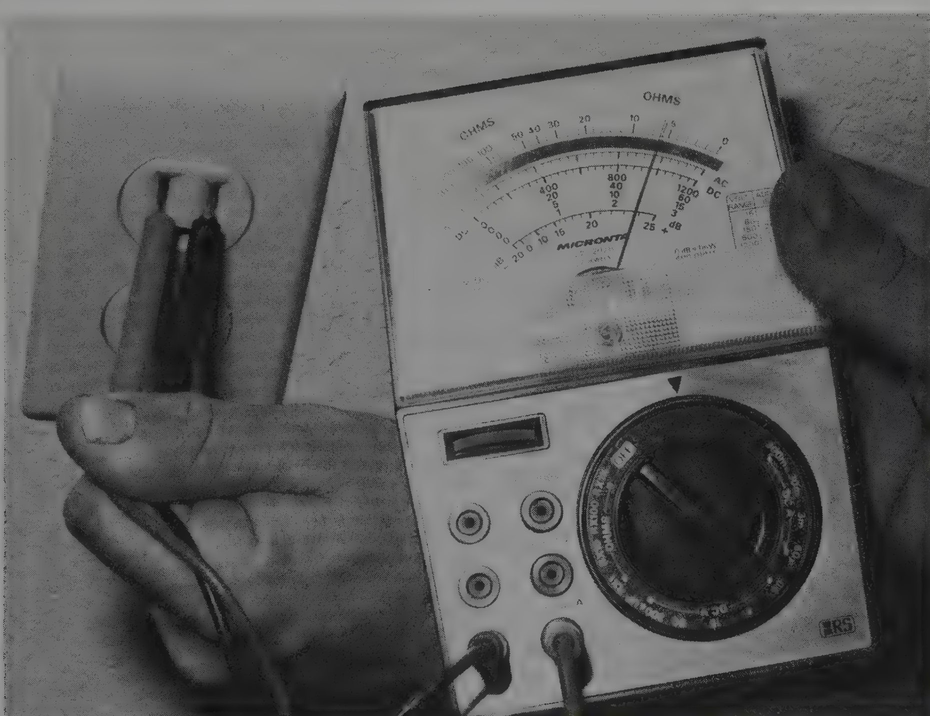


FIG. 2-4 Using a meter to check for power at the outlet.

the outlet and power cable are probably good. The problem then is probably in the power supply. The meter can help you determine this.

TESTING FOR POWER

If you turn on your computer and nothing happens, suspect the power supply. To isolate and test it, you'll need a VOM set to read 12 volts DC.

First, protect yourself. Most power supplies have between 2 and 4 outputs of +5, −5, +12, and −12, all of which are DC voltages and none of which are dangerous to you. (It's unlikely that your computer's power supply will have a 24-volt output, but if you notice that the meter needle swings violently off the scale, switch to a higher range and take another reading.)

A few power supply connectors have pins that carry 110V AC for such peripherals as the monitor. If there is no indication of AC present, don't assume it is not. Check all the pins for a possible dangerous current before proceeding (Figure 2-5).

Since the test for AC requires that the power be on and you are working around potentially lethal voltage, move slowly and carefully. Touch the probes ONLY by the insulated handles. Be sure that you are insulated.

Set your meter to read AC, preferably in the 220-volt or higher range. Attach one lead to a known ground, such as the metal chassis of the power supply or an obviously grounded bus bar. Use the other

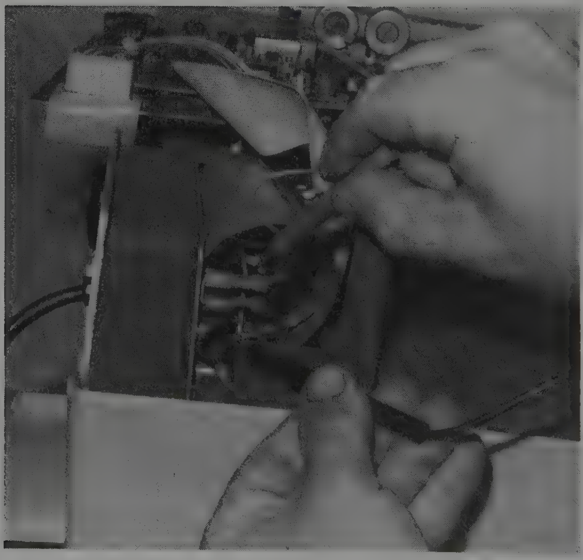


FIG. 2-5 Testing for AC power coming into the computer.

probe to test each pin in turn. Reverse the probes, and test each pin again.

After you have either identified the AC pins or have determined that there are none, you can then safely proceed to test the other outputs.

With the power off, find the ground wire, which is usually black. You may have to look inside the computer to find out which pin is grounded to the chassis. If you can't see the ground wire, set the meter to read resistance and (with the power off) touch the black probe of the VOM to a known chassis ground, such as the metal case of the power supply. Then test each pin on the power supply connector (Figure 2-6). When you get a reading of zero ohms, you'll have found the ground pin(s).

To test the power supply DC outputs, the power must be on, so be particularly careful. Set the meter to read in the 12-volts (or higher) DC range. With the black probe touching the ground pin, carefully touch the red probe to each of the other pins. Note the readings. You should be able to find the +5 and +12 pins easily. If the meter deflects downscale (off the scale on the wrong side of zero), you've located a negative pin. Reverse the probes to get the reading (either −5 or −12). All readings should be within about 10%. (For example, the +5-volt output is probably good if the reading you get is anywhere between about 4.5 and 5.5 volts.)

By making these readings when your computer is operating properly, you'll know what output values to expect. Sketch the power

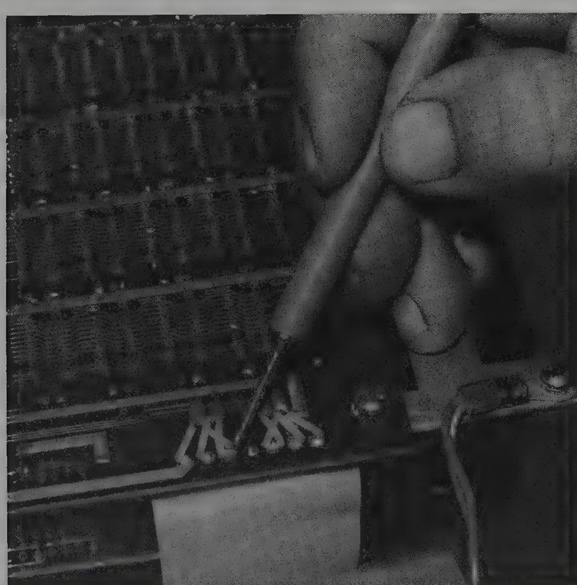


FIG. 2-6 Working up a power supply connector pinout.

supply connector and label it with your readings, being certain you know which pin is which. Most connectors are "keyed," which means that one side will be longer than the other; or there will be a clip on one side; or something else will make it impossible to plug in the connector backward. This same kind of marking should be done on all connectors that are not already keyed.

Now that you have a complete diagram of the power supply connector, you'll have a fair idea of its condition. If you can't find the +5 and +12 volt pins or if the readings are off by more than 10%, chances are the power supply is faulty.

The way to determine whether your problem is with the power supply or with the devices pulling current from it is to resort once again to the process of elimination. Shut off the power, disconnect all external devices, and try your computer again. If something outside the computer is causing a power drag, disconnecting those devices should allow the computer to boot. If power returns, reconnect each external device one at a time (with the power off each time) until the power fails again.

At this point, you'll know that either that particular device is at fault or the power supply isn't strong enough to drive everything you have attached. Disconnect everything and reconnect them again but in a different order—starting with the device that brought on the failure—and *always* with the power off each time! (If the device that caused the failure was the first one, try reconnecting something else first.)

Again, shut off the power. This time, open the cabinet. Carefully disconnect everything possible except the mainboard, if possible. If everything is still dead, the problem is either in the power supply (see Chapter 6) or in the system board (see Chapter 5). If you've tested the power supply outputs, you'll know where the problem is. If you haven't, go back a few paragraphs and run the tests; also see Table 2-1.

SUMMARY

Diagnosis is a matter of listing the possible causes and then eliminating those things (one at a time) that are not at fault until you find the one or two things that *are* causing problems. This is not nearly as difficult as it sounds. You have most of the tools you need already.

Most problems have nothing to do with the computer or its devices. By careful observation, you should be able to find out if the malfunction is within the computer or is a fault of the operator (most

TABLE 2-1. Troubleshooting Guide

Symptom	Possible Problem	Cure	Chapter
Power light does not come on	Light faulty	Replace bulb	6
	No power	Check obvious Check power supply	6
	Bad keyboard cable	Replace cable	6
	Bad keyboard	Replace keyboard	6
	Bad main board	Replace main board	5
Bell does not beep	Bad speaker Bad main board	Replace speaker Replace main board	5
Drive LED does not come on	LED bad	Check LED	4
	No power to drives	Check power	4, 6
	Disk drive bad	Check disk drive	4
	Drive controller card or chip bad	Replace card or chip	4
	Main board bad	Replace main board	5
Keyboard does not work	Keyboard not plugged in	Plug it in!	
	Keyboard faulty	Check keyboard	6
	Keyboard cable bad	Test cable	6
	Main board bad	Replace main board	5
Cannot load programs		Check for obvious	
	Bad diskette or tape	Try backup	
	Wrong DOS version or System program	Change DOS or System program	
	Incompatible program	Use another program	3
	Drive or cassette not working	Check with diags Check drive Replace drive	4
	Bad drive cable	Check drive cable	4
	Bad memory	Check memory (diags) Replace if necessary	5, 6
	Bad main board	Replace motherboard	5
Colors are wrong or poor display	Monitor or TV out of adjustment	Adjust monitor	6
	Bad main board	Replace main board	5
	RF modulator bad	Replace	6
No display	Monitor not turned on	Turn it on!	6
	No signal to monitor	Check cables	6
	No power to monitor	Check power	6
	Bad monitor	Check monitor	6
	Bad main board	Replace main board	5

common trouble) or within the software (second most common trouble).

The computer will normally tell you exactly what is wrong and where. The symptoms will indicate what is causing trouble. From there, it is a process of elimination until the exact cause has been found.

Anytime something seems to be malfunctioning, take notes. Make drawings if you do any disassembly. Both will guide you along and will provide valuable information if you have to consult a technician.

The following is a summary of diagnostic ground rules:

1. Check for operator error.
2. Check for software error.
3. Visually check for the obvious.
4. Pay attention to and use any built-in self tests.
5. Run the diagnostics program (if you have one).
6. Be sure to take notes throughout; make drawings when needed.
7. Repair or replace when you can.
8. Consult a technician when you can't repair, armed with all the above information to save time and money.

Chapter 3

Diskettes, Cassettes, and Software

If you were to tell a repair technician that your computer was malfunctioning (assuming that the problem wasn't obviously something like a power supply failure), he or she would immediately try to find out two things. First, what was the operator doing at the time? Second, is the software functioning? (For that matter, has it *ever* functioned?)

Operator error occurs for many reasons. Even the most experienced operator can make a mistake now and then. The more complex the program is, the more likely it is that the fault is with the operator. Before you write a nasty letter to the software or hardware manufacturer, eliminate all possibility of operator error. (Don't be too surprised if you find that the fault is yours even if you're *sure* that it is not.)

Ask yourself, "What have I done wrong?" Then ask, "Has it *ever* worked?" Don't answer either too quickly. After all, would you rather spend hours tearing apart a machine or a few seconds to be honest with yourself?

Go through the manual and other documentation again. These materials are notorious for being poorly written. (I know several people who have erased $500 programs due to confusing instructions in the "Installation" sections of the manuals.) Many manuals have an index, which can help you find the information you need on a particular subject quickly, even though the information may be scattered through the manual.

New programs are always suspect, both for software error and for operator error. If you've never tried to use the program before, you may not be putting in the proper commands. (Back to that lousy manual again.) Or you might be using a feature of the program for the first time. (Back to the manual.)

All clear? The fault is *definitely* not yours but with the program or the media? Fine. Now we can proceed.

DISKETTES

Although cassette decks are available for most computers, the usual method of data input and data storage with home computers is by using 5 1/4-inch diskettes. They are often called "floppies" because they are flexible. Sometimes they're simply called "media." If you think about what a diskette is and what it does, it might seem strange that they don't cause even more problems.

Information can really be packed onto the surface of the diskette. Each byte is made up of eight bits (or pulses), yet each byte takes up little more than a ten-thousandth of a square inch. (The space used to store a byte is about one hundredth of an inch wide and a few thousandths of an inch in length.) Just as your computer won't accept a command with a character missing, it probably won't accept a program with a scratch or blockage even if the damage is less than a thousandth of an inch in any direction if this is over a critical spot.

Diskettes are the least expensive part of your system. They are also one of the most critical. Try to save by buying cheap or poor-quality diskettes and you're taking the chance of losing in a larger sense. Although an unknown brand may be of equal quality to the name brands, you are generally better off dealing with a respected brand, at least for critical programs and data. Get the best possible.

HOW DISKETTES ARE MADE

The diskette begins as a thin sheet of flexible plastic. Mylar is the standard. (Mylar is a trademark of Dupont. The generic name for the material is polyethylene terephthalate.) The plastic comes to the disk manufacturer in rolls that are about a foot wide and often about a mile in length. The rolls are tested, inspected, and cleaned.

Next the plastic is given a magnetic coating on both sides (even if the diskette is later given the "single-sided" label). This coating is made up of extremely fine magnetic particles, a binder (like glue), and a lubricant. The microscopic particles have to be "glued" to make a perfectly uniform coating across the surface of the plastic. If they are not, there will be gaps and data will not be accurately recorded or read.

Once coated, the plastic is smoothed and placed back on the roll and then each roll is given a number for identification so the manufacturer can keep track of it. It is then stamped into the disk shape and is polished (burnished). The rougher the surface is, the more damage it will do to the diskette read/write heads. (The lubricant also reduces head wear.) It isn't possible to get rid of all wear, but efforts to reduce this are made by the better manufacturers.

The finished diskettes are placed inside the square outer covering (usually made of PVC plastic). Inside this jacket is a layer of thin and very soft material that helps to keep the surface of the diskette clean. Without this layer, the diskette would be constantly "attacking" the read/write head with particles of dust and other contaminants. The liner helps to protect the read/write heads by gently cleaning contaminants away. It also protects the diskette surface by preventing the soft diskette from rubbing against the harder plastic jacket. (See "Cleanliness" below.)

Throughout the manufacture of the diskette, tests are run. Its final label (single sided, double sided, single density, double density, quad density, etc.) is determined by these testings. A diskette that passes all the tests is given the highest rating and carries the highest cost to you. The more tests the diskette fails, the lower its rating and the lower its price.

What this means in simple terms is that the least expensive diskettes (single sided, single density) have the same basic surface and manufacture. They've just failed some highly sophisticated test along the way, and the manufacturer doesn't want to guarantee that the diskette will accurately hold data in higher densities. It's a fairly common practice for computer owners to try to save money by buying the less expensive single-sided diskettes and use them as double-sided ones.

ANATOMY OF A DISKETTE

The computer's formatting program divides the diskette (Figure 3-1) into the correct number of sectors and sets the size of those sectors. A diskette formatted by an IBM, for example, will simply not work in a Commodore 64 unless you reformat the diskette. But the formatting routines destroy all data stored on the diskette, so do not attempt to format a diskette that has data on it you wish to save.

There are two basic disk types. A hard sector diskette has a series of index holes to mark the sectors. These are preset by the manufacturer, and such diskettes are normally good only for certain machines. A soft sector diskette has a single index hole (to mark the first sector), after which all other sectors are marked magnetically.

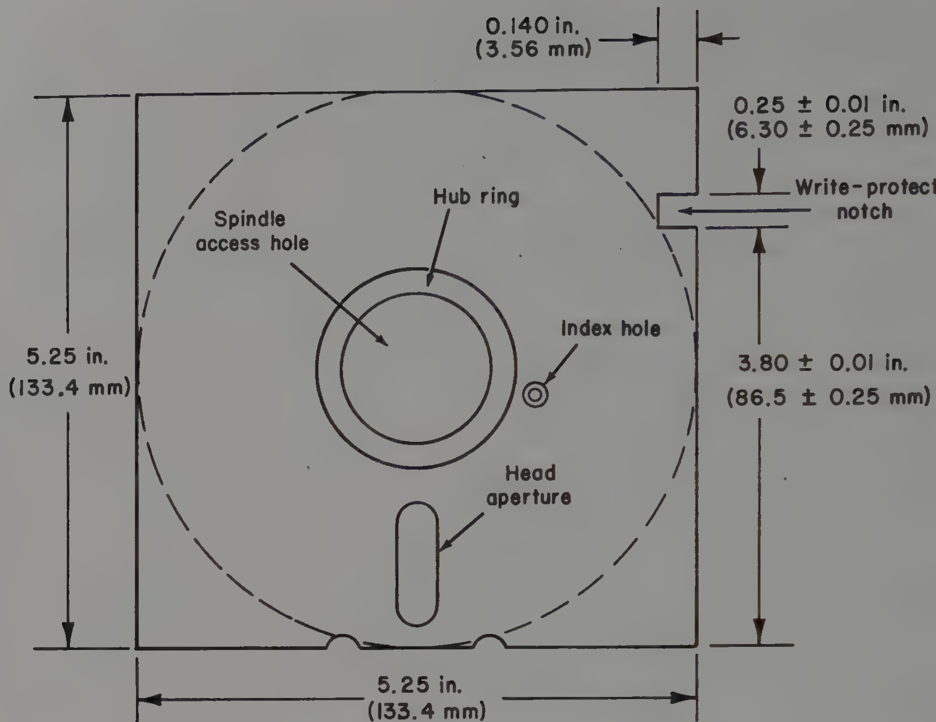


FIG. 3-1 Anatomy of a diskette.

For many home computers, there are 40 tracks (numbered 0 through 39). These are like the grooves of a record except that they are concentric circles and not in a spiral. When you hear your disk drive grind, it is because the read/write head is moving from track to track. (The sound you hear is the head stepper motor causing the read/write head to move. For more information on this, see Chapter 4.) Standard track width is about one hundredth of an inch, with normal density being capable of holding about 6,000 bits per linear inch.

Each of these tracks is divided into a number of sectors, with each sector capable of holding a certain number of bytes (a byte is a character or other piece of data that contains eight pulses). Each track, then, can hold the number of sectors multiplied by the number of bytes per sector of information.

For example, if your computer is set up so that it records 8 sectors per track and 483 bytes per sector, the total amount of information you can store on one side of the diskette is 40 tracks × 8 sectors × 483 bytes. That's a total of 154,560 (154K) bytes per side. Around 160K per side is about average.

Obviously, if you have double-sided drives, this storage is doubled, with the same specifications for each side of the diskette. In this case, the usual scheme is to store data in cylinders made up of two tracks. The read/write head moves to each cylinder and has two sides on which to write or from which to read. This greatly reduces wear and tear on the stepper motor and related mechanical parts of the drive.

In the center of the diskette is a round hole about an inch in diameter. This allows the spindle in the drive to make contact with the diskette and spin it. Most diskettes also have a band of extra material called a *hub ring* placed around the spindle access hole. This ring protects the diskette from damage by adding strength where it is needed most and allows a better contact between diskette and spindle.

The oblong cut from the diskette cover allows the read/write head of the drive to get at the information. This is the most sensitive part of the entire diskette. A fingerprint here can cause all sorts of troubles, both to the data (including format information) and to the read/write head in the drive.

When putting new labels on the diskettes, it is very important to keep the read/write access hole open and uncovered. If it is covered, two things will happen. First, the diskette won't work. The machine will give an I/O error. To the computer, there is nothing in the drive. Second and worse, the glue from the label may come off onto the recording surface of the diskette. If this happens, you may as well trash the diskette. You cannot clean a diskette nor should you try.

Along the side of most diskettes is a small notch. This allows a small switch inside the drive (see Chapter 4) to activate the recording head. When this notch is covered with tape, the recording head cannot function and you cannot write information onto the diskette. (You can read from the diskette, however. It's a good habit to cover this notch on any diskette that has data you won't be changing.) It is preferable to use only the pieces of tape that come with the diskettes to cover this hole.

FLIPPY FLOPPIES

You can get diskettes that have a write-protect notch on both sides of the diskette. Such diskettes will also have a second index hole. When these extra notches are present, the diskette is usually called a "flippy floppy," which means that you can use the diskette as though it was two single-sided floppies. To make use of the second side, all you have to do is to turn the diskette over. The second write-protect notch will allow the drive to look at the second side of the diskette as a new one.

A flippy floppy allows you to make use of all storage available on the diskette. You can have a program on each side complete with the batch program to have the program boot up by itself. The primary advantage is convenience. Normally, a flippy floppy costs about twice as much as a regular single-sided diskette.

A flippy has a disadvantage in that it tends to wear out sooner. As it is used on one side, it rotates in one direction. When you flip it over, it rotates in the opposite direction. This causes wear and also may increase tthe possibility of scratches on the surface from particles captured by the lining.

Some people physically cut a read/write notch into the diskette, thereby saving the added cost of buying a flippy. There are two problems with this. First, the manufacturer warrantees only what has been sold. That is, if the diskette was manufactured and sold as a single-sided diskette, the second side is not guaranteed to retain data. (In fact, cutting in the notch voids the warranty on both sides.)

Second and more important, the jacket of the diskette is usually made of PVC plastic. This stuff has the unfortunate tendency to shatter, when you try to cut it. If the notch isn't cut just right, tiny flakes of PVC will contaminate the diskette and possibly the disk drive.

HOW DELICATE IS A DISKETTE?

Despite its apparent fragility, the diskette is surprisingly tough. Many professional technicians relate stories of playing catch with an unjacketed diskette and then have it perform flawlessly. Diskettes that have been almost shredded by deep scratches zip through the drive as though brand new.

At the same time, a tiny piece of dust could cause a diskette to "crash" and become useless. You're never sure which will happen. Nor is lost data the only risk. Each speck of dust can be ruining the read/write head while it is slowly grinding the magnetic coating from the diskette surface.

The disk drive of most computers will read and write 48 tracks

Warning

If you try to make a single-sided diskette into a flippy floppy, you could damage your computer drives.

per inch (48 TPI), which means that the 40 tracks used for data plus the empty spaces between the tracks are squeezed into just 5/6ths of an inch (which includes the gaps between the tracks). On a normal single-density drive, the 193,200 bytes per side are packed into about six square inches of surface area.

Now you can see why the diskettes and drives are so sensitive. The read/write heads record or retrieve information from tracks that are about one hundredth of an inch wide and separated from each other by about one hundredth of an inch, all this while the diskette is spinning merrily at about 300 rpm. If the accuracy is off by just a slight amount or if something gets in the way, the data on the diskette may be inaccessible.

CASSETTES

Most of the information concerning diskettes also applies to cassette tapes (Figure 3-2). The plastic case of a cassette helps protect the tape inside much better than will the thin sheath of a diskette, but while the cassette case helps to keep dust out, once dust gets inside, it tends to stay there.

Unless the damage from temporary contraction and expansion due to temperature changes is severe, the diskette returns to normal once the temperature stabilizes. A cassette tape, however, is in a long string as opposed to a single, flat disk, so it has less tendency to change its shape or size appreciably because of differences in temperature. The plastic base of the tape stretches as it is used over a period of time, eventually stretching far enough so that information on it is unusable.

To increase the lifespan of the cassette, use a good cassette deck and keep it in top condition. Pay close attention to the tape quality. Some cheap tapes can harm both the deck and tapes. Never use extra-long play tapes as the too-thin tape has a greater tendency to stretch, break, or become raveled inside the deck.

If your cassette tape does get twisted in the works, be careful removing it as the oils from your fingers can ruin the data stored on the tape.

CARE OF THE MEDIA

You can't easily "repair" software. If your business program is malfunctioning, you probably won't be able to get inside to fix it. (Some programs can be fixed, such as those you've written yourself or those

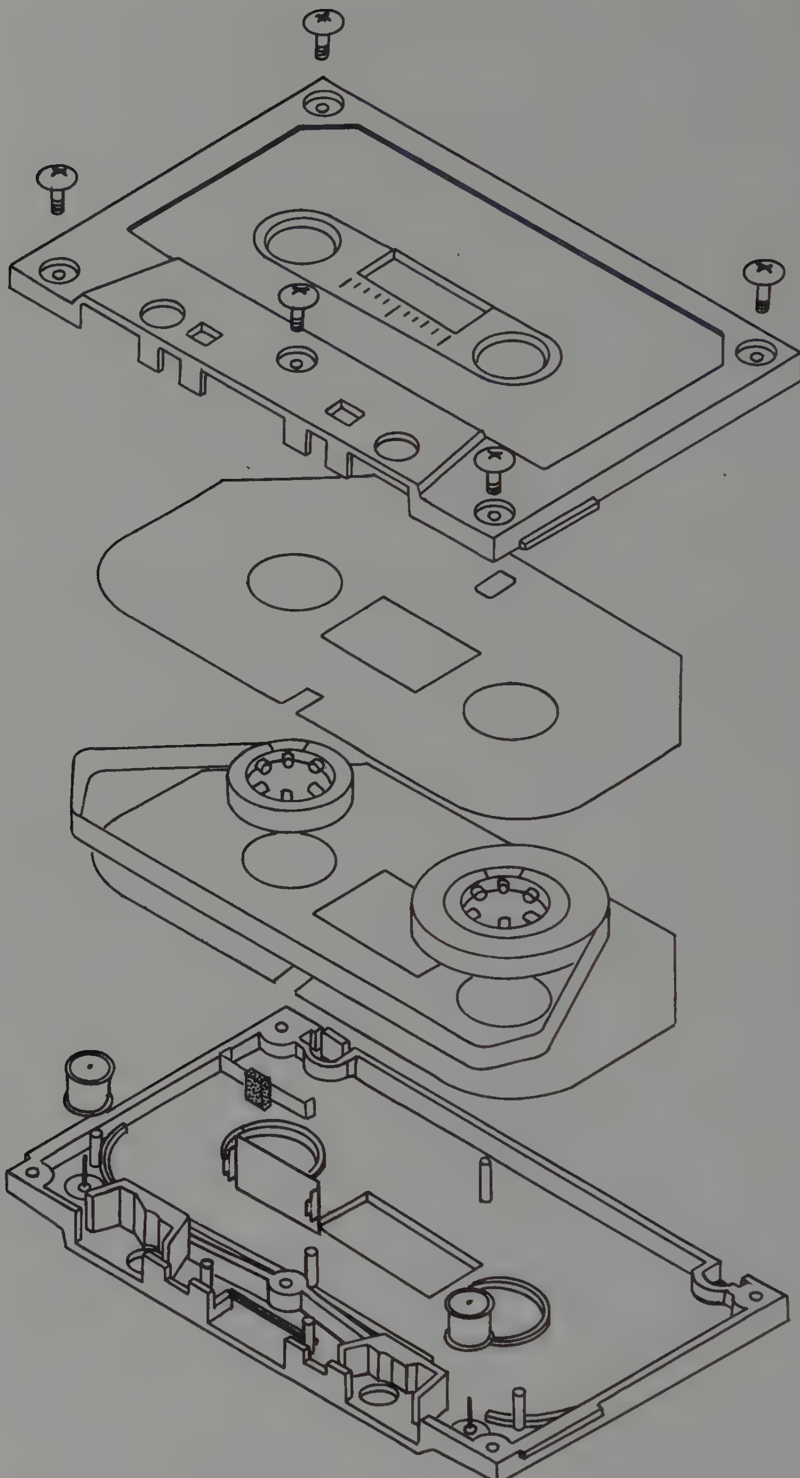


FIG. 3-2 Anatomy of a cassette.

written in a language you can access, such as BASIC.) Your goal is to prevent problems before they occur.

Software problems can be greatly reduced by simply taking care of the software. A disk or cassette might be tough but they're not indestructible. They're also unpredictable at times. One day, you can play catch with a diskette and have it work. The next day, a speck of dust or particle of cigarette smoke could fall onto the diskette and wipe out everything. (Not only can you lose software and stored data, you can cause damage to the disk drives by not properly caring for the media.) According to *Verbatim*, at least 80% of all diskette failure is attributable to fingerprints.

Care of the software is not complicated nor is it time consuming. The manufacturers have taken great pains to ensure that the diskettes or cassettes will last for a very long time with a minimum of problems. Extensive testing is done before the media is sold. Care is also taken to make the diskettes as tough as possible. It's not uncommon to find a manufacturer who guarantees that the diskette will not fail even after several million passes per track. In time, this translates to nearly a year of constant running before the life expectancy is reached for a diskette. Since normal operation calls for the diskette to be running just seconds out of every operating hour, the disk should, and could, last a lifetime (Table 3-1).

The lifespan of a diskette or cassette also varies on how it is used. Although the manufacturer might guarantee the diskette for three million passes per track, each time you use the diskette it goes to the "directory" track. Some applications refer to this track over and over again. Thus, the life of a diskette depends largely on how many times

TABLE 3–1.
Diskette Specification Standards

Tracks per inch	48 TPI
Tracks (number)	40 per side
Track width	.0108—.0128
Track density	6,000 bits per inch
Temperature (operation)	50 to 112 F 10 to 44 C
Temperature (storage)	−40 to 140 F −40 to 60 C
Humidity	
(operation)	20% to 80%
(storage)	5% to 95%
Disk speed (standard)	300 rpm

the one track can be used. As soon as this track wears out, the rest of the diskette is essentially dead.

A diskette and most cassettes can withstand any temperature between 50 and 120 degrees Farenheit (10 to 50 degrees Centigrade) and still operate without error. Even if the temperature happens to go beyond this range, the diskette is still likely to recover if you give it enough time to cool down or warm up. (See "Heat and Cold" on p. 57.)

Humidity does little actual damage. The official range for a diskette is between 20% and 80% (5% to 95% for storage). Drier environments tend to dry out the diskette (although it *does* take quite a while). Worse, static can build up, causing changes in data. More humid areas may cause dust to stick to the diskette. Humidity can also cause the liner to swell. If this happens, the diskette may not spin properly and you'll get an error display.

PHYSICAL DAMAGE

The soft liner inside the jacket doesn't just keep the diskette clean. It also serves as a cushion for the diskette to prevent damage. It does a fine job for most normal things, but it can't protect the disk against everything. This is up to you.

Anything that puts pressure against the diskette can cause a dent in the jacket, in the liner, or in both. At best, the diskette will have a hard time spinning in the drive. If this is all that happens, you may have enough time to make a copy of the ruined floppy.

This is why a felt tip pen is suggested for writing on the labels. Better yet, write on the label before sticking it onto the diskette. The tip of a ballpoint pen or pencil could easily damage the diskette. Even a soft felt tip can press a groove into the diskette. The pressure you use in writing may not seem like much, but remember that all that pressure is concentrated at the tip of the pen or pencil. You are pressing down with only a few ounces of force, but this is being applied against the diskette over a surface area of only the few thousandths of an inch of the pen tip. The force is effectively multiplied because of this.

Weight of any kind pressing against the floppy can cause damage. Diskettes are best stored vertically (standing up). This not only protects the diskettes, it reduces the risk that you might forget and drop a stack of books on top of a diskette.

The problem of weight is compounded if dust or other particles are trapped in the liner. Imagine having the pressure of five pounds of books concentrated onto the sharp edges of a millionth of an inch. Dust may *seem* to be soft. To get an understanding of what it can do, however, just take a look at the metal and glass of a car left in a dust storm.

Pretend that the soft liner of the diskette is made from coarse sandpaper. You *know* you wouldn't risk the information stored on such a diskette by placing even lightweight objects on it.

The hard plastic case protects the cassette tape inside quite well as long as it is not left sitting on a heater or on the dashboard under a blazing sun.

The tape of a cassette, more fragile than the magnetic diskette, is easy to snap with just your fingers. It takes even less force to stretch and distort it.

CLEANLINESS

When not in use, store all software in their cover jackets, preferably standing vertically inside a box as well. Cassettes should be placed inside their protective boxes. This is to reduce the amount of dust and other particles. The soft inner lining will help to protect the read/write heads but tends to capture those particles that in turn can cause scratches on the diskette. The tape cartridge helps keep dust out but, at the same time, tends to trap it inside as well. With the data being so tightly packed, even a small scratch can have devastating effects. That scratch may occur on an unimportant part of the tape or diskette. It might also happen over a critical bit of data and make the rest of the diskette useless.

A quality diskette storage box (Figure 3-3) might cost $30 or more. (Those made for cassettes are generally less expensive.) This sounds expensive until you think of what you're protecting. Many computer owners have hundreds of dollars invested in software and perhaps thousands of hours spent in punching in data. It's not unusual for a computer owner to have more invested in software than in the computer system itself. Why take the chance of throwing all that down the drain just to save a few dollars?

If you can't afford to buy a storage box, make one. Such a box should not be made of metal (because of magnetism). Use wood or plastic or even cardboard. The inside should be clean and unpainted (fumes). The top should close tightly enough to seal out dust. Beyond that, it can be as fancy or as simple as you wish. (I know people who use modified shoe boxes with great success.)

Homemade storage boxes are not good solutions, however. Wood

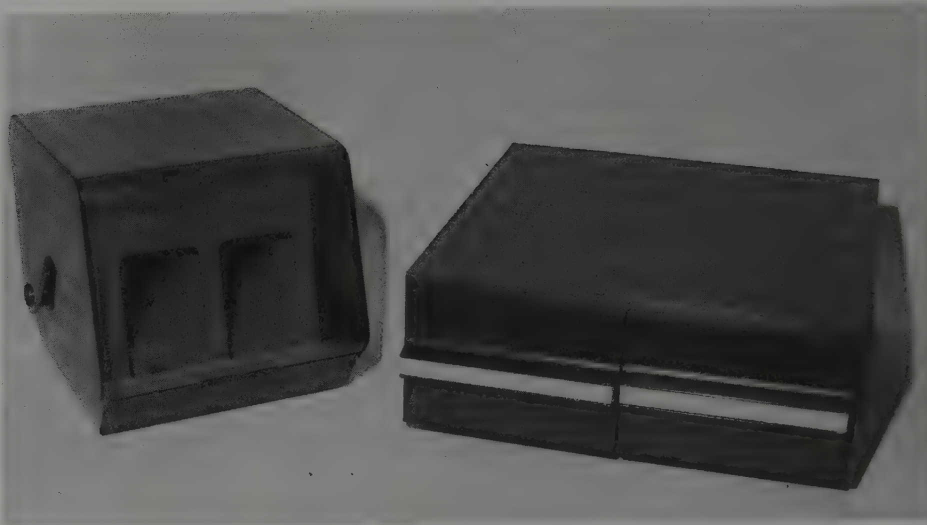


FIG. 3-3 Diskette and cassette storage boxes.

and paper both have large amounts of dust and other small particles, no matter how well you clean them. These particles can ruin the diskettes and possibly the drive. Plastic is a much better solution but is more difficult to work with. By the time you've bought the plastic and built the case, you probably would have saved by just buying a disk storage box.

However you do it, keep dust and other particles and contaminants to a minimum. You've invested too much time and money to waste it on a dirty environment.

If a diskette or tape gets dirty, do not attempt to clean it. Your cleaning is virtually guaranteed to cause more damage than any amount of dust. How dirty the media is and what kind of contamination it has will determine what you do with it. If it isn't too bad, store it for severe emergencies. Otherwise, toss it out. A dirty diskette or cassette means that it's time to pull out one of the backups. (Make another backup before going to work.)

MAGNETISM

The data on the tape is stored magnetically. It should be obvious that you have to keep the software away from other sources of magnetism. Yet computer operators are constantly erasing their valuable programs and data by not observing this precaution. Some cases are as blatant as setting the diskette next to the magnet of a speaker. Most involve less obvious sources of magnetism.

Inside the telephone is a small electromagnet. Normally, it just sits there and does nothing. Whenever someone calls, that little device (It rings the bell in the telephone.) lets fly with enough magnetism to destroy a diskette.

Other potentially dangerous sources are the monitor, the printer, the modem, the cabinet of the computer, any tape recording machine, fluorescent lights, and even a calculator. Motors work by using magnetic fields. It you're not sure, don't trust it. (Anything metal is automatically suspect.)

It's unlikely that these subtle sources of magnetism will ruin a program, but why take the chance? It's easier to pay attention to the surroundings and keep the diskettes away from any possible danger.

HEAT AND COLD

More important than solar radiation is the heat generated by the sun. Since the diskette is usually black, it tends to gather more than its share of the heat. Leaving it in the open sunlight is very likely to cause damage. Even if it's close to an incandescent lamp, it could pick up enough heat to cause harm.

Keep the software away from all sources of heat. At best, heat will warp the cartridge or the jacket of the diskette. If this happens, the data you've recorded won't be in the same place on the diskette. It won't matter, though. If the diskette or jacket become warped, the diskette probably won't spin in the drive anyway.

If just the cartridge warps, you might be able to save the recorded data by transferring the tape inside the warped cartridge into one that hasn't been damaged. This is a difficult and risky job, though. If you touch the tape with your fingers, you could damage both the tape and the tape deck. A far better solution is to get out the backup copy and trash the damaged copy.

The same things can happen with cold. Not only can extreme cold cause a diskette or cassette to crack, it can cause the recorded data to shift in position. A sudden change in temperature from cold to hot can cause other problems as well.

Even a slight change in temperature and the contraction or expansion this creates can cause the tracks to move away from where they are supposed to be. Keep in mind that the tracks on a diskette are just barely over a hundredth of an inch wide and that each byte of data covers a mere ten-thousandth of a square inch.

BACKUP COPIES

Always make backup copies of important programs (if copyable) and data. The cost of diskettes or tapes is low considering their value to you. Making backups is the least expensive method there is to protect yourself against software failure. Make at least two backup copies of all software and data diskettes that are important to you. The more important the original is, the more backups you'll want to make. If the data on those backups is no longer important, you can always reformat the diskettes and use them again if you decide later that you don't need that backup copy. In the meantime, you'll be protected.

The manufacturer provides a guarantee that the diskette will function without error for a certain period of time or for a certain number of passes. Many cassettes carry similar guarantees. These *do not* guarantee the recorded data, however. If a diskette goes bad, the manufacturer will replace it with a new diskette of the same kind, but the data is lost forever, as is the time you spent in punching it in.

PROGRAM PROBLEMS

If you're writing your own programs, you're almost bound to make some mistakes. The computer will generally tell you that you have made a mistake and will even show you the lines where the mistakes were made.

If your program doesn't work, accuse yourself before you accuse the computer. Refer to the operating system, BASIC, or other program language manuals to make sure that the commands you've punched in are correct. If you like programming, take some courses in the subject. Get some books. Learn the most efficient (and the correct) ways to do things.

When it comes to purchased software, you have much less control over what has been done. Many programs are inaccessible for corrections. Unfortunately, so are all too many software companies. It isn't uncommon for a company to have a disclaimer in the package that says, in effect, "If the program doesn't function as promised, tough! You bought it, now it's your problem." Other companies support their products but at an additional cost. (The old, "If you can't understand our poorly written manual, pay us an extra $100 and we'll explain it to you" attitude.)

At other times, you might be pleasantly surprised at the response. There are companies that do everything possible to make sure that the end user is happy and satisfied with the program.

When contacting a company about a software malfunction, be fair to them. Begin by doing everything you can to make sure that the error isn't your own. Read the manual carefully and thoroughly. If the problem still hasn't been solved, be as specific as possible in your communication with the company. Provide as many details as possible, including what you've done to correct the problem and even the version of that piece of software. They can't give you much of a response to "It doesn't work. Why?"

Notes of what you've done will be of help to both you and to the company representative. The more information you provide, the quicker will come the solution to the problem. Even jot down the page numbers in the instruction manual so you can readily refer to the proper sections for that particular function.

One of the advantages of working with a local dealer is that you have a quicker access to information. Even if you haven't purchased a training course on a particular piece of software, the sales staff will probably be happy to answer questions for you. Most will replace defective software without any hassle. (Bring your sales receipt! You can't expect them to guarantee a program you bought from someone else.)

FAILURE TO BOOT

There are a number of reasons a program will fail to load. The most common reason is a bad tape or diskette. It may also be the fault of the drive, the power supply, the memory, or even the keyboard. Usually, it is quite easy to find out what is causing the problem. Do one thing at a time in a process of elimination until you've located the trouble. Don't forget that the whole problem might be a board or program incompatibility malfunction.

Eliminate all the obvious things first. Is there any power at all? (If the plug is in the wall, the outlet has been checked, and there is still no power, go to "The Power Supply" in Chapter 6.)

Are you using a new program? Has it ever worked? Perhaps the software you are using is very old and has simply worn out. Try another program, one that you know is good. If this one loads, you'll know that the fault lies with the software. (Use a program that is not critical. Although it is rare, it is possible for the drive to malfunction and write over the top of the program even if it is write protected.)

Before tearing anything apart, look for the obvious. Is the door to the drive intact? (If it isn't, the drive will spin without any apparent effect and "I can't read your diskette" will be displayed on the screen.) Are the cables firmly attached to the drives?

A test of the drive or tape deck involves switching the unit. If you have dual drives, you may be able to simply change the default, causing drive B to become the primary drive and drive A the secondary. If you can't do this, you can manually change the settings on the drives. If your system has only one drive or cassette player, the only way you can make a swap is to replace the suspected unit with one you know is good.

A disk drive swap in a computer with more than one drive often involves changing the way the drives are set up. This involves moving a terminating resistor package from one drive to the other and moving some jumpers (see Chapter 4). After you've made the changes, what used to be drive B will operate as drive A and vice versa.

You'll know quickly if the malfunction is in the unit or elsewhere. If drive A was refusing to load and still refuses to load when configured as drive B, chances are good that the drive is at fault. If the drive swap doesn't change things, the problem is elsewhere (see Chapter 4.)

OTHER PROBLEMS

There will be times when a program loads and operates normally only to malfunction while the program is running. Data may suddenly come out changed or missing. The program could lock up the keyboard, causing the loss of the data you've been punching in.

If the problem is in the software (in the program itself), you should be able to reproduce the malfunction by pressing the same keys again. You may have already noticed where the failure occurs. (Don't forget to check the manual and eliminate the possibility of operator error!) Notes will come in very handy in tracking down the problem.

Changed or garbled data are often the result of overediting. The computer will automatically assign a chunk of data to a spot on the diskette. If possible, it will record these chunks in sequence. If something else has been placed in the next open spot on the diskette, the data will be moved along until a spot is found. This tends to break the file up all over the diskette. In reading such a broken file, the computer might miss something.

The solution for this is to copy files occasionally. This will help to rearrange the file in sequential order. Some computers offer two ways to make copies. One makes an exact copy of the original, complete with disjointed sections. The other copies sequentially, with each file copied completely and in order.

It is best to use a freshly formatted diskette for the copy since a diskette with data on it could break up the files even more (to make it fit between the existing files).

One track on the diskette is set aside for file allocation. Each time you bring up the directory of the diskette, the computer goes to this track and displays the files. Each time you tell the computer to load in a program or data file, it again goes to the allocation table to find out where the needed file is.

Earlier in this chapter, we talked about how many passes a diskette can withstand before malfunction (three million passes per track). This seems as though the diskette could indeed last forever. It *will* last for many years. The main reason it wears out is the number of passes against the allocation track. Each time the file is read, recorded, or used in any way, the drive head goes back to the allocation track. After a few years of this, the track might fail. Despite the fact that the information is still good on the rest of the diskette, it is difficult to get at it because the allocation track no longer tells the computer where to look.

The allocation track can become faulty for other reasons. Some programs do not "exit gracefully." If the program is in use and you lose power, either purposely by shutting down or accidentally in a power outage, the allocation table can become messed up. The end result is about the same as if the track had worn out.

The solution for both is prevention. Make backup copies of everything important. The more you use a particular piece of software, the more important backups are. If a diskette or tape has been in use for a long time, make a copy and replace it *before* it gives out.

SUMMARY

Most computer malfunctions are caused by either the operator or by the software. Eliminating operator error is a matter of proper training and of paying attention. Read the instructions. Learn how to work with the program and how to handle its functions—and its quirks.

Since you are unlikely to be the author of your functional programs, you cannot eliminate software problems. If the package comes to you with flaws in it, there won't be much that you can do other than to return the package for a refund. As soon as possible after getting a new program, test it out. The longer you wait to do this, the more difficult it will be to get a refund or an exchange.

Make backups of all important software and recorded data. Two backup copies of each is none too few. It's an inexpensive insurance against loss through operator goof-up, media flaw, or drive malfunction.

Taking care of the software is simple, since there is nothing to do other than storing and handling them properly. Provide a clean environment. Keep the software and stored data away from things that could damage them, such as magnetism, heat, contaminants, and physical dangers. Handle them properly and they can last a lifetime. When they finally wear out, you always have the backup copies to turn to.

Chapter 4
The Disk and Cassette Drives

The circuits of a computer allow electrons to move through the proper components at the proper times. The only motion is that of the electrons, and virtually the only wear is that caused by heating and cooling. Something mechanical is bound to have more troubles than something that doesn't move physically at all.

The only mechanical parts in most computers are the cooling fans, the printer, and the disk or cassette drives. (The keyboard is sometimes considered to be mechanical in that it requires a physical movement of the keys to operate.) Of all failures in your computer system, most will involve either the printer or the drives. (Printers are covered in Chapter 6.)

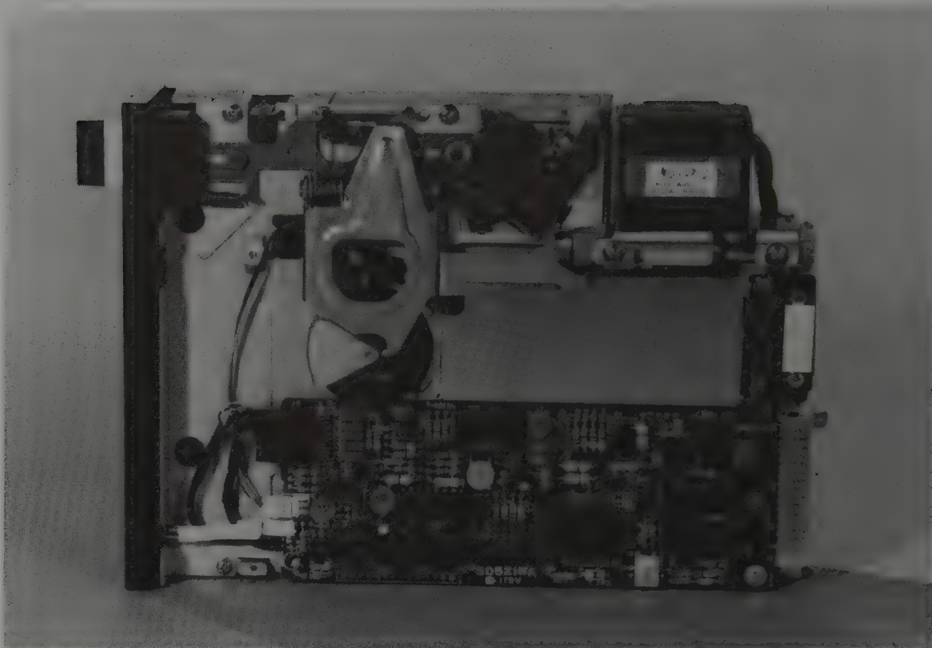
The disk or cassette drives are critical parts of the computer system. There isn't much that your computer can do without them.

The key to trouble-free operation is prevention. Turn to Chapter 7 and follow the maintenance information, and you'll have far fewer problems. When something *does* go wrong, this chapter can help you find the problem. If you can't fix the existing drive, turn to Chapter 8 for information on how to replace a disk drive.

DISK DRIVES

There are almost as many makes of disk drives as there are computers. Quite a few computers can make use of only one or very specific makes and models. For others, there is a wide selection of units.

Your own circumstance will depend on which model you have and when it was built. Some manufacturers make both single-sided and double-sided drives (Figure 4-1). If you have to replace your



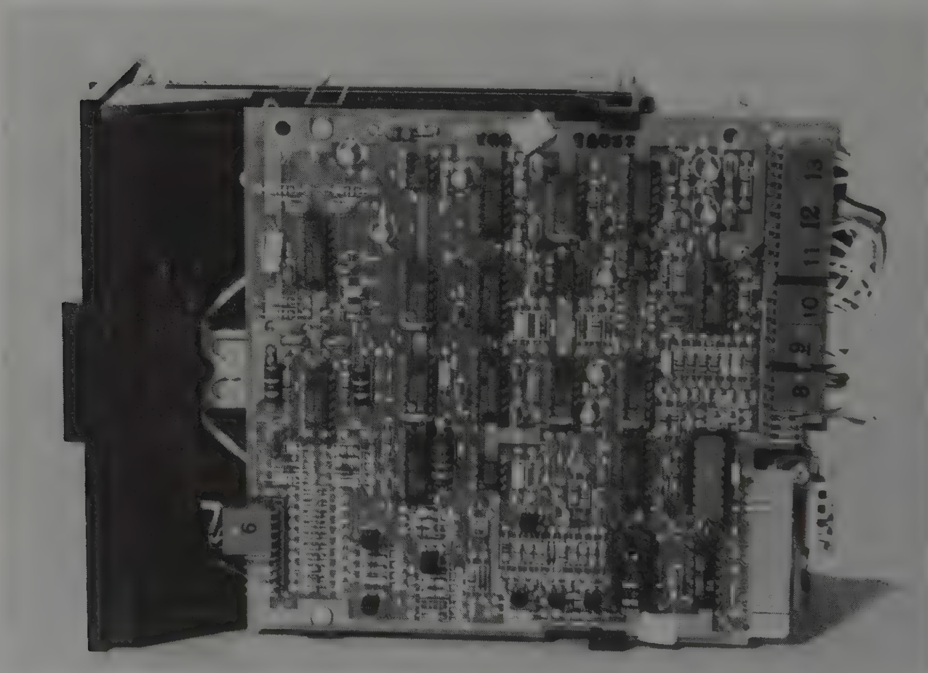


FIG. 4-1 Inside some typical disk drives.

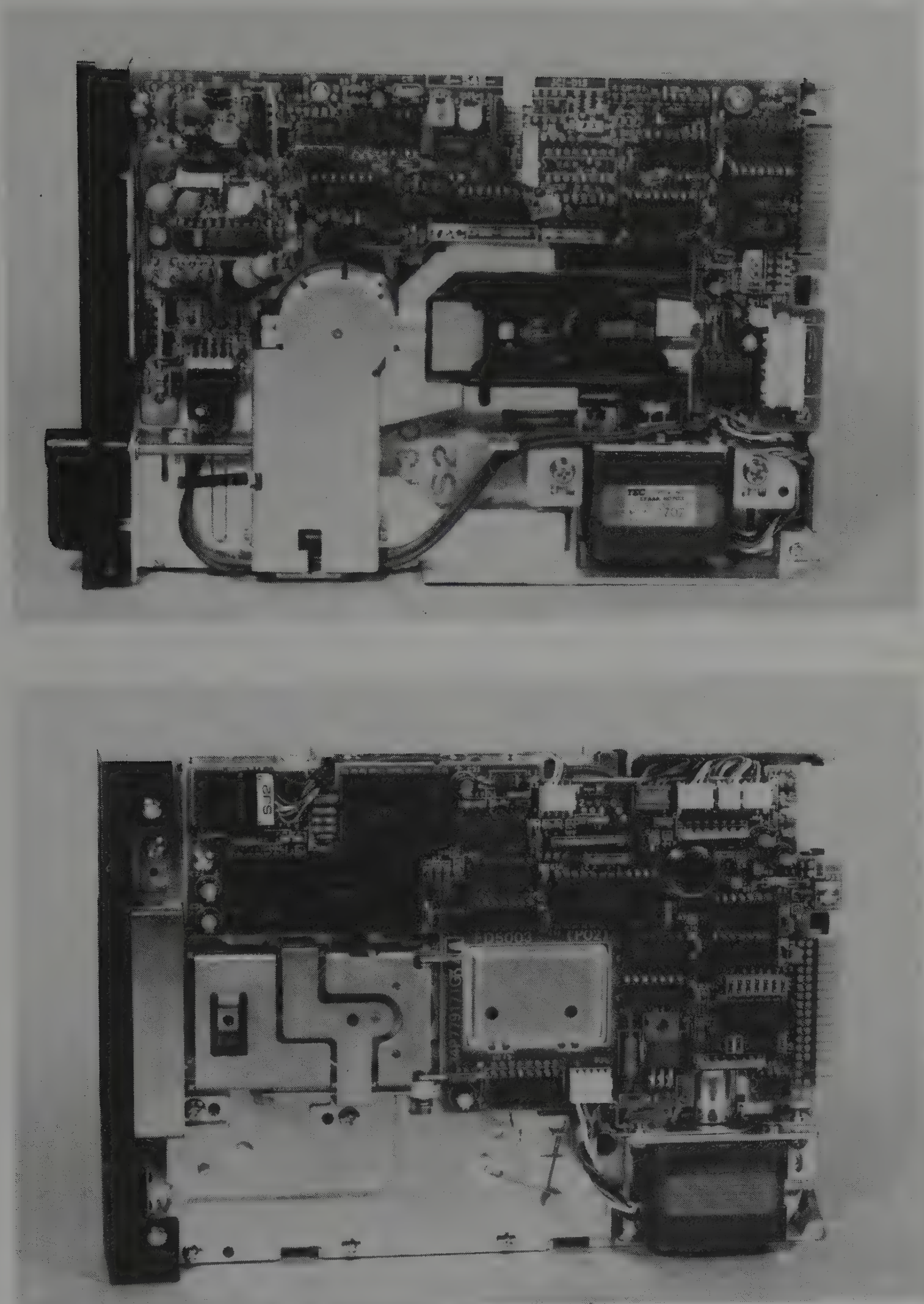


FIG.4-1 Continued

drive(s), the best thing to do is to explain to the dealer which system you have, and which drives, and ask for his or her recommendation.

The dealer may not have in stock the same drive you are replacing. If one of your two Shugart drives malfunctions and the dealer has only Epsons or Qumes in stock, there is no problem other than appearance of the front panel. You can replace both drives, but this will only keep the appearance the same. Putting up with a slight difference in the appearance can save you the cost of another drive.

If you decide to spend the extra for the sake of appearance, it's a good idea to keep the good drive on hand for emergencies and for testing (such as swapping a known good drive for a suspected bad one).

Most drives have the same basic construction. On the top of the drive is the analog card. This is the main circuitry of the drive. Half-height drives often have the top board linked with a second board on the bottom. Usually, this second board contains the servo circuits. (The servo circuits on many full-height drives, such as the Tandon, are on a separate board attached to the back of the drive.) This circuitry works together with the main analog board to control the mechanical parts of the drive, such as drive speed, head movement, and so forth.

On some drives, you can perform certain tests to determine if these boards are causing a malfunction; on others, you cannot. Most of the time, it doesn't matter since repair is by replacement of the entire drive. Internally mounted half-height drives, in particular, are not meant to be repaired. In most cases, all you can do is to save money by performing the actual replacement yourself.

It's frustrating to have to replace an entire disk drive simply because one spring on the closing mechanism breaks or one tiny slide warps, but with all too many drives, the parts are not replaceable. In these cases, all you can do is to track the problem definitely to that drive and know that the problem isn't elsewhere in the system.

It's a good idea to check around in your area to see if individual parts are available before you spend a lot of time diagnosing. A look at your drives should give you a fair idea if you want to continue diagnosis or if you will be satisfied with simply identifying a faulty drive.

CHECK THE OBVIOUS

Serious malfunctions in the drive are relatively rare. Most problems are brought on by small things and often by things that have nothing to do with drive operation directly. Don't yank out the drives and tear them apart until you've eliminated all the easy things.

Always start with yourself. Are you doing something silly (but common), such as putting in the wrong diskette or the right diskette but upside-down? Does the diskette you're trying to use have the correct DOS (operating system) on it?

Next, try different software. The diskette you are attempting to load could be faulty. This is more likely the problem than a faulty drive. (See Chapter 3 for more information on software and software problems.) You may also be trying to use one of the few programs that is meant for a specific model but not for the model you own. This slight incompatibility can make it seem that something is wrong when in fact you are merely using the wrong software. Try a different program, one that you know has worked before.

If you haven't cleaned the heads in some time, there could be deposits that are preventing the heads from operating. False or intermittent data read/write could mean that a dirty head is causing a problem. (See Chapter 7 for more information on cleaning the drive heads.)

Have you made any changes in your system? If so, you may have changed the way the computer "looks" at the world around it, including the drives. If everything was working perfectly before the change, you've probably done something wrong in making the change.

If cabling was necessary in making the addition, have you used the correct kind of cable with the correct pin allocations? Chapter 8 gives you a listing of the standard I/O (input/output) parts of your computer. These, plus the information provided in the instruction manual that came with the peripheral, will help you to match everything correctly. It may seem strange to have the drives appear to be malfunctioning due to a printer connection, but it *can* happen.

It's also important that the cables are plugged in correctly. The connectors are usually keyed, which makes it virtually impossible to make a mistake. Still, it is important to look at the way the cable is plugged in. Make a sketch of the proper alignment of the cable and connector if you're in doubt. If the cable doesn't plug in easily, don't force it.

Are the cables and connectors secure (Figure 4-2)? Try unplugging them and pushing them back into place (with the power off!). If the contacts appear to be a little dirty, clean them (Figure 4-3). For flat connectors, such as those for the drive signal cable (Figure 4-4), you can use a cleaner (see Table I-1, "Required and Optional Tools," in

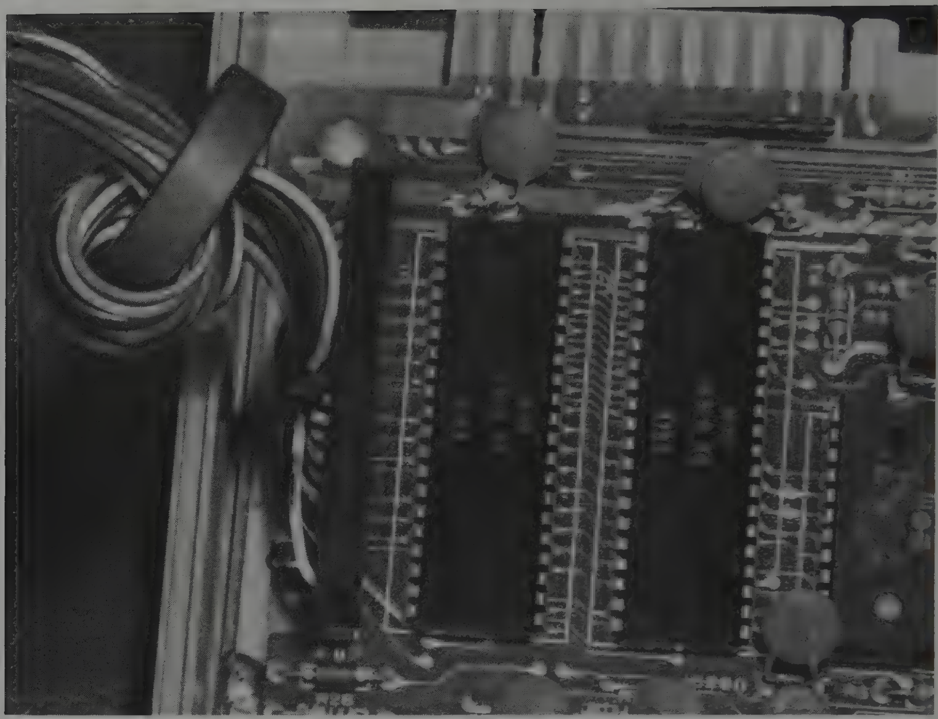


FIG. 4-2 Check the connectors, both as they fit on the board and for good contact in the wiring at the connector.

FIG. 4-3 Clean the connectors, especially if they appear to be dirty.

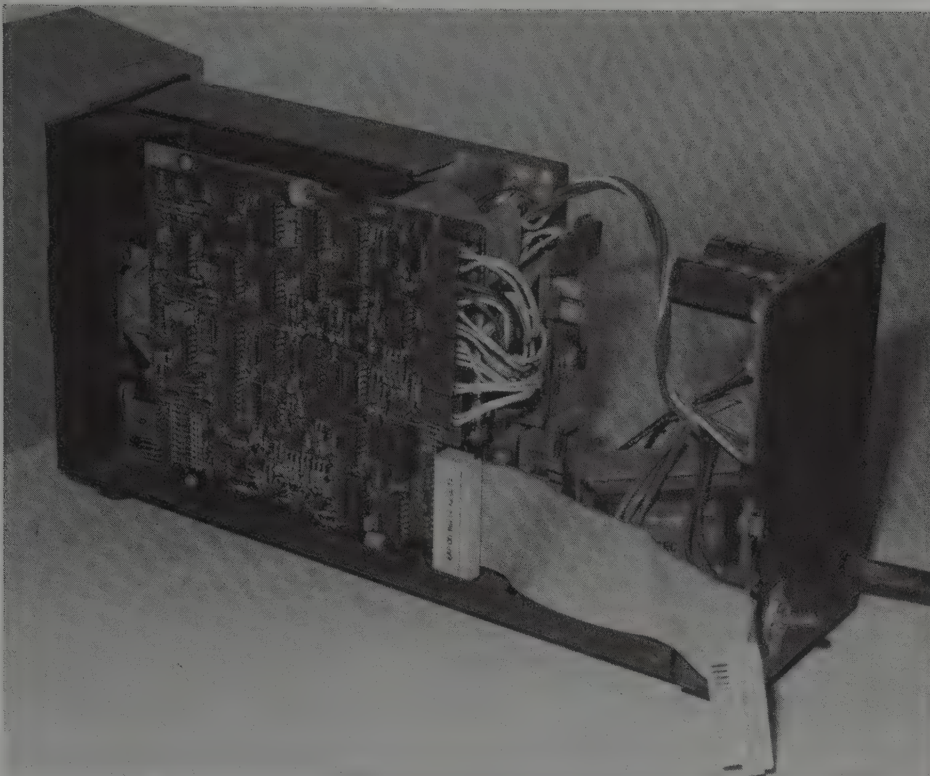


FIG. 4-4 Inside a self-contained disk drive.

the Introduction) that doesn't leave a residue or use the eraser of a pencil (taking care to keep the eraser shreds out of the computer). Cleaning pin-type contacts (Figure 4-5) requires a little more care, but if you use a quality cleaning fluid only, you'll have no problems. Be sure to shut down the power before removing or inserting any cables or circuit boards. Failure to do so will almost certainly damage the board and the computer.

OBSERVE SYMPTOMS

Before you go into the actual diagnostics to find out what has gone wrong with a drive, you can try several easy things.

The first step is *always* to observe the symptoms and then to eliminate those things that are *not* causing the problem. Make a note of all errors.

Are programs able to load at all, even in part? Listen to the sound of the stepper motor. Is it trying to move across the tracks or is it "stuck" somewhere? Does this happen with all programs you try to load or just with one?

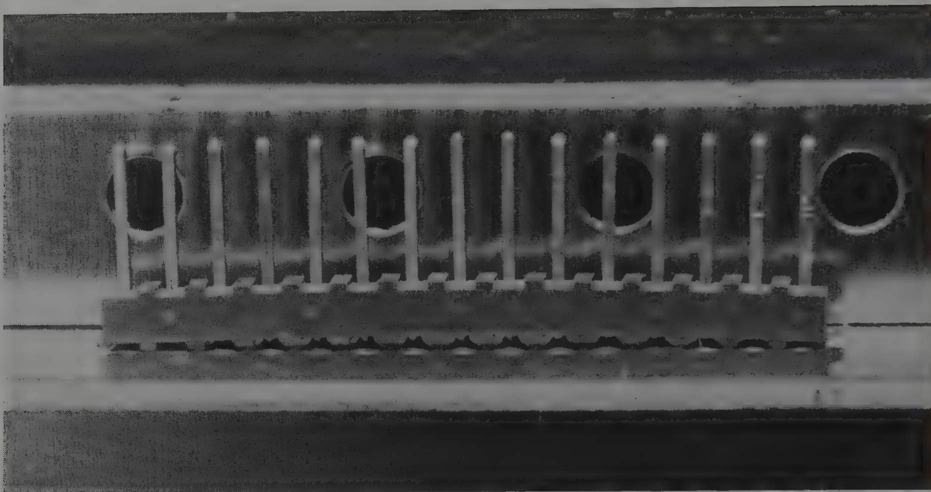


FIG. 4-5 Be very careful when cleaning pin-type contacts.

Are other functions working? If you can't write to a diskette or copy a file, can you format a diskette?

If drive A refuses to load a program, change the default and try to load the program with drive B. If you can't do this, you may have to open the cabinet and reconfigure the drives so that drive A operates as drive B and vice versa. (See "Drive Swap" below.)

Try to boot the main operating system diskette by itself. You're now loading only the system and not a full program. (See Chapter 3, "Failure to Boot.")

Check all cable and board connections, and clean them if they appear to be dirty. When was the last time you cleaned the heads?

Try to eliminate all the obvious things before you spend a lot of time and effort. Chances are good that you'll find that the problem isn't really a problem at all.

THE CLAMPING MECHANISM

As you insert the diskette (Figure 4-6) and close the door (or turn the latch), the diskette clamping mechanism goes down and the diskette is placed in the correct position for the spindle to make a positive contact and for the read/write heads to be positioned. If the closing mechanism doesn't come down and lock into place properly, the computer is likely to see the drive as having an open door. The diskette can't spin; the program can't load. The usual result of a broken door or latch in the drive is that the computer will wait for you to close the door, which you won't be able to do since it is broken. The problem

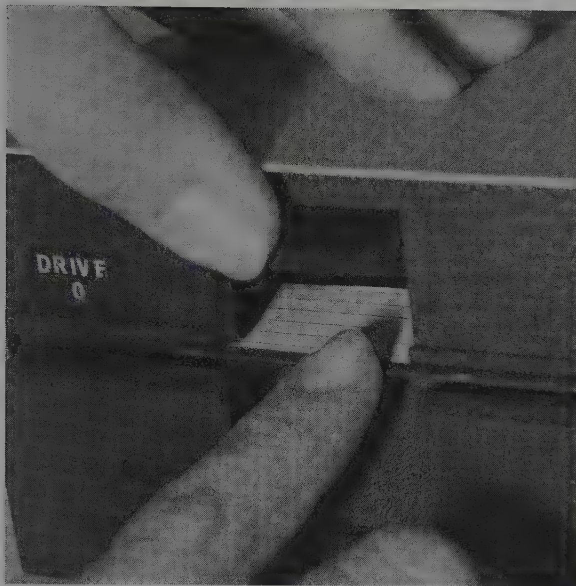


FIG. 4-6 Carefully insert a diskette to check clamping.

could also be intermittent, with data being read or recorded with errors.

The clamping mechanism is made of plastic and thin metal. Some, unfortunately, tend to break. Even if the break hasn't completely separated the door from the drive, it could still prevent the drive from functioning properly. The hub may not make a secure contact with the diskette, or the drive may simply think that the door hasn't been closed.

To adjust or replace the drive door (Figures 4-7, 4-8), such as in the Tandon, you'll have to remove the drive from the computer cabinet. Loosen the holding screws and then move the door with your fingers until the door is flush with the front facing of the drive. Changing a broken door requires little further effort. With the screws removed, the door will lift out easily, and the new door goes in just as easily. Attach the door with the screws, adjust, and then tighten those screws.

Adjusting or repairing a drive with a push-button or twist-type latch is more difficult. Quite a few drives have latches that cannot be adjusted or repaired. In most cases, the only thing you can safely do (and that only if you're *very* careful) is to lubricate the mechanical parts of the closing mechanism (Figure 4-9). Even then, it is a last resort before you throw the drive away. There are some dangers involved.

The danger is that oils don't get along at all well with the floppies

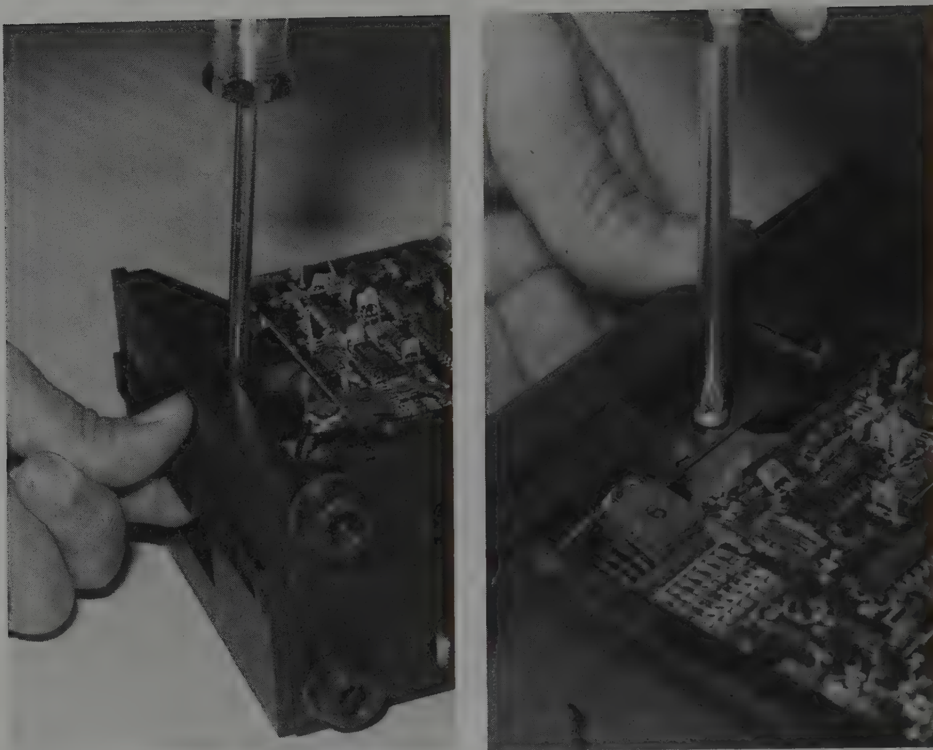


FIG. 4-7, 4-8 Replacing a door assembly.

FIG. 4-9 Lubricating the closing mechanism might help, but this is a last resort and must be done carefully.

or the read/write heads. The tiniest bit of contamination will ruin the drive and destroy any diskettes placed into it.

Silicon-based lubricants are okay. Fine grade machine oil is a little better. Do not use standard motor oil.

Electronics supply houses sell needle-tipped oilers. Even these put out too much lubricant for the drive. They're meant more for oiling delicate motors through access holes.

To lubricate the mechanisms of the drive, use a swap with a very tight tip. (You don't want the threads to flake off.) Put a drop of oil on the tip of this, and gently apply the oil that way. Then work the mechanism by hand several times until it operates freely again. Most of the time, you'll be able to see where the lubricant has been placed at the factory.

CHECK INCOMING POWER

If the LED on the front panel of the drive comes on, you might assume that power is getting to the drive and eliminate the power supply as the source of the problem. Chances are good that this assumption is valid. There is a simple check to make sure.

A 4-pin plug attaches to the analog board of the drive from the power supply. Normally, there are exposed soldering points above the board that make probing the incoming power easy. These are marked on the board as to which pin is which (Figure 4-10).

Facing the computer, to the far left is the 12-volt input: to the far right is the 5-volt input. The two pins in the center are the respective grounding pins. Set your voltmeter to read 12-volts DC. Touch the black probe to one of the grounds (Figure 4-11). The red probe is used to touch each of the other pins in turn.

If you get readings within about a half volt of the stated value (4.5 to 5.5 across the 5-volt pins; 11.5 to 12.5 across the 12-volt pins), the power supply is kicking out the proper voltages as far as the drives are concerned. If power is getting to the suspected drive but that drive is dead, chances are good that it is the fault of the drive.

Don't forget to take notes and make sketches. This is especially important if you are going to be doing disassembly. But it is still an essential step to help you keep track of what you're doing and what you've already done.

DRIVE SWAP

Next, if you have two floppy drives, you can try a swap. This isn't easy to do since you'll probably have to remove the drives from the

FIG. 4-10 Disk drive power connector.

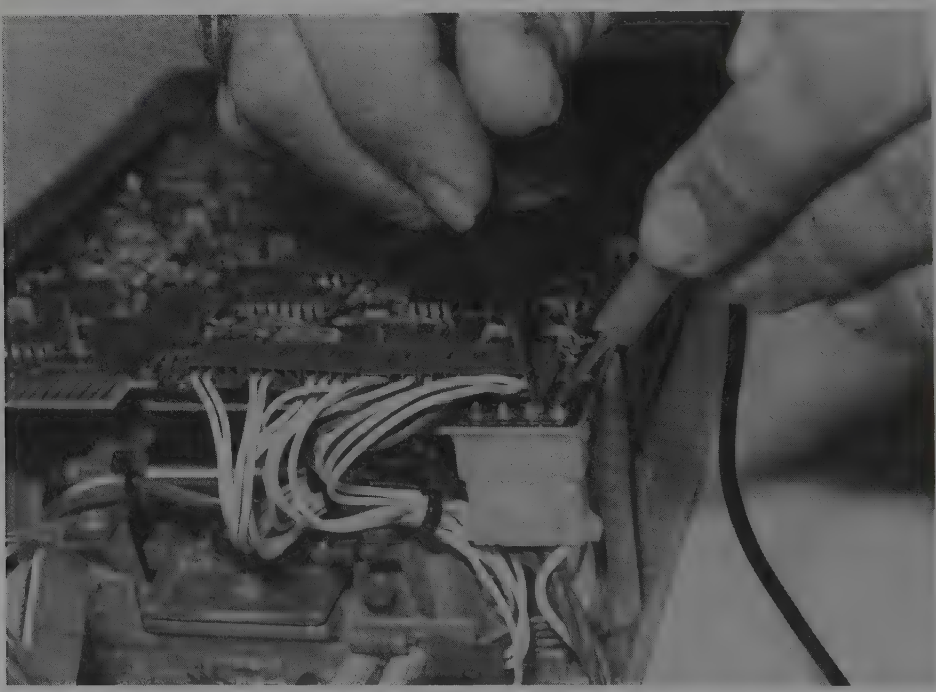


FIG. 4-11 Testing for power in a self-contained drive.

computer cabinet to make the change. The time required might be worth it, though. This will almost certainly show you if a particular drive is bad.

For example, if drive A seems to be malfunctioning but drive B is working fine, a swap will effectively change that suspected drive to B and the good drive B to A. If the new drive A *still* malfunctions, you'll know that the drives are not at fault. If the new drive A now functions but B is failing, the drive is at fault.

The easiest way to check drive malfunction is to connect the signal cable to another drive that you know is good (and is configured to operate as the suspected drive). This is the only way you can perform this step if you have just one floppy drive in your computer. If you have dual drives, you'll have to make a few changes to the drives to get them to act in the opposite configuration. If you have two drives, simply look at the physical configuration on each drive and then make each drive look like the other.

If you're buying a new drive, read the instructions completely. The jumper block and terminating resistor package socket are located near the signal cable connector. In all cases, the terminating resistor should be in place when the drive is being used as drive B and removed when the drive is serving as drive A. (It's best to use an IC extractor for removing the terminating resistor package.)

REPLACING THE HEAD LOAD BUTTON

Single-sided drives have a read/write head on one side only. The other side has a small fiber pad to hold the diskette firmly against the head. Occasional I/O errors can result from a worn head load button. This button is a small felt pad on the bottom of the read/write head assembly. Its function is to push down against the diskette while the read/write head presses up from beneath. This holds the surface of the diskette flat against the head. If the pad wears, the diskette may not be held perfectly flat. Data may be lost. A heavily worn pad can also damage the diskettes. If the pad falls out (rare, but it happens), the diskette can become badly scratched or destroyed.

A worn pad will be skewed to one side. It might also look hard and dry. Either way, it's time to replace it.

The method of attaching the head load pad to the arm varies with the drive being used (Figure 4-12). Some have a pad that snaps into place. Others are merely glued in. In these two cases, replacing the pad is a matter of pulling the old pad out with a needlenose pliers and just slipping the new one into place.

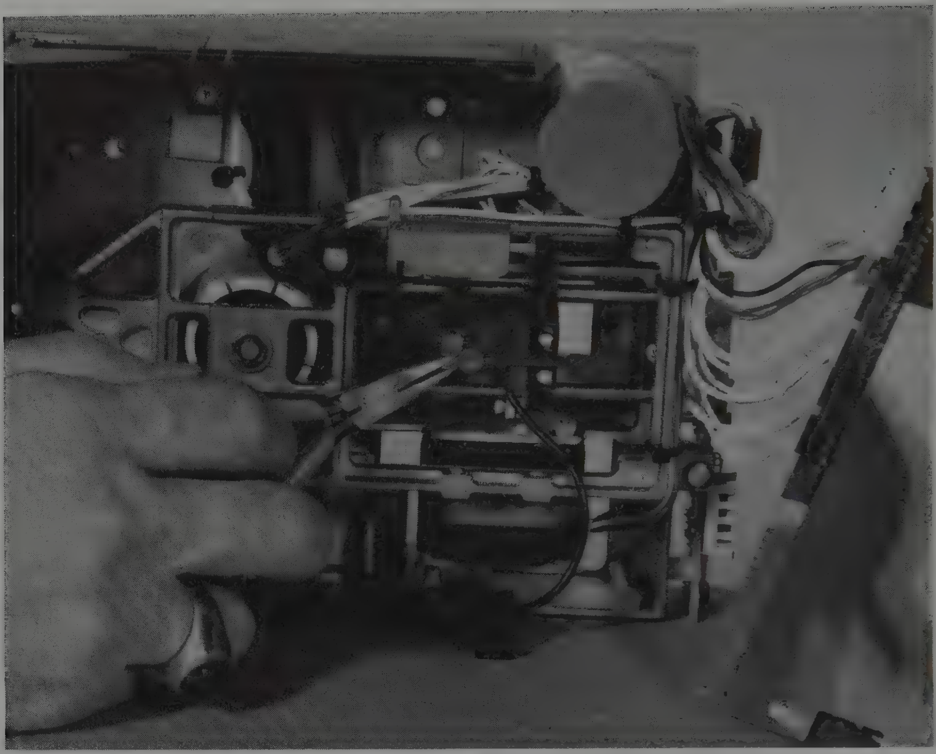


FIG. 4-12 Replacing the head load pad requires a partial disassembly—and care!

The top of the head load pad is sometimes a plastic cylinder with a round hemisphere on top. The cylinder and hemisphere have a notch cut into them. The assembly is forced up into the arm and spreads apart to hold it in, so glue is not required. To change this kind of pad, lift the head load arm and grasp the pad carefully with a needlenose pliers. The button usually comes off easily. The new head load button gets inserted into the holder. A slight push will snap it into place.

You can usually get a head load button from your local dealer. Prices vary. Some dealers will give them to their regular customers without charge. When they do charge, the price is usually less than a dollar.

TESTING THE SIGNAL CABLE

The signal cable is the multiwired cable that connects the drives to the main board. It's rare for this cable to go bad, but it is possible. Testing it is easy.

Set your meter to read ohms (resistance). The setting used doesn't matter. Touch one probe to a pin on one side of the cable and the other probe to the same pin on the opposite side of the cable. A reading of zero ohms means that the wire between those two pins is good. A reading of infinite ohms (no movement of the meter needle) means that the wire is broken somewhere along the cable. Usual repair is to replace the cable. (For those interested, this is checking for continuity and is the best way to test any wire or cable that is not presently carrying a current. You can even do this to test the wiring between your stereo and speakers.)

TESTING THE WRITE-PROTECT SWITCH

The notch on the side of the diskette is there to activate (or deactivate) the write-protect switch inside the drive. With the notch left open, you can write data on the diskette and can erase what is there. Cover this notch, such as with tape, and the data on the diskette cannot be changed. However, if this switch goes bad, the data and programs on the diskettes may be erased. If the drive malfunctions while the write-protect switch is faulty, you could find yourself with nothing but a blank diskette, even if all you've done is insert the disk and apply the power. If you find that this switch is faulty, do not attempt to use the disk drive until you have made the repair.

If you suspect that the write-protect circuitry is faulty or want to conduct an occasional safety check, you can perform a very simple test. Take a diskette that has nothing on it that can't be lost. Cover the write-protect notch. Then try to write onto the diskette or try to erase it. If the switch is functioning properly, you won't be able to erase or change anything on the diskette.

PULLEY AND BELT

Some drives have a pulley and belt on the bottom of the drive (Figure 4-13). Others are driven directly by a low-speed DC motor and have only a flywheel (Figure 4-14). With the drive removed, turn the drive over. You'll see which kind your drive uses. If it has a belt, visually inspect the belt for wear. (It's also possible that the belt has fallen off or has broken, in which case, you've found the problem right there.) Turn the pulley or wheel by hand to check for sticking, binding, or uneven turning.

SPEED ADJUSTMENT

There are several ways to test the speed of a drive. Many of the diagnostics diskettes available will do this and will allow you to adjust

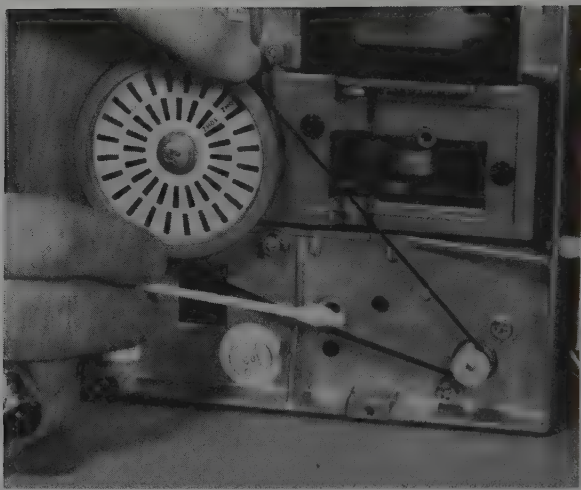


FIG. 4-13 Pulley and belt of the disk drive. Turn gently to check for sticking or binding.

the drive speed. This is by far the easiest way to do it and is an excellent means of periodically checking the drives. It's a wise investment to get one of these programs and to use it on a regular basis.

If you don't have a diagnostics diskette, you may still be able to test the drive speed by using a fluorescent light. To do this, the drives you have must have markings on the pulley or flywheel (Figure 4-15). Some drives do not have these and will have to be adjusted either with the special software program or with an oscilloscope.

Remove the drive and tip it on its side (Figure 4-16). Turn on the computer to get the drive to operate. You won't have much time and may have to press the reset button several times. (Each time you reset, the drive will try to load what is in the drive and the motor will spin.)

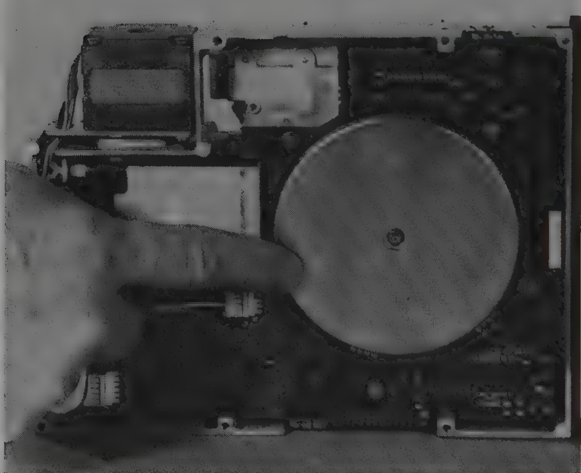


FIG. 4-14 Many newer drives use a direct drive motor. You can still check the flywheel for binding.

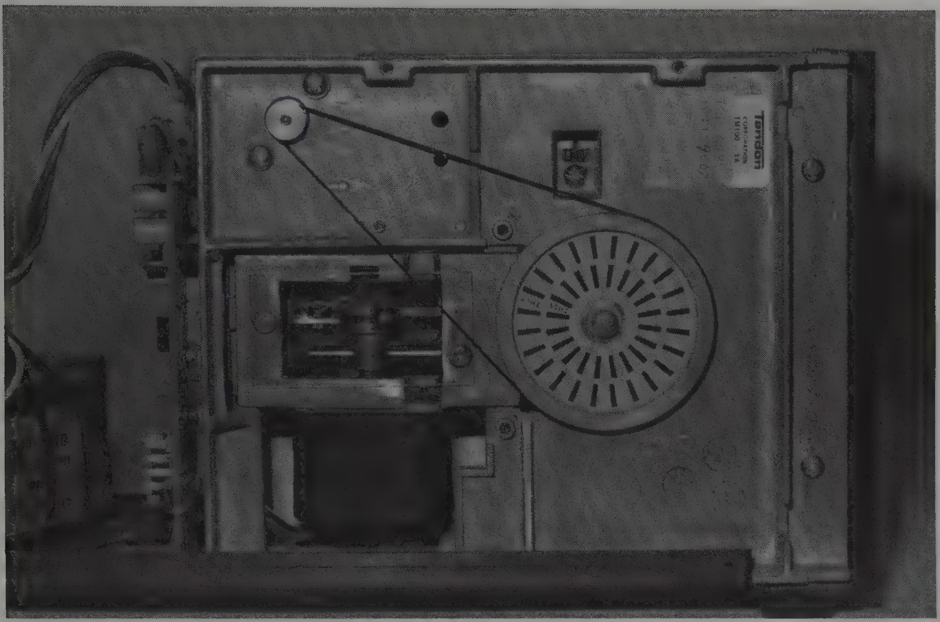


FIG. 4-15 Note timing marks on the pulley. The outer ring is for 60-cycle current; the inner ring is for 50-cycle current (European).

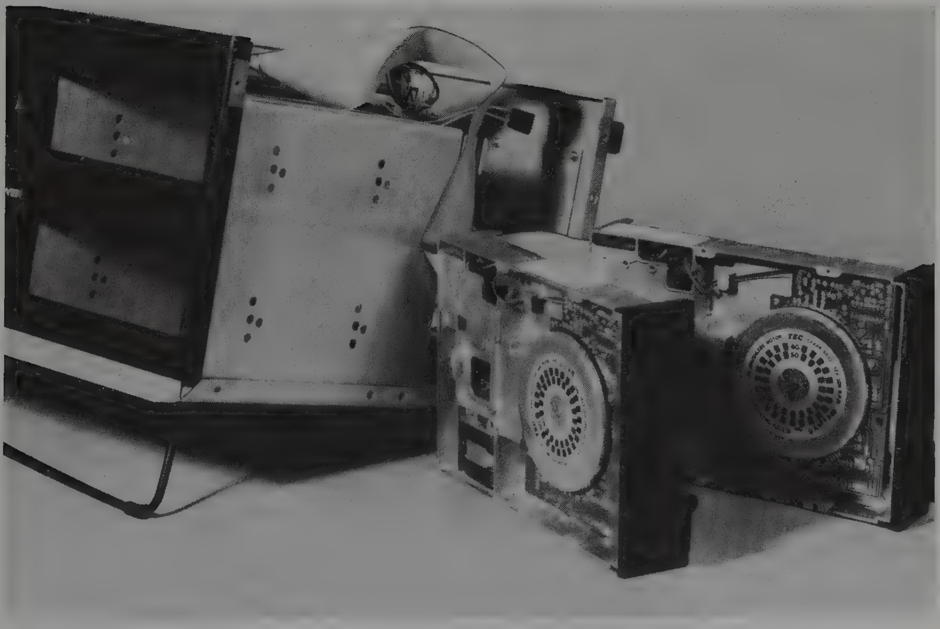


FIG. 4-16 Setting up to adjust drive speed.

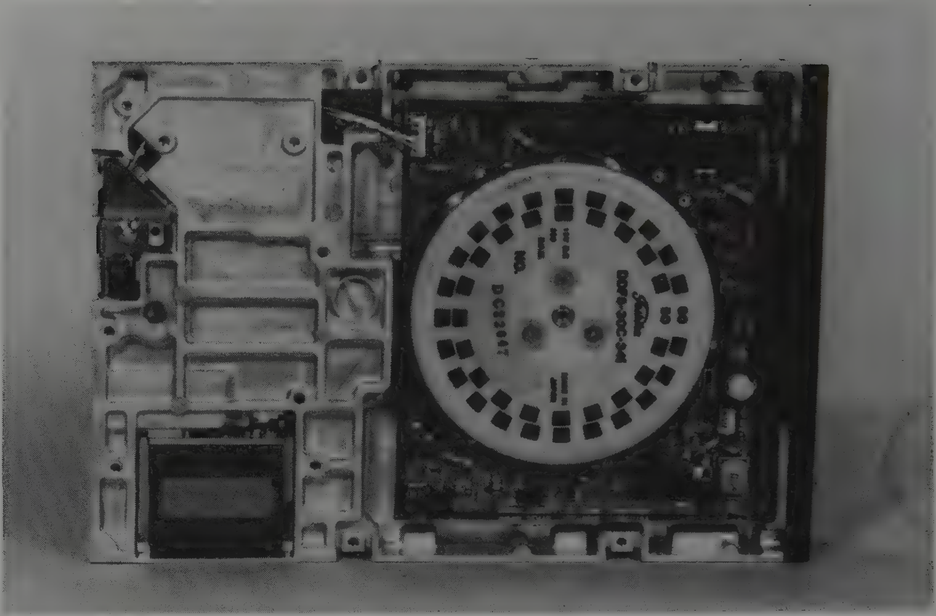


FIG. 4-17 When the speed is correct, the outer ring will seem to stand still.

Watch the pulley under the fluorescent light. If the drive is operating at the correct speed, the marks on the outer ring should seem to stand still (Figure 4-17). (The inner marks are for 50 hertz power.)

If the speed is off, adjustment is made by turning the variable resistor on the servo (motor control) section of the board (Figure 4-18). The full-height Tandon drive has a separate servo board at the

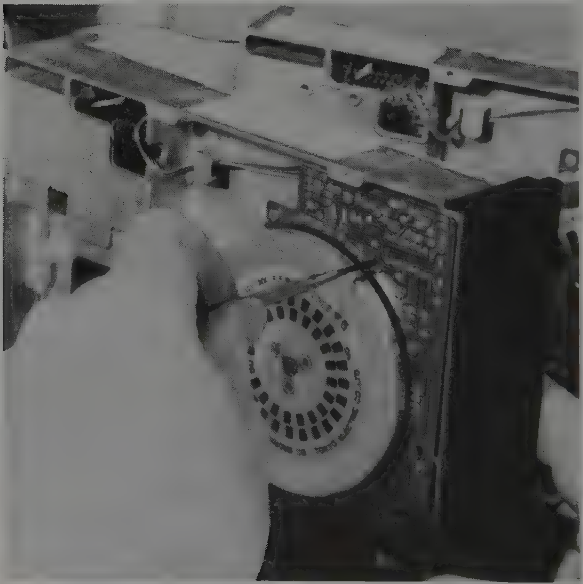


FIG. 4-18 Speed adjustment variable resistor.

rear of the drive and a "stack" with a screw top. Other drives will have this adjusting screw located through a hole in one of the boards, usually the bottom board. It may or may not be marked. Look around carefully. If you find a small slotted screw, you've probably found the adjustment. (It will *not* be a Phillips head screw.)

By watching the marks on the pulley (under the fluorescent light), you should be able to tell which way to turn the variable resistor for correct adjustment. At the proper speed, the marks will seem to stop moving. A diagnostics program will usually display what the speed is on the screen.

SOME OTHER PRECAUTIONS

You can avoid many drive problems simply by observing some precautions. Keep the environment as clean as possible. Dust and other contaminants can create havoc with the drive.

Regular cleaning of the read/write heads is a good practice. How often you do this will depend on your surroundings and how much the computer is used. *Don't skimp* when you are buying a head cleaning kit. Get the best possible. (More information on regular cleaning and maintenance is contained in Chapter 7.)

If your drive has to be realigned or if the drive speed is to be adjusted, make new copies of everything that has been recorded in that drive. Do this *before* you make the adjustments. Use that drive as the "source," with a drive that you know is good for the "target."

The reason for this is that the faulty drive has recorded the data according to its maladjusted characteristics. If you try to read that data on a properly operating drive, you'll probably get nothing but garbage. By using the faulty drive as the "source," you're allowing it to read the data with the characteristics embedded. The good "target" drive will record the data the way it should be.

Whenever you move the computer from place to place, protect yourself and the drive heads (Figure 4-19) by inserting either a blank

STOP!

Don't do anything to your drive until you've made copies of all data that was recorded on the maladjusted drive!

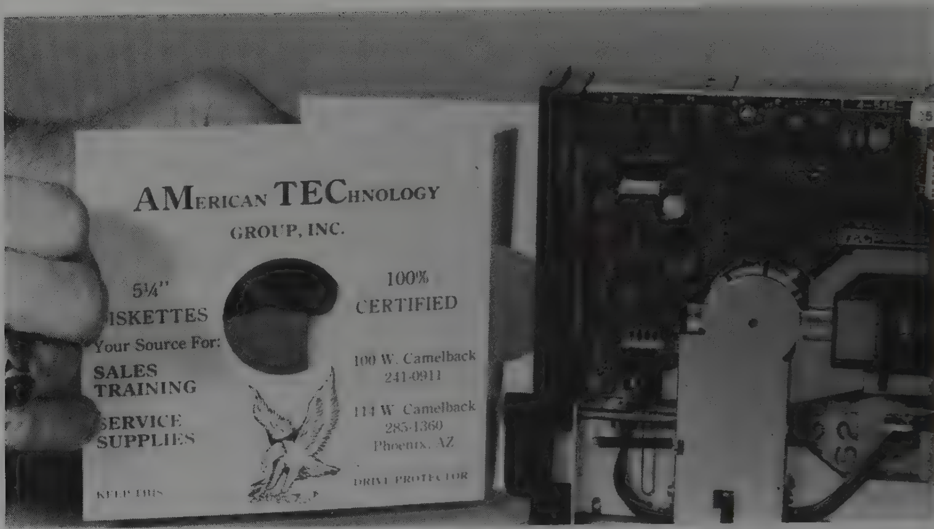


FIG. 4-19 When moving your computer more than a few inches, it's a good idea to insert one or two head protection cards or a blank diskette.

diskette that you can afford to ruin or a cardboard drive head protection card (two such cards is better yet.)

Earlier in this chapter, it was mentioned that you might be able to "fix" a faulty latching mechanism by careful lubrication. The same is true for other mechanical parts of the drive. The same rules apply—namely, *extreme* caution and very little lubricant. Lubrication is your last-ditch effort before throwing away the drive (Figure 4-20). Even then, don't use any valuable diskettes in the drive until you are absolutely certain that you haven't contaminated the heads.

REPLACING AN INTERNAL DRIVE

Getting the drives out of your computer can be time consuming and complicated. Since the entire computer is self-contained, the inside is prone to stray RF radiation (especially from the video section of your computer). To prevent this from damaging the drives and the diskettes, the drives are encased in a grounded shield.

With the cabinet off, you can access the mounting screws that hold the drives to the shield. Almost always these will be Phillips or hex screws, with the latter requiring Allen wrenches or an Allen-headed screwdriver (Figure 4-21).

With the holding screws removed and all wires and cables disconnected, the drive should slide out of the casing without difficulty (Figure 4-22). Be very careful doing this. Some drives have compo-

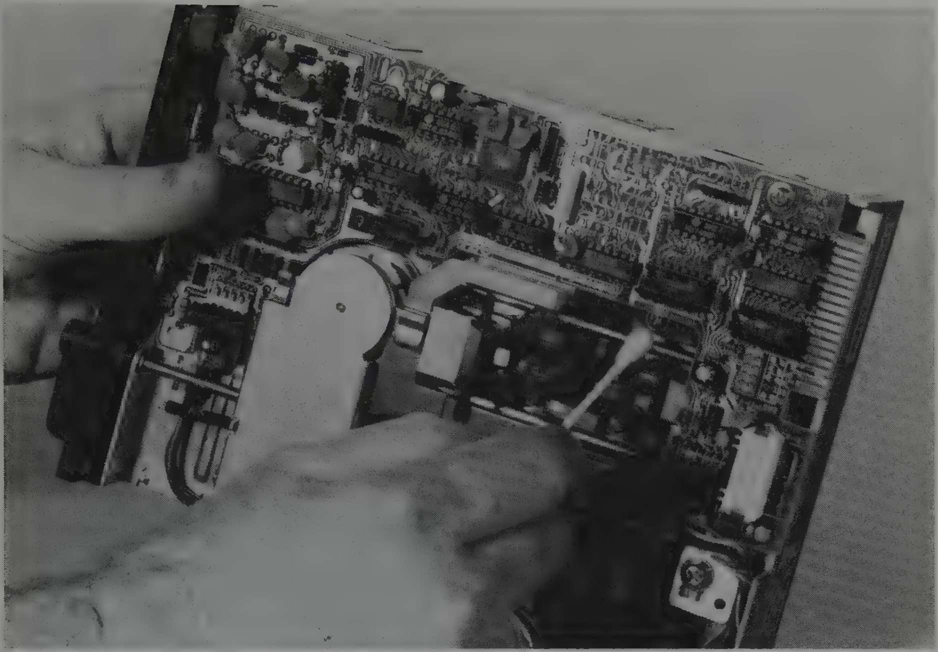


FIG. 4-20 Although it's possible to cure some problems by lubrication, always keep in mind that this is usually a desperate measure and must be done carefully.

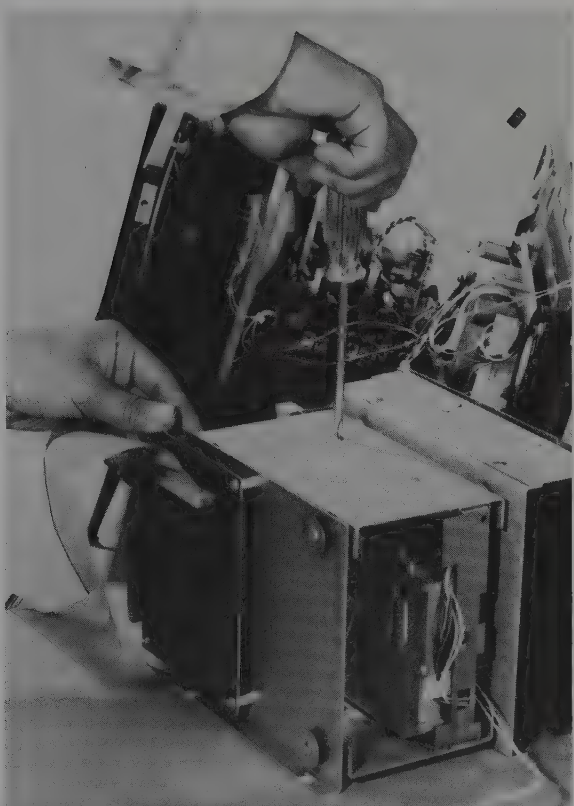


FIG. 4-21 Remove the holding screws.

FIG. 4-22 Carefully slide the drive forward through the opening.

nents sticking up that could catch against the chassis (Figure 4-23). It's better to take the extra few seconds to look and to be careful than to ruin the drive's analog board.

CASSETTE DRIVES

The cassette player/recorder used by the home computer system isn't much different from the standard cassette deck used for playing and recording music. The usual solution for a malfunctioning cassette deck is to toss it out and get another since the cost of technical help to make repairs is often higher than the cost of a new deck.

As with disk drives (Figure 4-24), there aren't many things that you can do to repair the unit without the proper equipment and technical background.

HOW IT WORKS

The cassette deck is in four basic sections: input/output, electronics, read/write heads, and mechanisms.

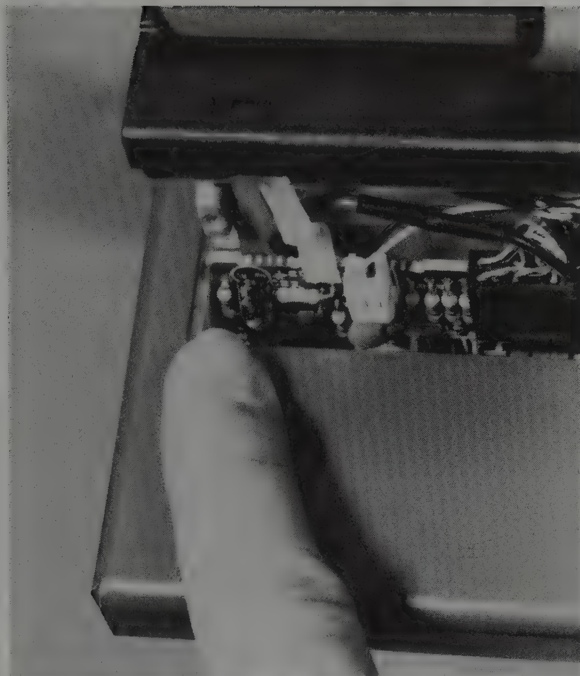


FIG. 4-23 Some drives have components sticking up that can catch and be damaged if you're not careful. Pay close attention to what you're doing.

FIG. 4-24 A typical cassette drive.

The input/output section brings signals into the unit for handling and takes prerecorded signals and sends them out. It includes any connectors and other ports used by the cassette.

The electronics—the circuitry—of the deck handles the signals either going to or coming from the read/write heads. This section includes the power supply if it is mounted into the deck.

The read/write heads generate magnetic fields of varying strength that are superimposed on the tape during recording. They also read the recorded magnetic field from the tape. Of the two heads in the deck, one is a true read/write head and the other only "writes." When activated, it erases anything on the tape before the tape can get to the read/write head, thus cleaning it so new signals can be recorded with no interference.

The mechanisms are those parts that cause the tape to move across the heads. This section includes any motors, all moving parts (capstans, pinch rollers, etc.), and the tape guides.

THE OBVIOUS

The first step in any diagnosis is to visually inspect the unit for anything obvious. Is the cassette plugged in? Is the cable between the deck and the computer firmly connected at both ends? Do you have a good tape in the machine?

If allowed to build up, cassette residue can cause a variety of problems, such as faulty read/write functions and the "eating" of tapes. If the heads are worn or dirty, you can try to clean them, but if the damage is severe, the only cure is replacement.

After the visual examination, the next step is to thoroughly clean the machine (Figure 4-25). Use a cotton swab with a tight tip and a high-quality head cleaning fluid or pure isopropyl alcohol (but use only the highest quality alcohol; anything less than 99% isopropyl—available at chemical supply houses and at the prescription counter of most drug stores—will leave residues actually damaging the heads).

Never use any fluid on the pinch rollers unless it states that it is good for cleaning rubber.

INPUT/OUTPUT

If no signal is getting to or from the deck, even the best computer will be useless.

If you can safely open the unit, first visually inspect the connectors for loose or broken wire or a corroded connector. Next, set your

FIG. 4-25 Cleaning the cassette heads, pinch rollers, capstans, and other parts can sometimes cure a problem.

meter to read resistance and check the connector for continuity and short circuits. Take a moment to test the cables for continuity (Figure 4-26). Disconnect the cable and touch one probe to a pin or wire at one end of the cable with the other probe touching the same pin or wire at the opposite end of the cable. A reading of zero ohms means the wire is intact; a reading of infinity means there is no connection between the ends. Either those two pins don't connect to anything or the wire between is broken.

POWER

An easy way to check a completely dead cassette deck is to test the power supply. If the deck uses an external power supply, an AC adaptor, or batteries, you won't have any problems. With self-contained units, see if you can find any test points or pins labeled with a voltage.

In a power supply, the AC line voltage from the wall outlet comes in and is converted to the needed value of DC. Before continuing, go to Chapter 6 for more complete details on testing a power supply.

Many of the smaller decks use only a +5 VDC leg. Others have both +5 and +12. If you have no idea what the voltages are, the

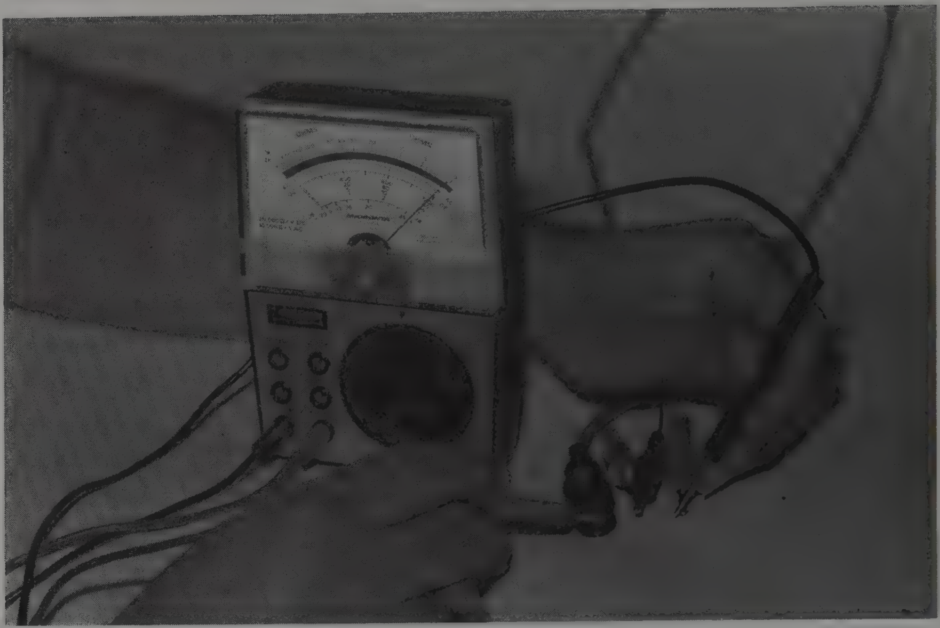


FIG. 4-26 Testing for cable continuity can tell you if the problem is in the cassette drive or in the computer.

safest way to determine this is to set the meter to read DC volts in a range that you know is higher than anything that will be present. (Don't forget to eliminate possible AC pins!)

OTHER STEPS

Once you've completed a survey of the obvious, a diagnosis can become complicated. Some suggest the use of blue dye for metal and then running a tape across the head until it rubs off the dye so any pitting will be obvious. This is an extreme measure, however, since the pits shown by this test will usually show under a magnifying glass.

Special head alignment tapes are hard to find and usually more expensive than the cost of having a professional replace the heads. Even then, you need special test equipment, such as an oscilloscope, to accurately measure the signal output while you make small adjustments to the head mounting brackets. An AC voltmeter can be used in a pinch but will rarely give as accurate results.

You can sometimes cure a read/write problem by demagnetizing the heads but *never* attempt to demagnetize the heads of a disk drive! To use a head demagnetizer, bring the device close to but not touching the head or metal part to be demagnetized, turn on the unit, *slowly* move the device away from the head to a distance of at least three feet, and then shut it off. Otherwise, you could cause damage to the heads.

Unless the deck you are using has a speed adjustment, the speed test is all but useless except as a diagnostics tool. You'll need a length of tape that has been measured exactly. The standard tape speed for a cassette deck is 1 7/8 inches per second. You would measure off, for example, exactly 112 1/2 inches for a 60-second test (1 7/8 × 60). With a stopwatch, let the tape run through the machine. At the end of 60 seconds, the tape should be just finishing. The longer the test, the better. It's also best to run the test more than once, especially if you are using a 1-minute or shorter testing.

Premeasured tapes that you know actually contain exactly 60 seconds of tape will save you time, bother, and hassle. You can also make note of the counter of the deck (if yours has one) and calculate the numbers into inches per second for the test tape. Once you have this calibration, make a note of it for future testings.

SUMMARY

The disk drives are probably the most critical part of your computer system. Unfortunately, they are also the devices most likely to cause trouble. This is because they are one of the few mechanical parts in the system.

If the drive malfunctions, existing programs may not operate. Data recorded on a misaligned or otherwise maladjusted drive can disappear once the drive is put back into shape again.

Only rarely will a drive suddenly fail. Most of the time, it will give you warning symptoms, such as a faulty read or a faulty write. Both can be caused by other things, but both also indicate that it is time to check out the drives.

Make drive checks and drive maintenance a part of your regular schedule. Clean the heads occasionally. A diagnostics diskette is a good investment. Run the diagnostics on the drives regularly to keep track of how they are performing. This way, you'll have ample warning if the drive is going bad.

Preventive maintenance is the best possible means of assuring that the drives will give you no problems. Backup copies of programs and data diskettes made while the drives are operating properly will help to ensure that a drive malfunction is not a disaster.

When you have finished the tests in this chapter or when you have simply noted the symptoms, you'll have a very good idea where the problem is. If power is getting to the drives from the power supply, the problem is most likely with the drive or cable. A simple continuity test eliminates the cable as the possible cause.

Diagnosis of cassette deck problems is essentially the same as it is for disk drives. Cleaning and maintenance of the units is often easier, which is fortunate, since the cassette tapes often leave more residues and contaminants.

As always, begin with the obvious. Only after you've completed all those easier steps should you progress to the more difficult. This is especially important with disk and cassette drives, since it usually takes special and expensive equipment for a more complete diagnosis or repair.

Chapter 5
Troubleshooting the Boards

There are many things on the circuit boards that cannot be tested without some very expensive equipment. Much of the time, your diagnostic steps tell you no more than which board is malfunctioning. Only rarely will you be able to track the problem to a specific component. Repair is usually by replacing the entire board.

The professional in a repair shop has an advantage. If the video board is suspected, for example, another one is likely to be close at hand. This can be substituted for the suspected board. If things work again, the problem has been found and the repair is complete.

The same technique can be used for individual components, and once again, the shop has the advantage of having a stock of components on hand. If the suspected component is socketed, the swap takes just a few seconds.

Unfortunately, neither avenue is open to the average end user. The cost of keeping all the spares on hand would be much higher than paying the shop. You'll almost certainly have to limit yourself to tracking the malfunction to a board rather than to a component.

More important than any tests you can perform is careful observation. Look for symptoms. What is happening? What is not happening? Then look for the obvious. Are all the connectors plugged in correctly? If the board has socketed components, give each and every one a push to make certain that they are seated in the sockets. (Don't fiddle with any connectors or components while the power is flowing.)

You should have a good idea of which board is causing the problem after you've completed your observation survey. By process of elimination, you should be able to locate what might be causing the problem. This way, you won't waste time on things that can't be

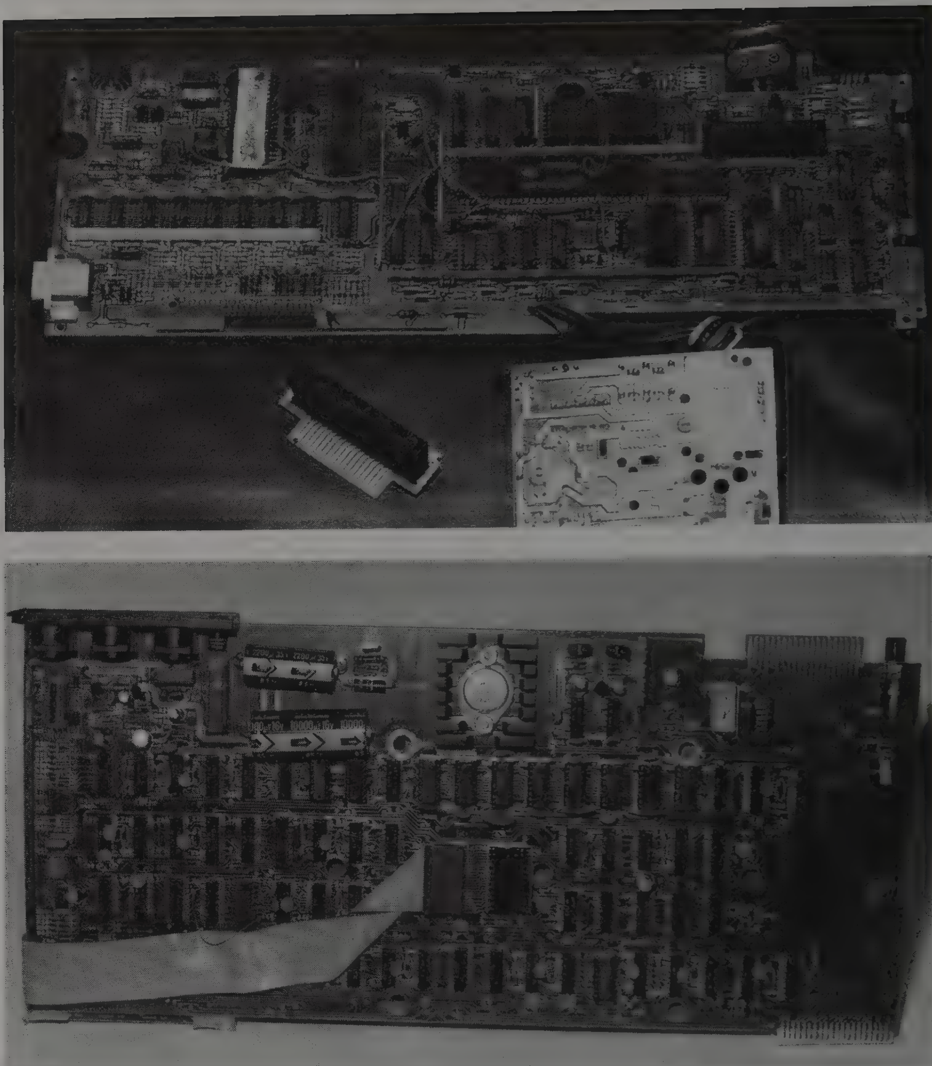


FIG. 5-1 Typical main boards.

causing it. Before you begin any testing or measurement, you should already be fairly certain that the board you are testing is the cause of the malfunction. Chances are you won't have to make any actual tests other than for power.

THE MAIN BOARD

The term *mother board* is used by Apple to describe the main circuit board of its computers (except the Macintosh). IBM calls it a *system board*. Whatever it's called, it is the same thing—the main circuit board of the computer (Figure 5-1).

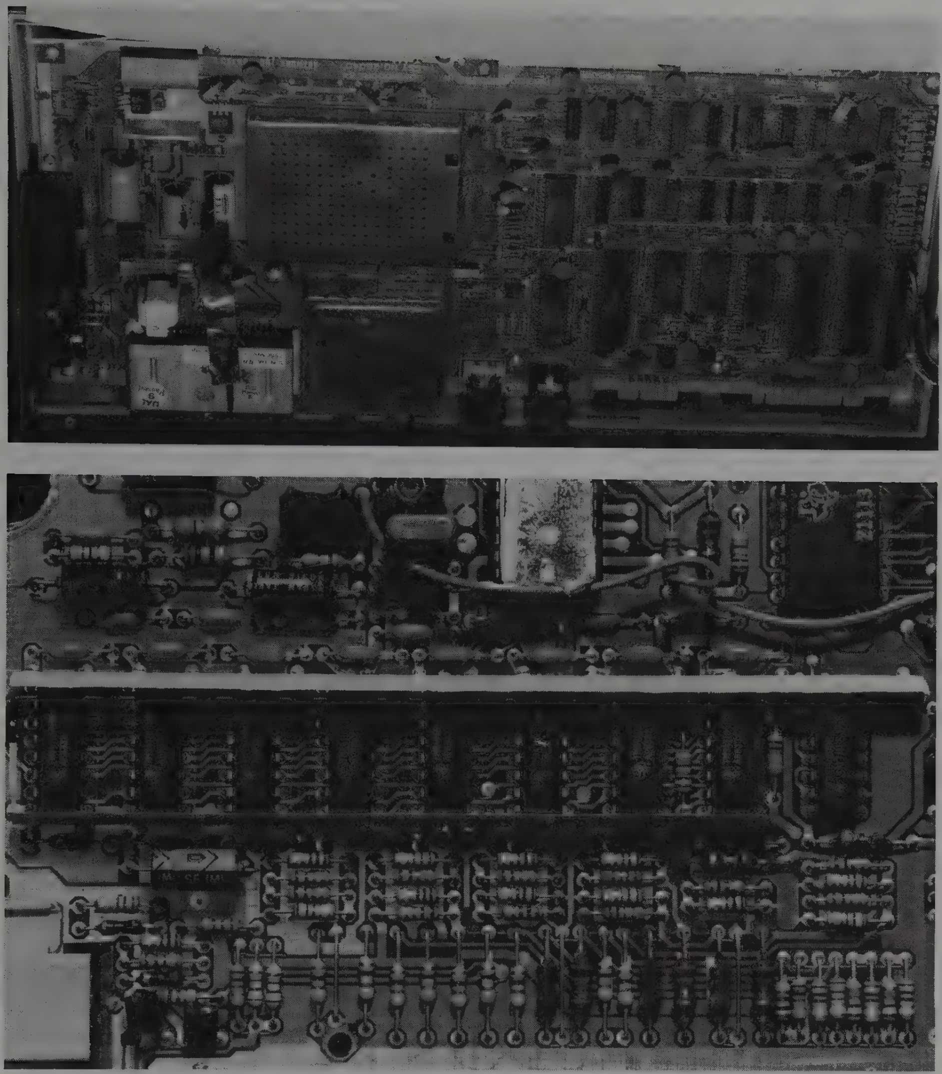


FIG. 5-1 Continued.

Unfortunately, if something is wrong with the main board, you probably won't be able to do much about it other than to swap it with a new one or take it to an experienced technician who has the right test equipment. The technician will probably just replace the entire board. Even if the problem *can* be tracked to a single component, the labor charges involved with this lengthy search can cost you more than the new board.

If you're lucky, the service personnel might be able to guess at the cause of the problem by the symptoms you describe. Once again, it's important to take notes. The shop may then be able to swap individual components (such as socketed ICs) with known good ones in their stock. RAM and ROM in particular are easy to test this way. (Most repair shops have these chips around.) This route to finding the problem isn't open to the average owner, though, since not many of us keep a shelf full of computer parts.

Many computer main boards have virtually all the components soldered into place. This means that a problem with the RAM chips, for example, requires the technician to desolder the multipinned ICs (16 pins per chip, with eight chips in the RAM section of the main board) and then solder in the new chips. The usual solution was to avoid all this by replacing the entire circuit board. Newer main boards have more socketed components, which makes a simple swap considerably easier.

The malfunctioning board has a trade-in value. If you damage the board in some way, such as burning it with a soldering iron while attempting to change a chip, this trade-in value goes up in smoke. If you decide to attempt any repairs, do so with extreme caution. The same applies for any modifications to the hardware.

Before you yank out the main board and pay for a new one, try to determine if the main board is actually at fault. As mentioned, this isn't easy. Tests made with a VOM, or even with an oscilloscope, aren't necessarily conclusive. They are just indicators.

Shut off the power and check the system board carefully to be sure that all connectors are secure. Unplug them and inspect the contacts for signs of burning or corrosion. Cleaning them might not take care of a problem but is so quick and easy that you might as well give it a try. Clean the silver or gold contacts (the "fingers") with a quality cleaner or a pencil eraser (or other soft eraser). If possible, do this away from the computer, especially if you use an eraser. Be sure that the eraser crumbs do not fall into the computer. Reinsert all the connectors.

With the power still off, gently press down on all socketed ICs to make sure that they are in good contact with their sockets. This is especially important if the computer has been moved around.

While you're going through these steps, visually inspect everything inside the computer. You might be able to spot a damaged component or something else that is obviously at fault.

Now try the system again.

If things still don't function properly, get out your meter and set it to read 12 volts DC. You'll be testing the power flowing into the main board by measuring across pins of the power supply connector. It's usually easy to locate this connector (Figure 5-2) since it leads from the power supply to the computer. If your power supply is

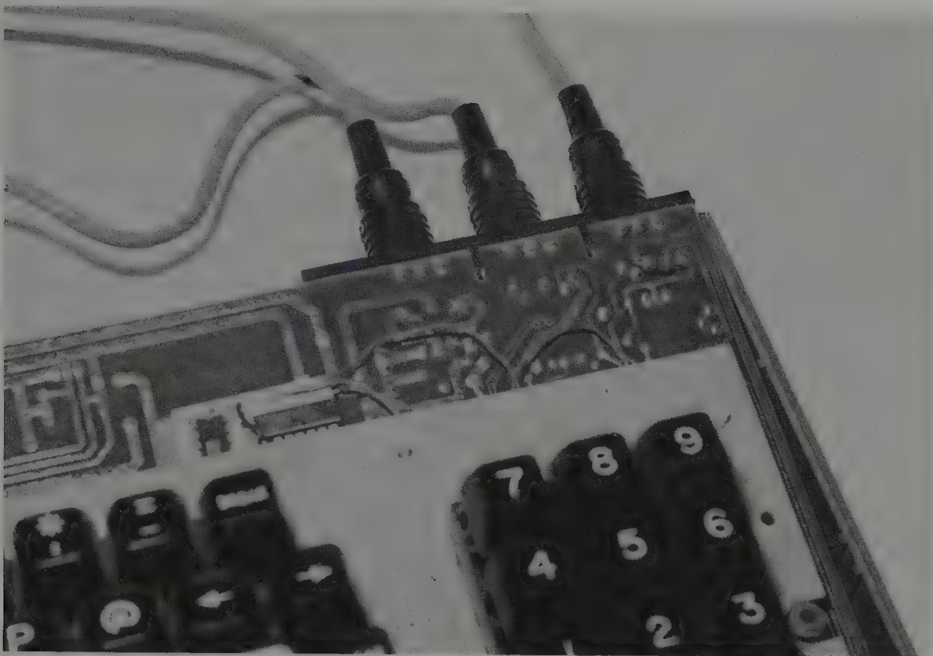


FIG. 5-2 Locate the power connector to main board.

external, it's even easier, but thorough testing in this case might be more difficult since the actual wires might not be accessible without some major disassembly.

Quite often, this connector is "keyed" and will connect only one way, such as having nine pins in the computer with a gap and a 10-pin connector on the cable with this spot filled in. Make a sketch to help you identify both the pins on the main board and the pins in the cable so that you will plug the two together correctly (Figure 5-3).

Most manuals do not tell you the pin-out of any of the connectors; however, it's easy to figure out. In some cases, you can do the test quickly without removing the connector. With others, you'll have no choice but to unplug it (while the power is off) and test the output of the drive directly. The power is flowing while you make the measurement, so be very careful.

If the ground pin of the connector isn't immediately obvious, you'll often see the trace (Figure 5-4) from one pin connected to one of the holding screws or perhaps to a wide strip along the edge of the circuit board.

A second method of finding the ground pin is to use your meter. Shut off all power. Set the VOM to read resistance and hook the ground

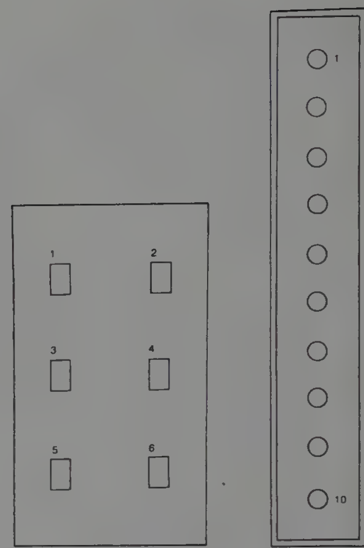
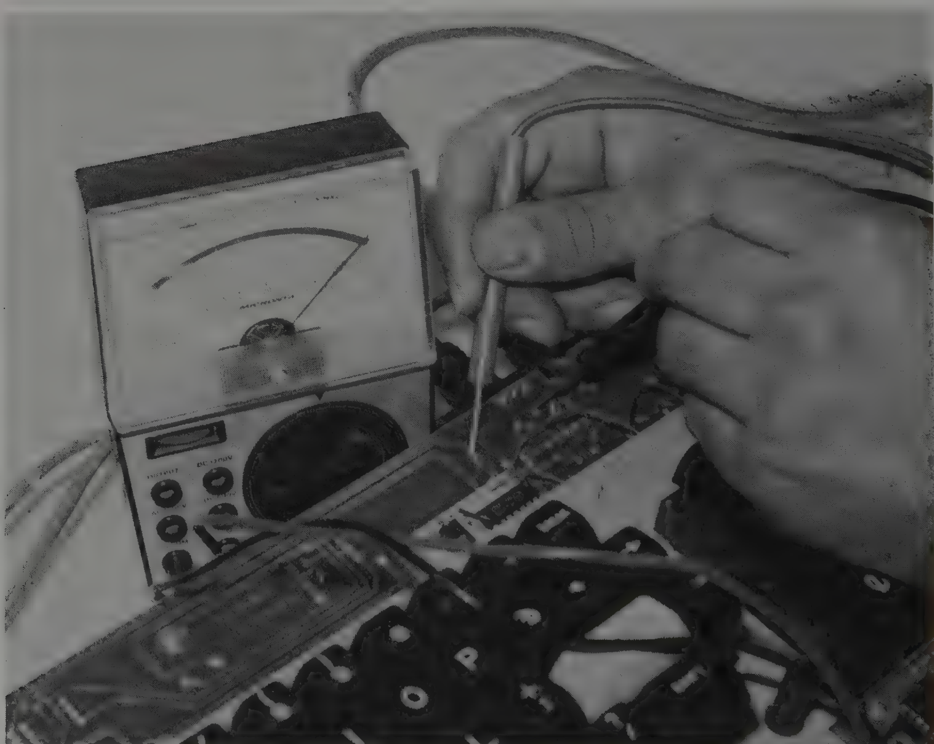


FIG. 5-3 Typical pin locations on power connector.

FIG. 5-4 The first step is to locate the ground pin or pins. Note trace from the ground pin.



(black) lead of the VOM to the metal of the chassis. Touch the probe to each pin one at a time. When you find the ground pin, the meter will swing full scale, indicating zero ohms (Figure 5-5).

Take readings of all the pins and jot them down in the tables below or in the back of this book. Also record the meter and specific setting used to take the measurements. If you don't, the readings you take later on while searching for the source of a problem may be inaccurate. It is important that you create both tables now—one for voltages and one for main board resistance — while your computer is functioning perfectly.

MAKING THE VOLTAGE MEASUREMENTS

It's possible that the power connector will have both AC and DC voltage. If the incoming AC is obviously going to the strip of connector pins, you'll know to exercise caution when probing the pins. You can often tell just by finding the fuse and visually tracking the wires.

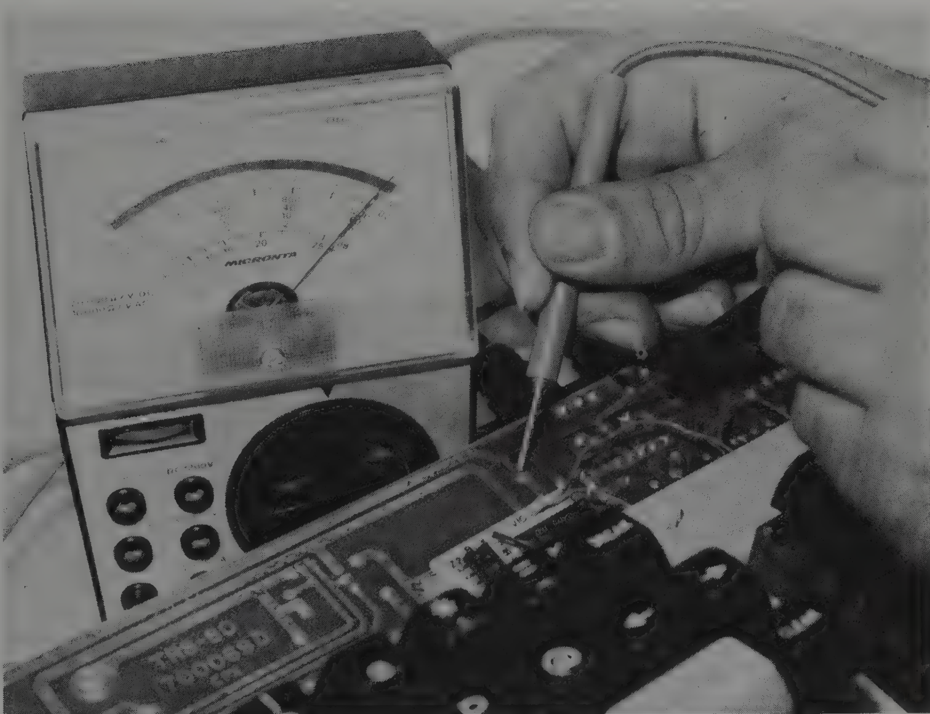


FIG. 5-5 Note the reading of zero ohms. This indicates that you've found the ground pin.

More commonly, there is only DC present on the pins if the power supply is external or is an enclosed unit with an obvious AC line cord going to it and if there isn't an internal (built-in) CRT. Obviously, there is no AC present if your computer is battery operated.

If there is AC present on the pins, there is a danger to you. To be safe, set your meter to read AC voltage in the 120-volt range, and read the voltage between each of the pins and a good chassis ground.

One other precaution must be taken when probing the power pins if you have an internal CRT or any CRT that is powered directly by the computer. Not only will there be normal AC line voltage present, there will be the boosted voltage to drive the CRT, which can easily be in the tens of thousands of volts.

Typical power connector pin readings will be in one of two DC ranges: 12 volts and 5 volts, both positive and negative. (If your meter needle swings in the wrong direction on the scale, you've found a negative voltage. Reverse the probes—that is, touch the red probe to ground and use the black probe to touch the suspected pin—to take the reading. Be sure to mark this pin as a negative voltage when you fill in the table.) The 12-volt supply generally powers any motors in the computer while the 5-volt supply powers most or all of the circuitry.

It's common for these voltage readings to be off by as much as 10%. Normally, the 5-volt supply should give a reading of between about 4.5 and 5.5 volts DC; the 12-volt supply is just fine from about 10.8 to 13.2 volts.

MEASURING MAIN BOARD RESISTANCE

While you're figuring out the power connector voltage pin-out, take a few more seconds and make resistance measurements on the various pins. Shut off all power and unplug the connector. (It's best to take readings of the main board alone, not the main board and power supply together.) Connect the black VOM lead to the ground pin or to the metal chassis and probe each of the other pins just as you did when you measured the voltage (except the AC pins, if present). Jot down the values in the table below. Also record the meter used and resistance setting.

Resistance readings on the main board pins give you an indication of large changes in the circuit board components. Small changes aren't important.

TABLE 5–1.
Power Connector Voltages

Meter Used ______________________

Setting Used 12 VDC and 120 VAC (if needed)

Pin	*Value*
1	______
2	______
3	______
4	______
5	______
6	______
7	______
8	______
9	______
10	______

TABLE 5–2.
System Board Resistance

Meter Used ______________________

Setting Used ______________________

Pin	*Value*
1	______
2	______
3	______
4	______
5	______
6	______
7	______
8	______
9	______
10	______

USING THE TABLES

If something goes wrong with your computer, you now have quick and easy ways to eliminate major portions of the computer system as possible causes.

If the pin that is supposed to supply 5 volts DC is suddenly reading just 1 volt, chances are good that the power supply has malfunctioned.

If the new resistance readings vary greatly from the original readings, something in the main board has either aged beyond functional life or has shorted.

For the comparative resistance readings to be of any use, you'll have to make additional readings with various expansion boards both in place and disconnected. Then if you get a large change in the reading after a malfunction, you can disconnect those expansion boards and compare those readings to the originals.

Imagine that your computer has malfunctioned. With the power off, you take measurements across the main connector and notice that pin 5 is giving a vastly different reading. Then you notice that the only time the new reading varies so much from the original is either when all the boards are plugged in or when the modem board is plugged in.

You've found the problem.

If all readings are correct but the computer will still not power up, there are two possibilities. The power supply could be wearing out and is incapable of producing the needed amount of current; or one of the other boards (including the main board) could be faulty and pulling too much current for the power supply to keep up. (It's also possible that you simply have too many things hooked up to the power supply.) In the case of a worn power supply, about all you can do is get a new one. Sometimes, the power supply tends to overheat, which in turn will cause the power supply to fail. The trick here is to add a cooling fan. (See Chapters 6 and 8).

WHAT NEXT?

Before you go to a lot of trouble or expense, make sure that you've eliminated all other possible causes of trouble by looking for the obvious once more. Open the cabinet and visually inspect the inside. Is there anything that could be causing an accidental short (like a screw that has fallen onto the board)? Are all boards plugged firmly into place? Are all the cables and connectors secure? (For both things, unplug and reinsert, clean the contacts—always with the power off.)

Outside the cabinet, are the plugs and cables secure? Even more important, are they in the right places?

With the main board, the usual place to start is to see if power is getting to the board. You should have already checked all the plugs and connectors and should have pressed on each socketed component to be sure that none have come loose.

Now with the power flowing, touch the chips with your finger very carefully if there is even a remote chance that AC voltage is near. You're looking for any chips that are overly hot.

If the main board passes all these tests, chances are you'll have to replace the main board. Unless you have a diagnostics diskette, you can't test the various sections. If you happen to have extra chips around the house that match those of the computer, you can try swapping them. Other than that, there isn't much you can do.

REMOVING THE MAIN BOARD

If tests indicate that the entire main board has to be replaced (rare!), you may wish to do the work yourself. It's not difficult. Go slowly. Don't force anything (Figure 5-6).

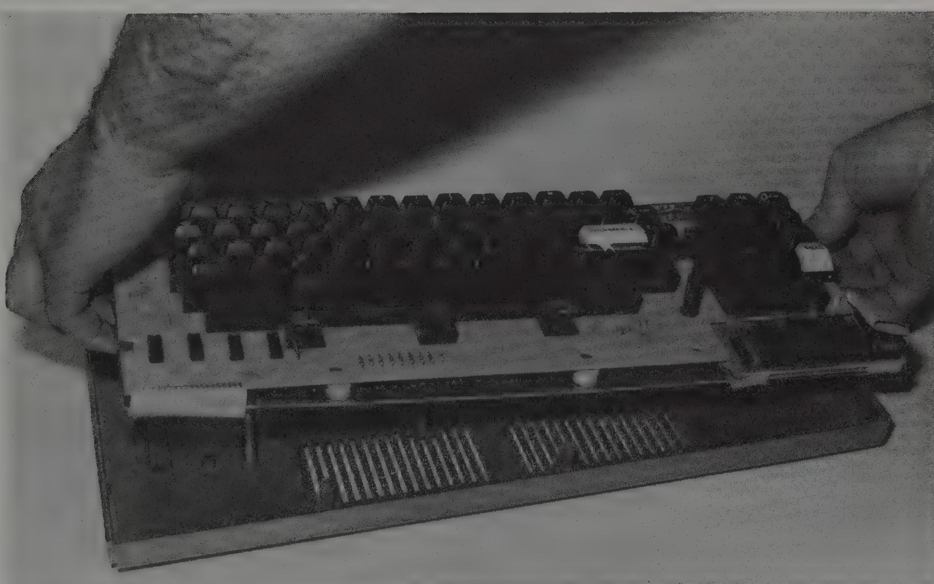


FIG. 5-6 Proceed carefully. In almost every computer made, if you've found all the holding screws and clips, the main board will lift out easily. Don't force anything.

To remove the main board, unplug the computer, take off the case, and disconnect everything going to the main board. Be sure to make detailed sketches so you'll know exactly how everything goes back together. Label everything.

Sometimes the circuit board is held in place only with screws. Other times, there will be clips. If you've removed the necessary screws and the board still won't move, look carefully for hidden clips. If the clips are plastic, be careful. They break easily.

Installation is just the reverse. If you've made sketches and have labeled all cables and connectors, you'll have no problems.

OTHER BOARDS

Without sophisticated test equipment, you probably won't be able to find the specific problem with a circuit board. Generally, the fastest way to test a particular board is to swap it out with one you know to be good. If everything works again, you'll have found the problem.

However, you can do a few simple things on your own. First, visually check the suspected board. Is it snugly connected? Are all cables going to it tight? Have any of the components worked loose? (Don't forget to shut down the power before removing or inserting any board, cable, or device and before pushing on the components to make sure that they are seated properly.)

Try cleaning the contacts with a high-quality electronic cleaner (*not* a television tuner cleaner. Don't use anything that could leave a residue!). If you don't have a cleaner around, you can use a soft pencil eraser, making sure that you don't get any particles inside the computer.

If the suspected board is new to your system, you must consider the "Has it ever worked?" question. Have you made any other changes to the system?

SUMMARY

Diagnosis of circuit board problems is often difficult and time consuming. Even professional repair shops commonly track the problem to a particular board and then just replace that board.

By observation and note taking, you should be able to isolate the malfunctioning board quickly.

As always, take some time to visually inspect for the obvious.

Are all cables and wires firmly attached? Are they connected correctly? If the suspected board is not the original or an exact replacement, is it compatible and designed to work with your particular model? Has it changed something else?

Fortunately, if a board operates when you first install it, it will probably continue to function for many years. No maintenance is required.

Chapter 6

Power Supplies, Keyboards, Printers, and Monitors

You can connect a number of different options and devices to your computer. Since there are so many different options, so many different manufacturers, and so many variables, it is impossible to cover them all. We have included only the most common options in this chapter. These should give you some basic guidelines for repair.

Use the information in Chapter 2 before you begin poking around in the equipment. The steps you took in Chapter 2 should have led you to this chapter.

THE POWER SUPPLY

The driving force behind your computer (and all things electronic) is the power supply (Figure 6-1). It does just what the name implies. It takes the 120 volts at 60 cycles per second from the wall outlet and changes it to a clean, steady 5-volt and 12-volt DC supply (Figure 6-2).

Normally, it does its job just fine and gives no problems. Chances are you'll never have to worry about anything going wrong with the supply other than the mechanical on-off switch (Figure 6-3).

If the power supply is acting up (Table 6-1), you may not be readily able to spot it as the source of the problem. The computer might seem to be completely dead. This could be caused by the power supply, but it could also be a problem with the system board or from a combination of other things. Your computer could also seem to be operating normally except for a data read/write problem. You might be inclined to place the blame on the memory or on the drives while

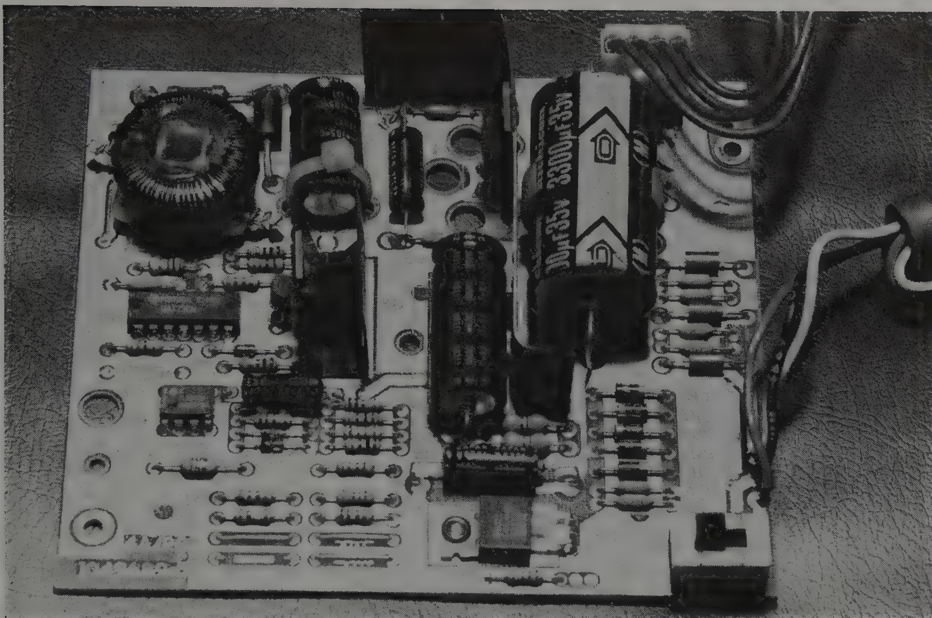


FIG. 6-1 A typical power supply.

the actual cause *could* be with the power supply. Don't replace it until you know for sure.

POWER SUPPLY DIAGNOSTICS

General diagnosis is the same for almost all power supplies. Repair is normally by replacement of the power supply unit.

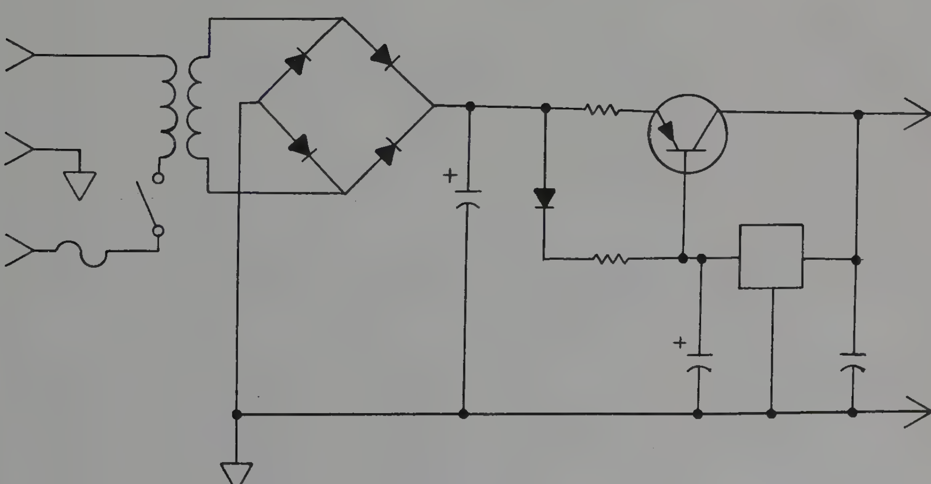


FIG. 6-2 A typical power supply schematic.

FIG. 6-3 Some small computers use an AC adaptor as a power supply.

Many computers and computer-related equipment make use of a switching power supply (Figure 6-4). This is a special and highly efficient means of changing the incoming AC voltage to the proper value of DC voltage. By its nature, it often costs more to repair than it does to simply replace the unit.

The AC adaptors used by some small computers are difficult to repair. Since cost of replacement is around $10, it's usually not worth the effort.

If nothing happens when you flip the power switch, you are likely to accuse the power supply without further thinking. This symptom could mean that the power supply has died. It could also mean that something else is wrong.

TABLE 6–1. Typical Power Supply Specifications

Input Power	90 - 130 volts AC (120 nom) @ 60 Hz; 2.5 amps	
DC Output	+5 VDC ± 10%	1 - 5 amps
	+12 VDC ± 10%	0.5 - 3.5 amps
	−12 VDC ± 10%	.25 amps
Maximum Case Temperature	130F (55C)	

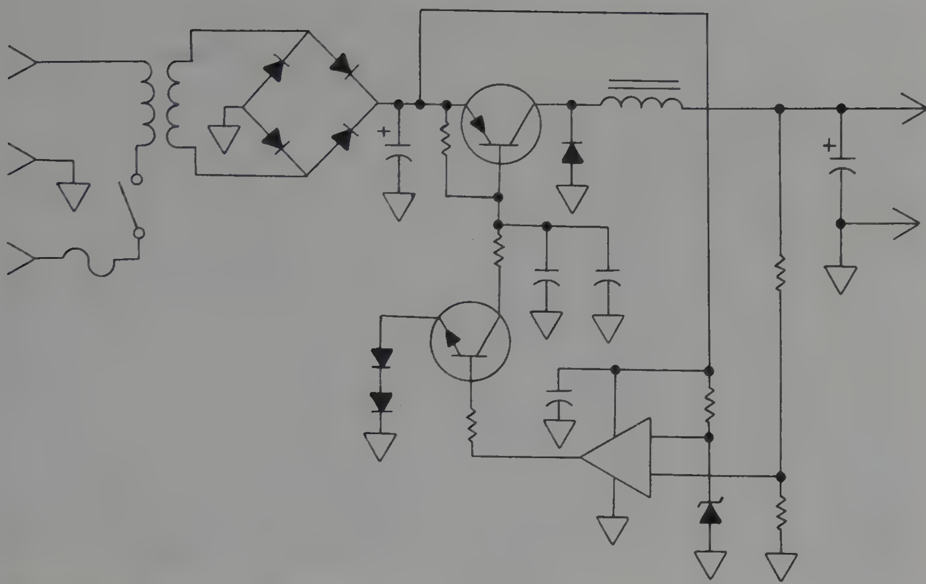


FIG. 6-4 Schematic of a typical switching power supply.

If the problem is outside a power supply, the power supply will try to reset itself. Each time this cycle occurs, the oscillator passes through an audible range and produces a soft click that you may be able to hear. If you hear this steady click, click, click, the power supply is working (or is trying to). Finding out for sure isn't difficult.

CHECK INCOMING POWER

If power is obviously present (e.g., the lights on the keyboard and computer come on or you hear the clicking), you can skip this first check and go on to the next steps. If nothing at all is happening, begin with this step.

The first things to check are the fuses, the power cord, the plug, the outlets, and the power switches. Once you have done this and know that power is getting *to* the power supply, you have eliminated the obvious. You've also started the process of isolating the problem.

As mentioned in Chapter 2, you can use a lamp or any number of other things to check the outlet for power. You are better off checking it with a meter. The power supply operates in the range of 107 volts and 132 volts. A lamp will operate beyond these ranges without any apparent difference, but the power supply of the computer will automatically shut itself down. Until you've checked the outlet with a meter, you won't know for certain if the problem is in the computer or in the lines that supply the outlet. (More information on using a meter to check outlets is contained in Chapters 1 and 2 and in the Appendix.)

If the outlet is good, check for 120 volts going across the fuse on the power supply. If you get no reading then the problem is somewhere between the power supply and the wall outlet. One by one, eliminate the external fuse, switch, and power cord. If you do get the correct reading (and the power supply fuse is good), go to the next step and check the power supply output.

CHECK POWER SUPPLY OUTPUT

If power is getting to the power supply but nothing is happening, it's time to see if the power supply is putting out the correct voltages (Figure 6-5). Most are designed to supply both 5 volts and 12 volts DC.

If you don't know which power supply output pins carry what voltage, follow the information given in Chapter 2 to take the readings. Keep in mind at all times that power is flowing during this test.

First, visually look over the output connector (Figure 6-6). If it's obvious that it does not carry the AC voltage to the power supply, proceed to the next paragraph. You can also skip to the next paragraph

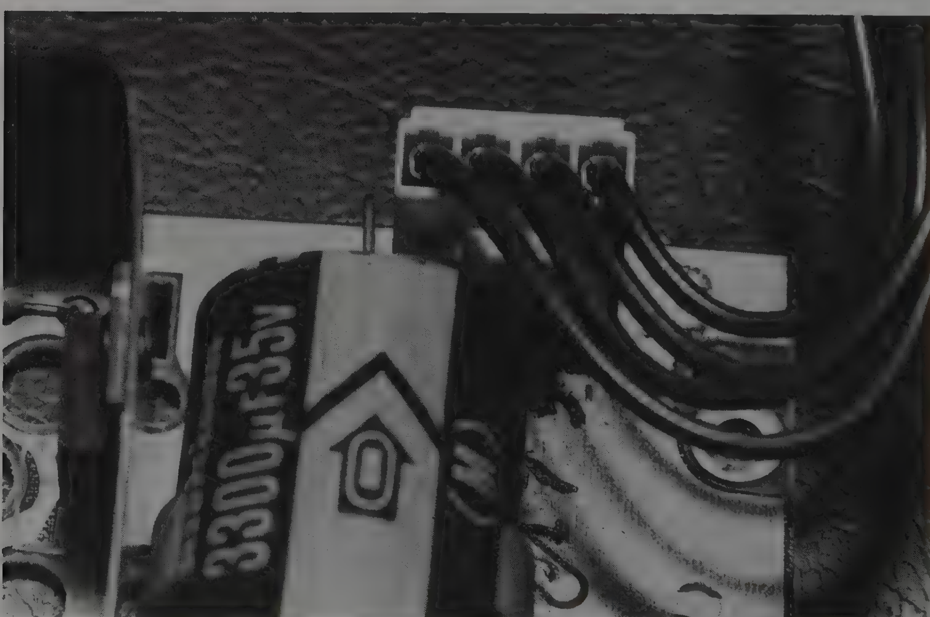


FIG. 6-5 Checking the voltage to the power supply.

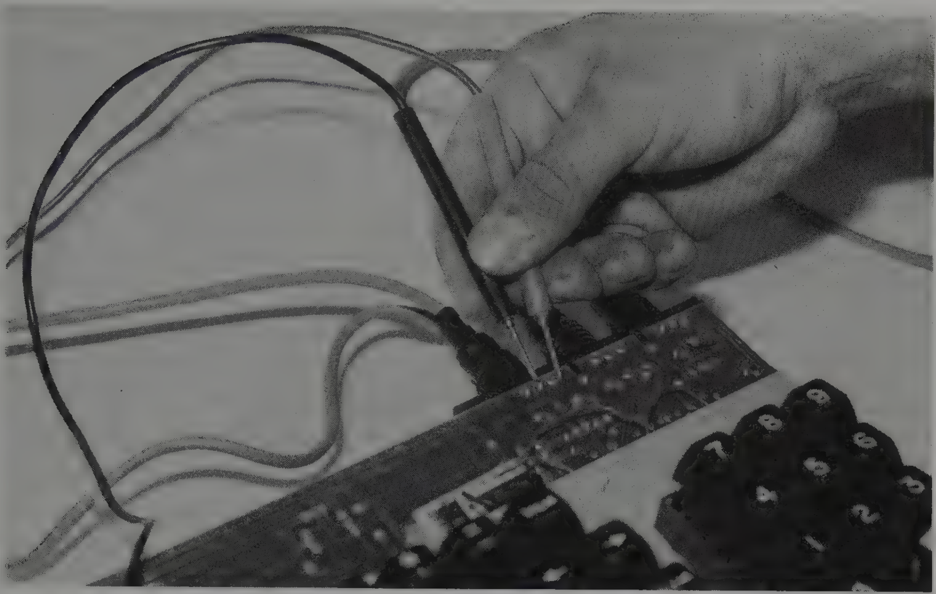


FIG. 6-6 Checking power supply output.

if you can see which pins carry the AC; otherwise, set your meter to read 120 AC volts. Connect the black lead to a known ground and carefully probe each pin in turn. You should get no reading on any of the pins unless the pin is carrying AC voltage. Be sure you make note of them and be extra careful around that connector.

Set the VOM to read DC volts, preferably in a voltage of at least twice what you expect to find. (This is to protect your meter. If you have your meter set to read 12 volts DC and touch the probes to pins that carry +12 VDC and −12 VDC, your meter will give you a reading of 24 volts—the difference of potential between the two pins.) With the black probe connected to a known ground, carefully touch each of the pins in turn. Be very careful not to cause a short by touching the probe to two pins at once.

You should now be able to create a table of voltage readings for the connector. If a pin shows no reading then one of three things is happening: either you've found a ground pin; that part of the power supply is bad; or you're doing something wrong.

After you know which pins carry what voltage and which are ground, you can more accurately probe them by using a DC voltage range setting on the meter that is closer to the actual output at the pin being probed. You're looking for 5 volts and 12 volts, possible as both negative and positive voltage. (If you notice that the needle of the meter swings in the wrong direction, you've located a pin carrying negative voltage. Reverse the probes and take another reading.) With most power supplies, a reading anywhere within about 10% of those values means that everything is fine. You're generally only concerned with larger differences, such as getting 2 volts from the 5-volt output pin.

TEST INTERNAL DEVICES

If you get no readings from the power supply, it means that either the power supply itself is bad or something is drawing too much current, causing the power supply to shut itself down.

Try to do your testing as quickly as possible to reduce the amount of time that the power supply is not loaded. With the power off, disconnect the power supply. You'll be probing that connector directly (Figure 6-7). If you don't already have the pin-out of the power supply, create one at this time. For the sake of illustration, assume that pin 3 is supposed to carry 5 volts DC. When you probed the connector with the equipment hooked up to the power supply, you

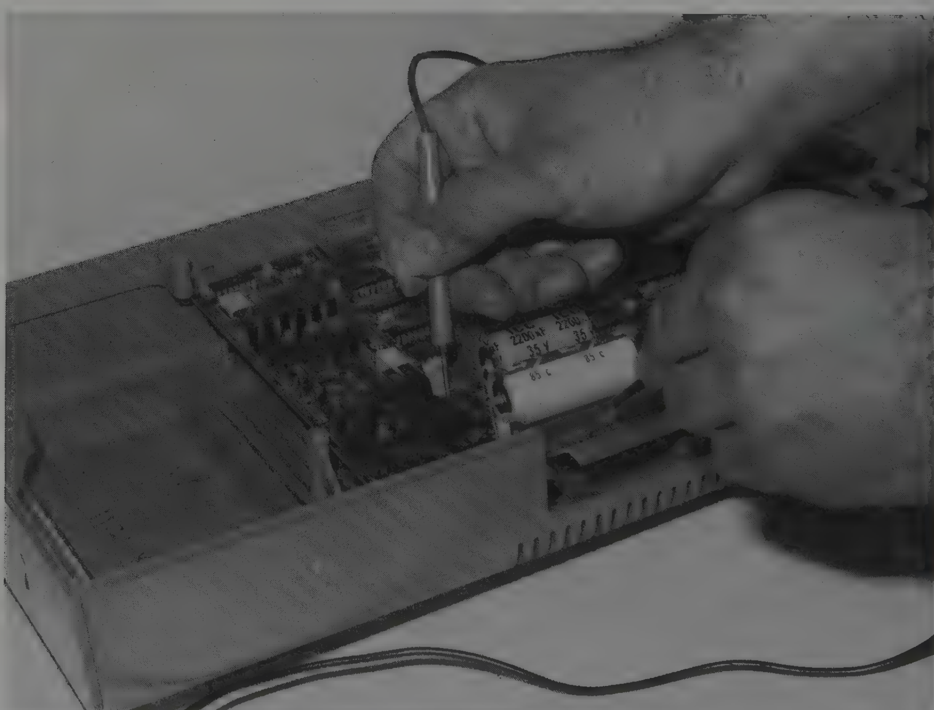


FIG. 6-7 Probing the internal devices.

got no reading, but now by probing directly, you get a measurement of 5 volts DC. Chances are that something connected to that 5-volt leg of the power supply is dragging it down and causing it to shut off.

Keep in mind that with most computers, +5 volts is supplied to operate the various circuits and +12 volts is supplied to drive the motors. If the device being tested has circuits only, it will probably be getting only the +5 volts DC (plus a ground for current return). If it has both circuitry and a motor, such as with a disk drive, it is likely to have both 12 VDC and 5 VDC coming to it.

If these voltages aren't correct, you'll know that the problem is definitely in the power supply. All you can do then is replace the faulty unit. If you still can't seem to find the trouble, shut off the power, reconnect the main connector, disconnect each device possible at the device (not at the power supply), then reconnect these devices one at a time until the power supply fails. Again, remember to shut off the power *each time* before making a new connection.

If a device is suspect, go to the appropriate section in this book for further help (e.g., if the offending device is the disk drive, see Chapter 4).

It's possible to get inconsistent results if the power supply is just starting to go so repeat this step several times, reconnecting the devices in a different order. Start with the device that caused the failure the previous time and you'll know very quickly if that device is really faulty.

CHECK DISK DRIVE POWER

This step tests if power is getting to the drives. If the drives have been causing trouble, you can find out quickly if the problem is in the drives, in the power supply, or in the drive cable.

With computers that use internally mounted drives (Figure 6-8), the power supply used is the same as the one that powers the computer. With this kind, a 4-wire cable connects at the edge of the analog card, usually on the rear left of the drive. If you suspect that the drive is causing the problem, it is best to unplug the cable and test the cable itself.

Of the four pins going to the drive, two are usually soldered together. If this is true on your disk drive, you've found the ground pin. The other two carry +5 and +12 volts DC. Set your meter to read 12 volts DC. Touch the black probe to the ground pin(s) and the

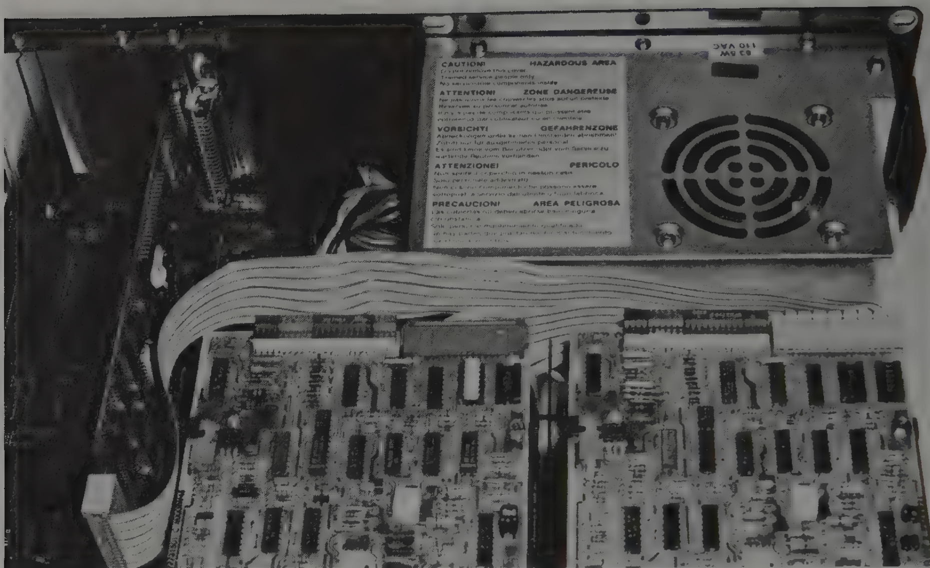


FIG. 6-8 Location of signal cable of an internally mounted drive.

red probe to each of the other two. If you don't find +5 and +12 VDC, power is not getting to the drive circuitry.

For disk drives that are self-contained, the power supply is enclosed in the same cabinet as the disk drive. Line voltage (AC) comes into the power supply, where it is converted to the needed DC voltage. If the incoming AC is removed, the power supply can't do anything. If the power is getting *to* the power supply but isn't coming *out* then the problem is with the power supply. If the power supply output is providing both the +5 and the +12 VDC then the problem is in the circuitry or in the mechanisms. (See Chapter 4 for more details.)

CARE OF THE POWER SUPPLY

A well-designed power supply lasts for years. However, quite a few manufacturers save money by using a minimally designed power supply.

To determine if you have one of these, you'll know if you find yourself replacing power supply after power supply or if your case is hot to the touch after the power supply has been in operation for only a few hours.

If the power supply runs hot, the key is to get the heat away from it. First, be sure that the power supply has plenty of ventilation. If the problem continues, install a cooling fan.

REPLACING THE POWER SUPPLY

The power supply is tucked inside the main cabinet of the computer. To make the removal and replacement of the power supply easier, remove the main board (see Chapter 5).

The power supply is held in place by screws that run through the rear or bottom of the cabinet (Figure 6-9). After you've labeled and disconnected all wires going to the power supply, remove these screws. The power supply will lift out easily. Installation of the new power supply is just the reverse of this.

If the time comes when you have to replace the power supply, look at the new unit before it is installed to be sure that it is set for the correct incoming voltage. Many computers use power supplies that can be set to handle 120 or 240 volts and either 50 CPS (European standard) or 60 CPS (American standard) current. This is done with a jumper—either a wire or a jumper block (Figure 6-10).

THE KEYBOARD

Each key is a switch. The keys are similar to the buttons on a joystick but much more durable. As you press down on the key, contact is made and the appropriate signal is sent to the computer by the circuitry.

Some of the IC chips on the keyboard are extremely sensitive to static electricity. They can be damaged if you even touch them with

FIG. 6-9 Removing the holding screws from the back of the chassis.

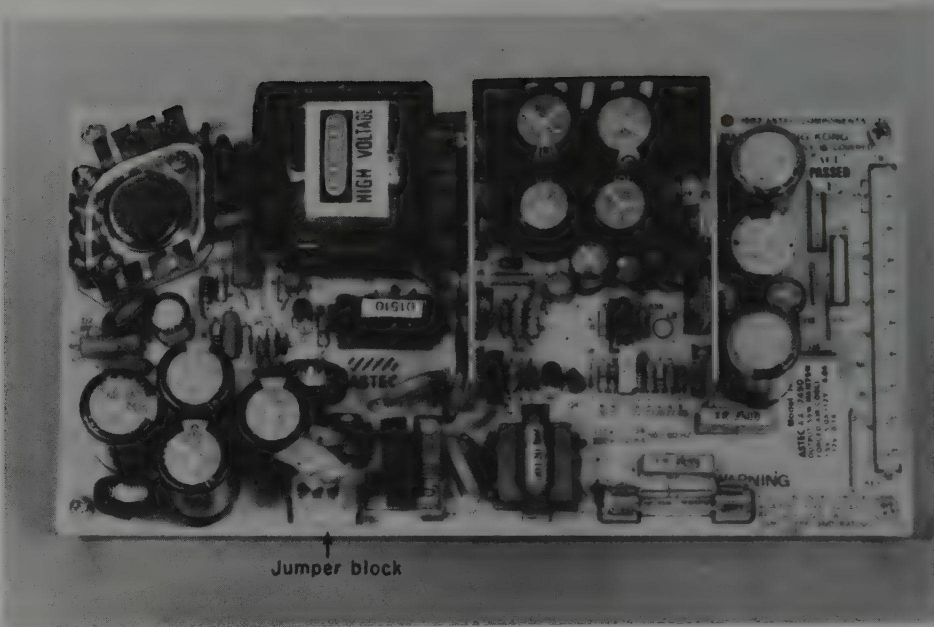


FIG. 6-10 Jumper block on an Astec power supply. For 110 volts, the block covers the two pins to the left.

your fingers. If you *must* touch them, be sure that you have drained off any static charge in your body by placing your other hand on the metal case of the power supply or by touching some other reliable ground.

Although the keys and keyboard are durable, like anything else, they can cause trouble or quit working entirely. When this happens, the easiest and quickest solution is to replace the entire keyboard. But before you toss out the malfunctioning keyboard, run a few simple tests. The problem might actually be elsewhere or could be something that is easily fixed.

As always, begin with the obvious. Is the keyboard plugged in? Is it plugged in correctly? (You're not trying to operate the keyboard through the modem port, are you?)

If the keyboard is doing nothing but is attached correctly, it might not be getting power. Press the Caps Lock key. If the LED comes on, then you know that the keyboard is getting the 5 volts it needs to work. (This can also be tested inside the keyboard, as detailed below.)

Set your meter to read resistance (ohms) to test the continuity in the cable. You can find out quickly if the problem is in the cable. This is done by touching the meter probes to the ends of each of the wires in the keyboard cable. The reading should be almost zero ohms between the ends of each of the four wires. If there is a break in the

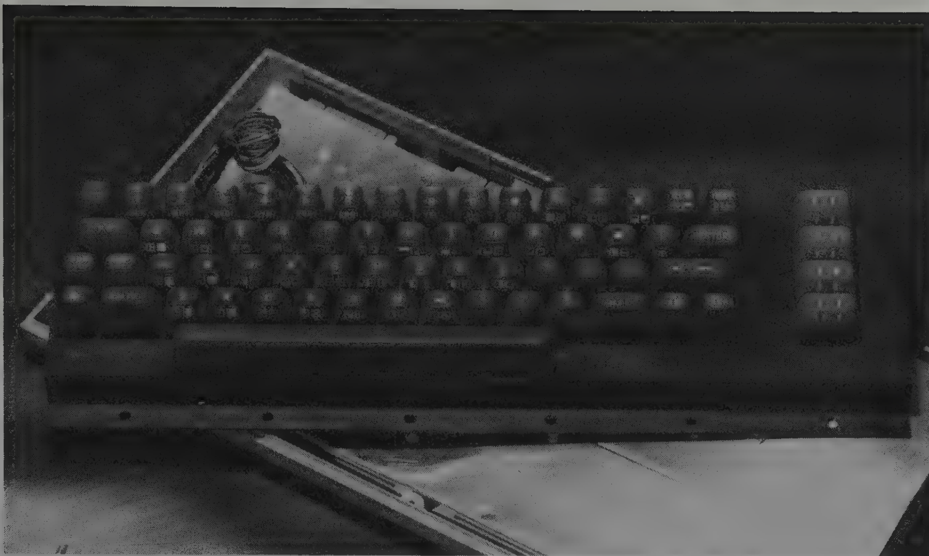


FIG. 6-11 Inside a typical keyboard.

wire, the reading will be infinity. In this case, replace the cable, and you're back in business.

An external keyboard is held together by screws. These are the small screws located on the sides and back of the keyboard case. The internal assembly (Figure 6-11) is secured by other screws on the bottom of the case but sometimes inside.

With the top cover off, you'll see where the cable connector attaches to the keyboard circuit (Figure 6-12). There are four or five

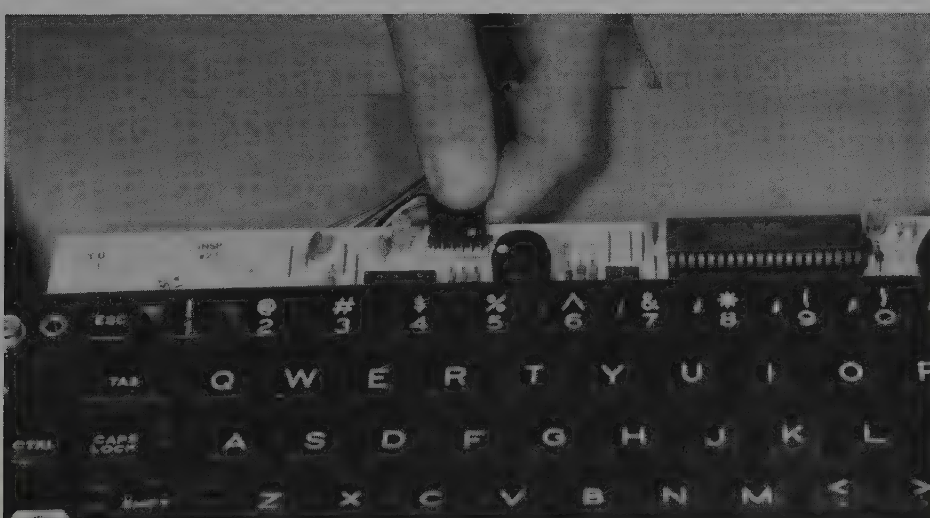


FIG. 6-12 The connector to the keyboard logic circuit board.

TABLE 6–2. Keyboard Pins

Pin	Wire Color	Use
1	______	______
2	______	______
3	______	______
4	______	______
5	______	______
6	______	______

active pins and more rarely six pins. By touching the probes of your meter across the pins (*carefully*—don't cause a short!) you can find out if power is getting to the keyboard. If it is, and if the keyboard is still dead, the keyboard circuitry is faulty.

Inside the keyboard are the electronics that handle the signals between the keyboard and the computer. Unlike the keys themselves, the electronics are prone to damage from fluid. To protect your keyboard, keep *all* fluids away from it.

In a sense, you test the keys each time you use the keyboard. To test an individual key electronically, you'll have to remove the keyboard case and the assembly. Set your meter to read resistance (ohms). On the bottom of the assembly (Figure 6-13), you'll see a number of traces (parts of the circuit board that act as wires). Trying to locate which points are which isn't easy, but if you're patient, you should be able to find the appropriate points. Touch the probes, one to each of the traces of that particular key. The reading should be infinite,

FIG. 6-13 The bottom of the circuit board. To replace a keyswitch, your first job will be to locate the two traces to that particular key.

showing that there is no pathway. When you press the key, the resistance should drop to almost zero. If this doesn't happen, the keyswitch needs to be replaced.

CHANGING A KEYSWITCH

Changing a key isn't an easy job. To do it, you will need a high-quality soldering tool and some experience in using it. If the heated tip touches the circuit board for more than about three seconds, the heat could lift the tracing from the board. Melt the solder on the pins of the switch. A desoldering tool is very helpful in removing the melted solder. If you've done everything right, the key should come out easily. *Don't* force it.

The new key is installed in reverse order. Once again, be very careful when using the soldering tool. If you don't have experience with soldering, leave the job to a professional. Soldering is not as easy as it seems. In fact, most people prefer to replace the whole assembly rather than going through the time and bother. Unfortunately, sometimes you have to replace the entire computer since some models have the keyboard as a physical part of the computer.

PRINTERS

There are many different printers available. Each has its own characteristics and construction. One might require a partial disassembly to just reset the switches. Another will have a built-in memory buffer. Still another could have the dual capabilities of both computer printer and standard typewriter. There are differences in speed, print quality, and printing technologies. The printer may require a serial connection, a parallel connection, or may allow you to choose which you prefer. Some may even require some special software patched to your regular programs. With the wide range available, it isn't possible to give repair information on all makes and models.

The manual that came with your printer is the best source for specific information. Become familiar with it and find out what capabilities your printer has and how to take care of various problems that could come up.

PRINTERS IN GENERAL

Many printers give you the option of connecting it either as a parallel device or as a serial device. Parallel is the more common means of connecting a printer for several reasons. If the computer has one port of each type, the serial port is usually kept open for communications. Devices such as modems require a serial connection. By connecting the printer as a parallel device, you can keep the serial port available.

Since the printer is a mechanical device, it is prone to more wear and tear than most things connected to the computer. It has at least two motors (for head and platen) and may have more. The print head moves back and forth across the platen. It also either spins (as with a daisywheel printer) or has a print head that makes characters by punching at the paper with wires (dot matrix printer). All this motion causes wear. It can also create fair amounts of heat. If allowed to build up, heat can cause all sorts of damage, both mechanical and electronic.

The first thing to do is to get out the manual for your printer and become familiar with the information. Many manuals give specific error signals to let you know what has gone wrong. Also included will be information specific to your printer, such as how to remove the platen and other parts to free up a paper jam, how to load the ribbon, and so forth.

Paper can jam as it feeds through the printer. Even single sheets can cause a paper jam. Printers that use multiple sheets (with sheet loader or tractor) are even more prone to jams. Jams also tend to be more common if your printer is connected as a serial device. When a jam occurs, the printer can grind to a halt. Sometimes the jam isn't apparent. A few printers require a fairly complicated disassembly to get at it.

If the ribbon isn't installed properly, all sorts of strange things can happen. Part of a character might print, leaving the other part weak or nonexistent. It could shut down the printer entirely or print a couple of characters and then act as though the signal had stopped.

In some printers, the end of the ribbon is sensed by a small switch. As the ribbon reaches its end, the switch stops the printer. This switch can also signal that the ribbon is used up if the cartridge isn't attached properly or if the switch fails. Other printers feed the ribbon through continuously. When the print gets light, you replace the ribbon.

Many printers have a safety switch in the lid. Lift the lid and the switch tells the printer to stop. If will tell the printer the same thing if the lid isn't closed all the way or if the switch is faulty.

If the printer is not making an impression, remove the paper and look for indentations. The print head will make indentations in the paper if it is working, even if the ribbon is not. If the paper has the marks from the print head, the ribbon or ribbon advance mechanism is causing the problem.

There are lots of adjustments possible with most printers. There are the usual spacing and forms thickness (number of sheets) adjustments, the release catches plus others. Just as a typewriter won't function properly if the adjustments aren't correct, neither will the computer's printer.

Checking for all of these things goes back to the standard rule, "Look for the obvious." The majority of the time, the problem will be something very simple.

By performing occasional maintenance checks and cleaning the printer, you can greatly reduce the malfunctions. Clean the ribbon guides, print shield, and the inside of the machine. A buildup of ink or paper dust can cause problems. If your printer has a built-in self-test, run it occasionally. (Run it once when you first get the machine and know that the printer is operating correctly. How else will you know what the results of the test are *supposed* to be?)

This self-test allows you to carry the diagnostics one step further. If the test shows that the printer is operating correctly, you'll know that the problem is in the printer interface, in the cable, or in the computer. You can eliminate the cable by testing for continuity with your meter. The diagnostics diskette can tell you if the printer adapter card and port are functioning correctly. About the only thing left is the interface in the printer itself.

PRINTER DIAGNOSIS

If there seems to be no power going to the printer, check the outlet, the power cord, and the fuse before assuming that the problem lies in the power supply. If power is obviously present, you can skip all power checks and go to the more detailed diagnostic steps, such as running the self-test of the printer (if it has one).

If power is getting to the printer but nothing happens, check once again all cables, connectors, switches, and the software itself. You can eliminate some things simply by knowing that the printer once functioned as it should.

The self-test cycle of the printer (if it has one) should give you a good idea of where the problem is. If the self-test operates, the printer itself is likely to be just fine. The problem is then more likely to be inside the computer or with the cable.

You can easily eliminate the cable as the possible cause by using your meter. Disconnect the printer cable. With the meter set to read resistance (ohms), touch the black probe to a pin on one end of the cable and the red probe to the same pin on the opposite side. A reading of near zero ohms means that the wire between the pins is good. An infinite reading shows that the wire in the cable is broken or that those pins are not used.

The cable between the computer and the printer has up to 36 pins if it is configured as parallel and up to 25 pins if the printer is serially connected. In either case, some of the pins are not connected to anything and will give a reading as if the wire inside is broken. The printer manual should tell you which pins are used and which are not. Without this, you'll have to take the cable heads apart to know the wiring. Inside, the wires are probably color-coded. If even one wire is broken inside the cable or if just one isn't making proper contact with the connector, the printer might refuse to function. (See Chapter 8 or the tables at the end of this book for a listing of the pin allocations for the standard ports used by computers.)

Refer to the manual for the correct switch settings. If these aren't set correctly, the best the printer can do is punch out meaningless garbage. It is also important to have the software you are using "installed" (getting that piece of software compatible with your printer) if the program calls for this. (The procedure for this is usually in the software documentation.)

Change just one thing at a time in a step-by-step method. It's sometimes tempting to use a "shotgun" approach, but this can only cause confusion.

VIDEO PROBLEMS

Monitor problems are usually obvious. The screen may be blank. It may show an incorrect display. It could have an image that is tilted, too small, too large, out of focus, too dim, and so on. If the image on the screen is out of whack, the problem is probably with the monitor itself. If the problem isn't in the monitor, there are only a few other places it could be. You can find out quickly by running a few tests.

Unfortunately, working with the video circuits of a computer presents several dangers. Testing and adjusting can be done only with power flowing. And the power you'll be coming into contact with is potentially deadly.

The CRT requires a high voltage to operate. If this doesn't scare you away from the monitor section, trying to reach those circuits often means that you will be very near the power supply and the incoming 120 volts. A piece of insulated tape, such as black electrical tape, placed over the fuse and other hot spots can reduce the risk to you.

It can't remove it entirely. (Obviously, have the power shut off when putting the tape over the fuse.)

One very simple thing can be done. With the cabinet off look at (DON'T TOUCH!) the neck of the video tube. Under a dim light, you should be able to see a soft glow. If this glow is present, chances are good that the CRT tube itself is not at fault. The problem is more likely in this case to be in the video circuitry.

Check the brightness control knob and other controls before you do anything else, even if you're sure that it hasn't been touched. You can also dig out your meter and run a continuity check on the signal carrying cables. Do not attempt to check any wires that could be carrying voltage unless you know how to discharge the CRT (Figure 1-1).

A sudden change in the display during operation indicates that something besides the manual adjustments is wrong. A simple adjustment probably won't help. If this happens, make detailed notes of what is happening and when. Then take your computer to a professional.

SUMMARY

Power supply problems are not always obvious. The built-in protective circuitry will shut down the power if something is wrong elsewhere in the system. A "nothing happens" situation does not necessarily mean that the power supply is at fault.

Testing the power supply is a matter of eliminating devices one at a time and of taking a few voltage measurements. Within just a few minutes, you should be able to isolate the problem to something specific.

The keyboard is continually tested merely by using it. If pushing a key consistently does nothing or if the key simply feels wrong, you'll know that it's time to perform a more thorough testing or that it's time to replace the individual key or the keyboard itself.

Printers are famous for giving troubles. They are mechanical devices with at least two motors spinning along. Just connecting the printer in the first place can be a frustrating chore. Once it is up and working, you can keep it that way by some occasional maintenance, such as cleaning out the paper dust.

As with printers, a malfunction of the monitor is generally obvious. Begin by eliminating other possible causes. If you haven't found the problem after this, it is far better to abandon further attempts at repair and take the computer to a professional. There is considerable danger involved in working around the video section of your computer. Even if you don't mind the risk of your life, proper repair or adjustment requires special tools. Leave it to someone who knows and who has the proper tools and software.

Chapter 7

Preventing Problems

Computers are actually very simple devices—less complicated than most other electronic devices around your home or office. Most of the activity takes place inside the circuits. There isn't much to be done as far as maintenance goes. There is very little to adjust, very little to clean, almost nothing to go wrong.

Even so, you can reduce repair costs and aggravation by performing a few simple maintenance checks now and then.

THE ENVIRONMENT

The most important aspect to the overall health of your computer system is its surroundings. The more dust and other contaminants that are around, the more often your system will give you trouble.

One owner used his computer to keep track of his electroplating company. The computer was kept separate from the plant but not separate enough. The acidic fumes were obvious, both to the nose and to the computer. Every few months, he would have a major computer failure. Twice in the first year, he had to replace the drives and once the entire system board.

Another company hired an operator who smoked heavily. Within a few months, one of the drives was malfunctioning. When opened, it was discovered to have a heavy layer of grime. The second drive was in nearly as poor condition.

The cleaner you keep the computer room, the better. You won't be able to keep it sterile and totally dust free, but this isn't really necessary. Your goal is to reduce the amount of contaminants.

As electricity flows through the circuits, heat is generated inside the computer. Computers with internally mounted hard drives tend to build up even more heat. If the heat is allowed to build up inside, some strange things can happen. One of the most common is puzzling BIOS errors that seem to pop up for no reason. If the heat buildup continues, actual damage can occur.

To improve cooling, some computers have a small fan. A filter is provided to reduce the amount of dust that gets pulled inside the computer. If this filter gets dirty, the fan can't do its job. What appears to be a serious malfunction (the BIOS errors) is likely to be nothing more than a dirty filter.

It takes only a few minutes to clean the filter (Figure 7-1) which should be done once a week. Although a little dust is unlikely to affect the circuits, it's murder on anything mechanical. When dusting around the computer, use a damp cloth. This will pick up and trap the dust, not just spread it around. It will help to keep dust out of the air. While you're cleaning the area, clean the computer equipment. Dust will gather on the equipment, particularly on the monitor screen.

On the cloth, use a gentle cleaner or just plain water (squeeze out the cloth so it is barely damp). Be especially careful with the monitor screen. It has a nonglare coating that can be damaged.

Do not have open containers near the computer! It's too easy for

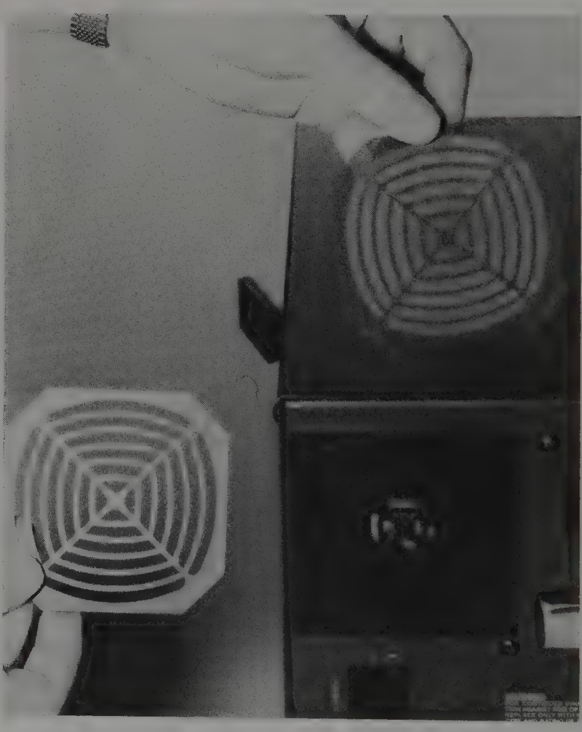


FIG. 7-1 Some computers have a filter cover. Usually, this is screwed into place, or it can be popped off with your fingers. If your computer has a filter, be sure to keep it clean.

liquids, powders, or whatever to spill. When they do, they have the unfortunate tendency to fall exactly where they can do the most damage.

Be very careful to avoid getting liquids of any kind into the electronics of the computer. A slightly damp cloth can be used to clean the cabinet, monitor, printer case, and the outer edges of the keyboard. *Do not* use a damp cloth inside anything electronic. You're asking for trouble if you do. Dust will have very little effect on the electronic components under normal use.

The inside can be cleaned with a vacuum cleaner (with a soft brush) if the dust has built up. This isn't really necessary, as the components inside the computer itself aren't sensitive to dust as long as it is dry. The internal parts of the printer are more important. Paper gives off a surprising amount of dust. This paper dust can collect in all the wrong places and can jam the mechanical parts.

There is no such thing as being *too* clean around a computer. Keep the area as clean as possible, and be sure that your cleaning doesn't just toss all the dust and grime into the air. For example, if you use a vacuum cleaner, move it slowly to keep down the amount of dust. Don't use anything like a feather duster anywhere around the computer because it just throws dust into the air.

ELECTRICITY AND TRANSIENTS

"Dirty" power is another computer-environment problem. Power companies are well known for supplying "dirty" power (with surges, spikes, and brown-outs). Although it isn't actually a maintenance step, keeping these electrical transients out of the computer is important in preventing damage to the delicate circuits.

Many manufacturers are building in special AC line filters to help reduce damage caused by transient voltage. An external device (Figure 7-2) takes the protection one step farther. If your area is prone to brown-outs (drops in line voltage) or regular and unpredictable power outages, you might also want to invest in a battery backup unit for your computer. These devices keep the power flowing at a steady level even if the electricity coming into your home or office fluctuates or stops.

READ/WRITE HEAD CLEANING

There are two opinions about head cleaning. One is that it is never necessary and can only cause damage. The other is that you should

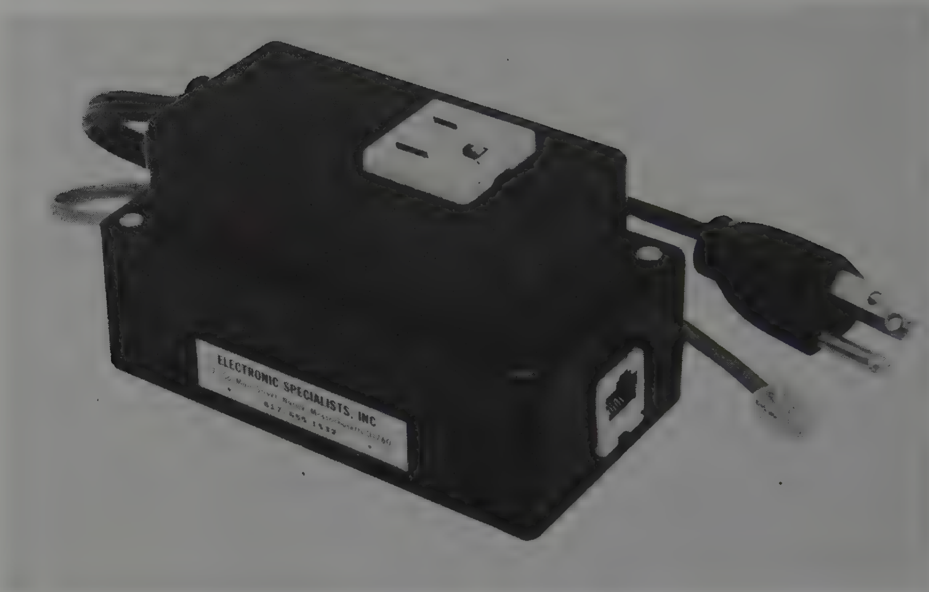


FIG. 7-2 Devices to protect your modem are available.

clean the heads after every so many hours of use and that the cleaning will cause no damage at all.

Both are true, sort of. Obviously, you're better off leaving the heads alone as much as possible. But when cleaning is necessary, it has to be done. Nor can you afford to wait until the recorded data is full of errors due to a dirty head.

Anything abrasive used on the heads is obviously capable of damaging the heads. The same goes for cleaning fluids that can affect other parts in the drive. If you stay with a well-known brand, you should have no trouble at all.

The idea of cleaning the heads after so many hours can also be misleading. The key is your own environment. Obviously, if you work in a sterile environment and use only the best quality diskettes, deposits will be minimal and you won't need to clean the heads very often. On the other hand, if you're a heavy smoker or have the computer in a poor air environment (shame on you!), you will have to clean the heads more often.

Head cleaners can only take off "new" deposits. If you let those deposits build up over a long period of time, they become permanent parts of the heads. No cleaning kit in the world will take off such deposits, at least not without destroying the head at the same time.

There are various ways of cleaning the heads. Before people realized how much damage could be caused, abrasive cleaners were used. These literally scratched away the contaminants. Fortunately, very few of these are around now. Such a cleaner will certainly take away all the built-up grime. It will also take away the surface of the head.

The next step is a "nonabrasive" head cleaner with a bottle of fluid in the package. Again, you have to be careful of rotating pads that are too abrasive. Stick with a reputable brand and you won't have much to worry about in this respect.

Be careful not to oversoak or undersoak the pad. Both can cause problems. If the pad is undersoaked, the abrasive action is increased. (It also won't clean the head as well.) If it is oversoaked, you'll have the excess fluid sloshing around inside the delicate parts of the drive. It will evaporate before too long, but in the meantime, it can cause problems. Worse yet, there's no way to know if harmful materials have been deposited elsewhere in the drive or if other damage has been caused that will show up at a critical moment.

The most expensive head cleaners are presoaked with cleaner. Carefully measured amounts are already on the diskette cleaning pad, which means that you have virtually no risk of having the cleaning fluid (and the stuff it has dissolved) dripping into places you don't want it.

The disadvantage of such a cleaning kit is that the cleaning diskette not only costs more to begin with, it also wears out sooner. Since only the minimum amount of cleaning fluid is used, the fluid can evaporate more quickly from the cleaning pad, making the diskette useless, if not dangerous. This won't happen if you follow the directions, though. The advantage is that you have much less risk of damaging the heads, the drive itself, or other diskettes you put in.

You can clean the heads manually, of course. This involves some work and risk on your part. To do this, you'll have to remove the drive case and the circuit board inside. You simply can't access the heads safely otherwise. There is also the very real danger of knocking the heads out of alignment. Generally, this is *not* the way to go about it.

If you choose to clean the heads manually, you'll need some very clean cotton swabs (the tighter the better) and cleaning fluid. Isopropyl alcohol will do but *only* if it is pure. Much of the alcohol available to the general public has water and certain oils in it. Some has other contaminants that could be harmful. Using alcohol that is available "off the shelf" is a great way to guarantee damage to the heads and drive. Technical grade alcohol is available through chemical supply companies. Be sure that you specify *pure* isopropyl alcohol with *no* contaminants.

You can also use fluid head cleaner for audio tape players. Again, it is important that you get the very best possible. Don't try to save a few pennies. The heads of your disk drives or cassette deck are too important and too expensive to replace.

CASSETTE TAPE TRANSPORTS

While you are cleaning the heads of a cassette deck, visually inspect the transport mechanisms (Figure 7-3) for any parts that are obviously damaged or out of alignment. Since the tape will leave a residue of oxide and binder on the heads, rollers, capstans, and other parts, these deposits must be cleaned away for perfect operation.

Unlike disk drives, the read/write heads of a cassette deck can usually be cleaned manually. This is the best way since so many of the cleaning cartridges for cassette decks are of inferior quality and may actually leave a film behind on the head that is worse than the deposits the cartridge is supposed to clean off.

The same cleaner you use for the heads is fine for use on the metal parts. Do not use alcohol or head cleaner on the rubber rollers unless the bottle label specifically says that it is okay. Most cleaners dry out the rubber prematurely.

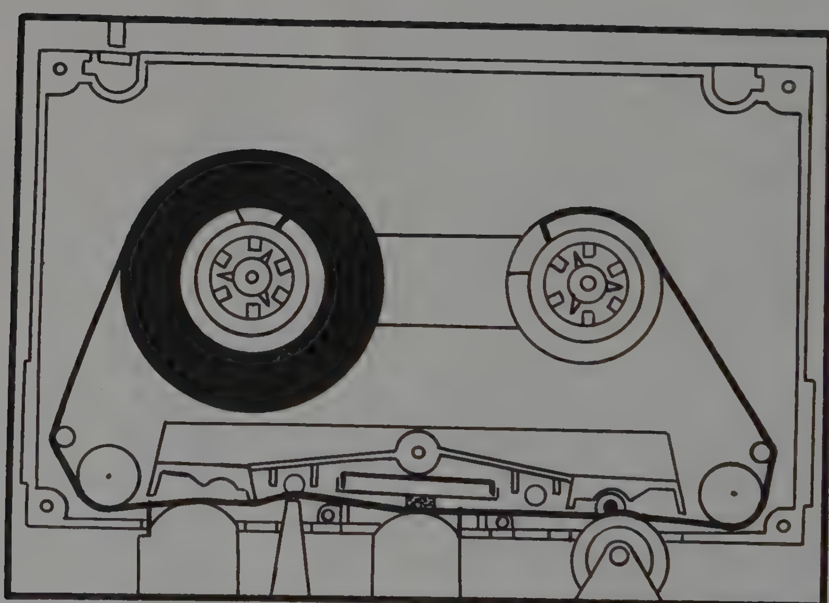


FIG. 7-3 The basic parts of a typical tape transport system.

DISKETTES, TAPES, AND SOFTWARE

The more you use a piece of software, the greater the chance of trouble. In Chapter 3, you learned how tough—and how delicate—a diskette is. Its major problem is that of the "allocation table" or "catalog." Each time you use the diskette, the computer seeks out this track to learn what you have on the diskette. This means that the life of the diskette is directly proportional to the number of times you use this track.

The second major problem with diskettes is that of overediting. A disjointed file is much more prone to hand out errors than one that is in a logical sequence. The computer has to keep track of which changes you've made and to which files. They may end up scattered all over the diskette.

The solution is to make copies often of a single file, a group of files, or all the files on a diskette. Complete instructions are in your "User's Guide."

One method of diskette copying creates an exact duplicate of the original, complete with all the fragmented files. To correct for overediting, do not use this method. The second takes a complete file from one diskette and copies it sequentially onto the other. Although a bit slower, this will correct the fragmentation.

Programs used often should be copied on a regular basis. (Not all programs allow this in an effort to thwart software pirates.) The new copy also has a new allocation track, which will bring a worn program back to life again.

If the program is "copy protected," you may be able to make a backup copy by using a program that breaks through the protection schemes of "uncopyable" programs. The purpose of such copy programs is not to help software pirates but to allow legitimate users to backup their important (and expensive) originals.

Don't wait until the program or stored data has failed before making the backup. Do so immediately! If the backup sits on the shelf or in the box for a year, great. You don't make the backup to use, you make it to ensure that a diskette failure doesn't knock you down and out.

Before filing away the backup copy for safekeeping, test it thoroughly. If it is a program, don't just see if it will load. Actually work it. If it is a data diskette, check it to see if the data has been transferred intact and without errors.

Unlike the diskette, cassette tapes have a tendency to stretch out of shape over time. Moving through the rollers also gives the tape plenty of chances to bind or wrap around the rollers. Sometimes you can fish out the raveled tape or splice it, although this could mean that you'll be cutting away necessary data for the computer.

Improper storage increases danger: if the tape becomes too dry, it can become brittle or develop minute static charges on its surface that can in turn cause changes in the stored data.

DIAGNOSTICS PROGRAMS

There are a number of diagnostics software packages available for many computers (see Chapter 2.) Some check out the whole system, including the various major circuits and chips. Others test only the disk drives. If you don't already have one of these packages, invest in one.

Many people spend the money to get one of these packages, thinking it is useful only to spot problems after they have happened. Actually, its main function is that of spotting problems before they *are* problems.

Using a diagnostics package should be a part of your regular maintenance schedule. Especially important are those programs that test the disk drives since these are the most critical devices in your computer and the ones most prone to malfunction.

OTHER STEPS

It's all too easy to get used to the power of the computer and forget that it is quite delicate in certain ways. Make it a habit each time you sit down to the computer to review in your mind all the things that can go wrong. Pay close attention to what your machine is doing and how things are working.

If you have a friend with the same computer as yours, swapping computer time will help keep you informed of any serious malfunctions that are occurring, especially if you do it on a regular basis.

If your friend's computer is not compatible, your dealer may let you use one of the floor machines. Lacking this, consider joining a users' group, where others are likely to be after the same sort of cross-checking.

SUMMARY

There is very little maintenance to be done with your computer system. Invest just a few minutes per week and you've done just about everything necessary to keep your system running without trouble.

TABLE 7–1. Maintenance Routines

Daily

1. Make backup copies of all data diskettes you've been using. This should be done at the end of each session and periodically during the session.

Weekly

1. Give the computer area a quick clean to cut down the amount of dust.
2. Make copies of any data diskettes that have been used heavily to restore the data to a sequential order.
3. Clean disk drive heads, if needed.
4. Clean fan filter.

Monthly

1. Thoroughly clean entire area, including the inside of the printer.
2. Clean the read/write heads.
3. Run a diagnostics program on your system.
4. Test devices and equipment that are rarely used.

Occasionally

1. Test backups already made.
2. Make new backups of important programs and data, if needed.
3. Spend some time with your diskettes on someone else's compatible computer.
4. Learn something new about your system and its programs.

The environment around the system is critical. The cleaner you keep the general area, the fewer problems you'll have and the less maintenance you'll need. Keep dust and other contaminants away from the computer as much as possible.

If you ignore the drive heads for too long, they could develop a permanent build-up of particles that no cleaner can remove. The result will be faulty reading and writing of data at unpredictable times. A periodic cleaning of the heads, using the best quality head cleaning kit, will help to keep the heads working perfectly for many years. How often you clean the heads will be determined by how much your computer is used and what the surroundings are like.

The most delicate part of a computer system is the software. Handle the diskettes carefully. Just as important, make backups of all diskettes a regular part of your work schedule. The cost of diskettes is cheap compared to the cost of replacing lost programs or data.

Table 7-1 is a guide to regular maintenance of your system. The actual frequency the maintenance routines are performed will be determined by your usage of the system. For example, if you only work at the computer for a few hours per week, you probably won't need to clean the read/write heads as often. Table 7-1 is only a general guide. Set up a schedule to suit your own circumstances.

Chapter 8

Adding to Your System

Just when you think you have everything you need as far as computers go, something else comes along. The printer you have may not be printing fast enough for your needs, or perhaps the character quality needs to be improved. You may decide that the built-in monitor isn't large enough and that you want an external monitor. There are a number of modifications that can be done to the hardware. You're almost certain to be adding new software programs from time to time.

Even if you don't add something to your system, the day could easily come when an existing piece of equipment requires replacement. The steps in replacing a device are nearly the same as adding that device for the first time.

This chapter will show you how to handle some of the most common additions. Your own circumstances will be slightly different in some cases, depending on the equipment you're using. However, the general guidelines presented here should help.

When installing a new piece of equipment, try to change only one piece at a time. For example, if possible, don't add a new printer *and* a new, untested printer cable.

It's important that you become as familiar with the new device as soon as possible. If it has an installation manual with it (most accessories do), read it through carefully. Certainly don't try to install it while reading the manual for the first time.

The biggest problem that most people run into is that of being in too much of a hurry. Take your time. If you don't understand the instructions, go back and read them again. Have a good idea of what you're doing before you start and you're much more likely to have the installation work. Before actually installing anything, go through the procedure at least once mentally. Do you know which steps to take and when? Check and double-check any switch settings (Figure 8-1) or jumper changes you've had to make.

Finally, NEVER install a device while there is power flowing. Shut off the switch. To further protect yourself, unplug the computer. If you leave the computer plugged in, be aware that the line and power switch are still "hot."

REPLACING A DRIVE

The most delicate part of any computer system is the disk drive. Since it's mechanical, it gets more wear and tear than the nonmechanical parts (the electronic circuits).

Chapter 4 gives you detailed information on how to determine what the cause of the trouble is and how to fix some of those problems. The steps from Chapter 7 are important for preventing those malfunctions *before* they happen. Even so, the day may come when you have to replace one of the drives.

You won't be able to buy just any disk drive and hook it up to your system; however, chances are good that you will be able to find

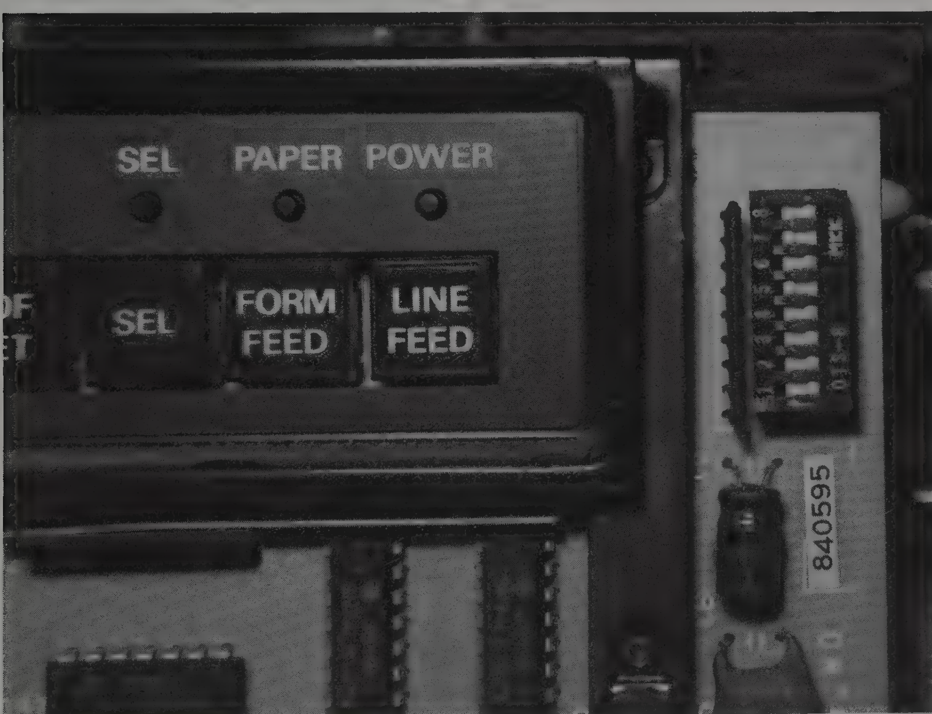


FIG. 8-1 The DIP switches of a printer.

at least three or four manufacturers who build drives that will work with your system. When replacing a bad drive, find an exact replacement for the drive you already have. You have merely to look at the old drive to know how to set up the new one; otherwise, follow the manual instructions.

THE BASIC STEPS

Whichever drive you use, there are certain steps that are always the same. The power should be off and the power cord removed from the wall outlet.

With an external drive, plug in the signal cable between the drive and the computer, then plug in the drive and you're ready to go.

For a computer where the disk drive is internally mounted (Figure 8-2), remove the cabinet to access the holding screws in the brackets for the drives. These might be standard screws, hex nut screws, or screws with Allen heads.

Disconnect the signal and power cables (Figure 8-3) from the rear of the drive to be replaced. These are keyed, but take note of where they go and how. With the cables and holding screws removed, the

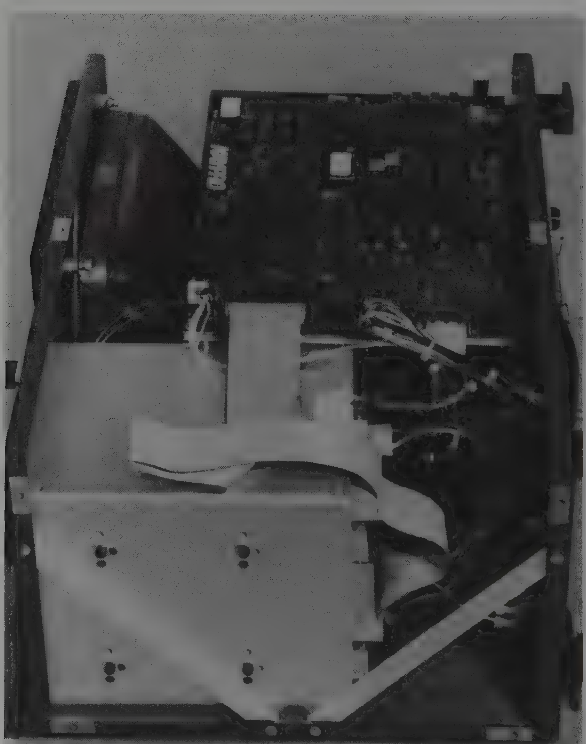


FIG. 8-2 Inside the computer. Note drive case.

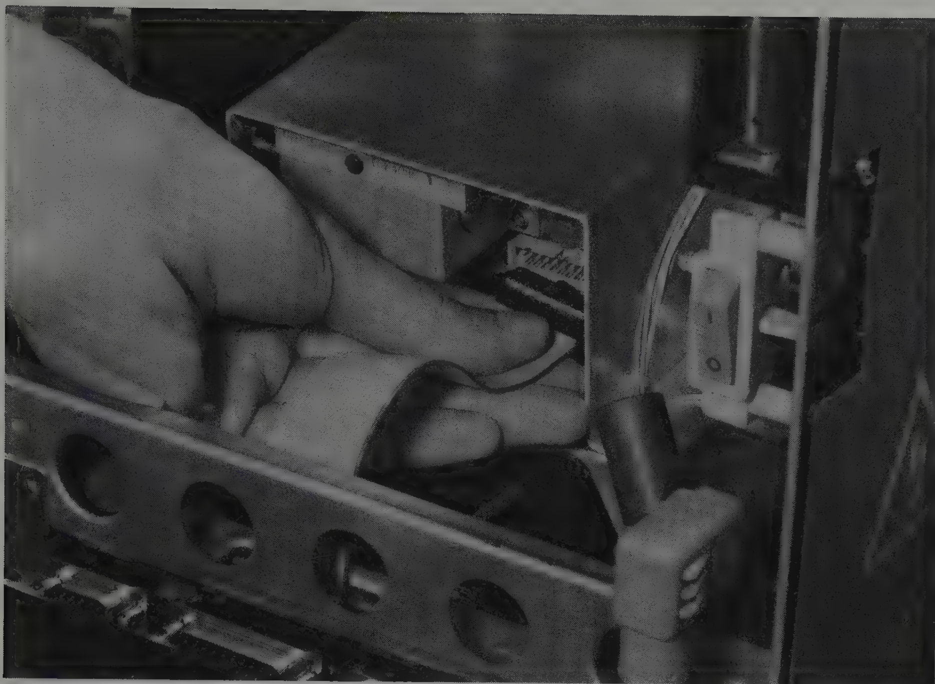


FIG. 8-3 Disconnect signal and power cables.

drive should slide out easily. If it doesn't, look again to be sure that you haven't forgotten something. Be especially careful of banging the components on the chassis as you slide the drives out.

CONFIGURING THE DRIVE

Drive installation differs depending on whether the drive is installed as drive A or drive B. Usually, you'll be inserting or taking out a jumper wire or jumper block and/or a terminating resistor (Figure 8-4).

If the drive uses a jumper wire instead of a block, you can make the jumper from almost any small bit of wire, such as a clipped lead from a resistor or other component. In a pinch, an ordinary staple will do. Cut and bend the wire carefully for an exact fit and be extremely careful that you put it in the correct spot. It's always best to scrap the ends of the jumper wire, cleaning away from the computer and wiping the jumper wire clean before inserting it into the block.

If the drive has a jumper block, you can do it with your fingers

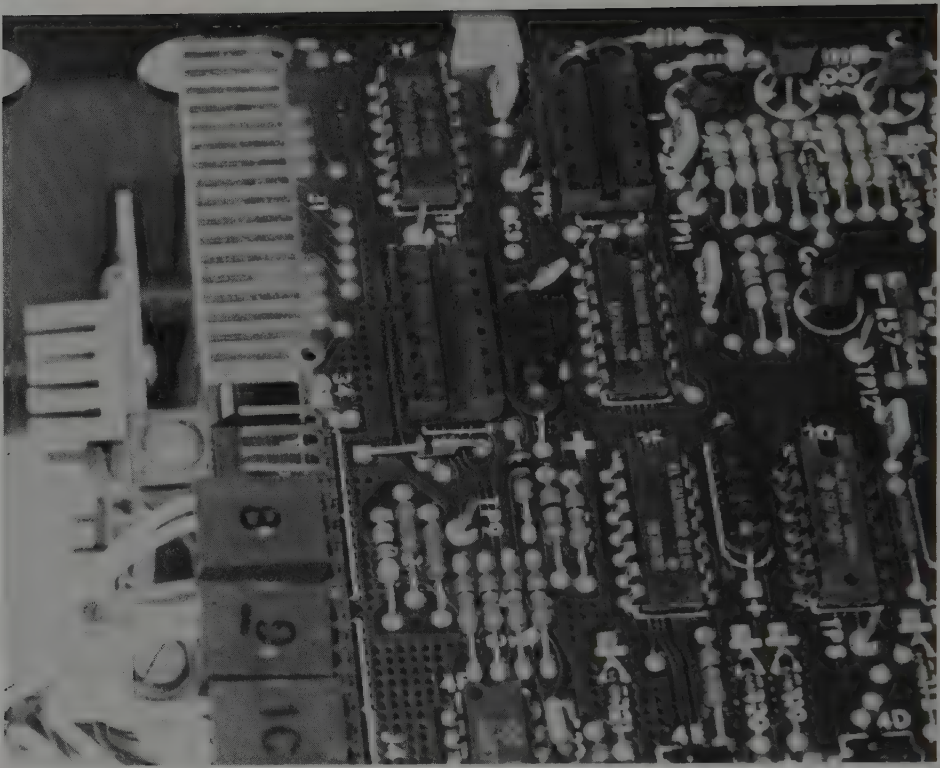


FIG. 8-4 A typical jumper block section and terminating resistor.

or a needlenose pliers. Move the jumper block to the correct position, being careful not to damage the block.

A terminating resistor is similar in appearance to an IC module. It is located near the spot that requires the jumper wire or jumper block and will be socketed (quite often it is the only socketed component on the drive board). The terminating resistor package used by most computers is a 470-ohm component. An IC extractor makes removing it much easier.

A terminating resistor package serves to identify the last disk drive. It is removed from a unit working as drive A and kept in place in a unit operating as drive B.

HARD DRIVES

As with disk drives, not just any "Winchester" hard drive will work with your system. Since the unit is sealed at the factory, there is no repair or maintenance on a hard drive other than cleaning the contacts or checking the external cabling. Everything else must be performed in a special, dust-free room. Do not attempt to open the hard drive under any circumstances.

You can't buy just any brand of hard drive and expect it to work. Your dealer should know which hard drive will work with your system and how to get it to work. Along with a decrease in the price of hard drives have come an improvement in operation and an easier time of installation.

PRINTERS

Printers come in two basic types and in two basic configurations. The two types are dot matrix and those that use a wheel or ball (letter-quality printers). The two configurations are parallel and serial. A serial printer uses data that is sent one bit at a time. The parallel printer uses data that is sent one byte (eight bits) at a time. Most people use the parallel configuration since this leaves open the serial connectors for other functions, such as modem communications. However, many of the smaller computers can support only the serial protocol.

Cabling is the biggest consideration when installing a printer (Figure 8-5). The parallel output of the computer is a standard Centronix configuration. With very few exceptions, it will drive any printer that is meant to handle the information via parallel. Cabling a serial printer is only a little more complicated.

Building a cable isn't that difficult since the manual that comes with your printer tells which pins are used for which function (Figure 8-6). Tables 8-1 and 8-2 provide charts for the standard serial and parallel outputs from the computer (Figure 8-7). All you have to do is match these to the printer. (Don't forget to test the cable for continuity.)

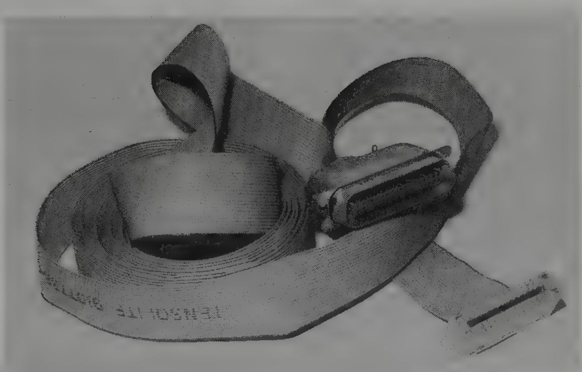


FIG. 8-5 A printer cable.

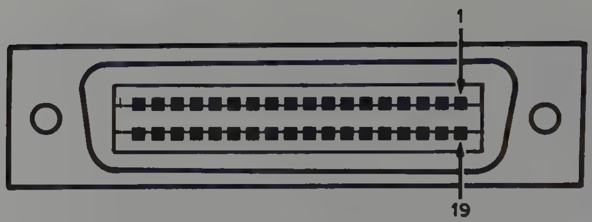


FIG. 8-6 A parallel connector and pin numbers.

Before even attempting to make any connections, get out the manual for your printer and read it cover to cover. Become familiar with the operations, options, switch settings, and so forth. Visually inspect the printer. Locate the controls and learn how to use them, even if you don't think you'll need those options. Also look at the print head. Some are tied in place to reduce damage in shipping. Others may be packed along the sides.

As with many computer devices, printers often have DIP switches to set. Since the printer was designed and built to accommodate a variety of computers, the switches allow you to configure the printer to your needs and set other functions (see Fig. 8-1). Use the printer manual as your guide.

MODEMS

There are two basic types of modem currently available—internal and external. In the more usual external type, one side hooks to the telephone and the other is cabled to the computer through a serial (RS-232) port. The internal type is either plugged into the computer or is hard wired, an integral part of the circuits of the computer. The only "port" in this case is usually just the phone jack to make the connection with the outside world.

With most computers that use the internal type, a modem circuit board plugs into one of the internal expansion slots. If this is the case with your system, compatibility is a major factor since you'll have to get a modem board that is made specifically for your computer.

The major advantage of having a built-in modem is that it is

TABLE 8–1. Parallel (Centronics) Pin Allocations

Pin	*Use*	*Pin*	*Use*	*Pin*	*Use*
1	Strobe	7	Data bit 5	16-17	Ground
2	Data bit 0	8	Data bit 6	18	Not used
3	Data bit 1	9	Data bit 7	19-30	Ground
4	Data bit 2	10	Not used	31-32	Not used
5	Data bit 3	11	Busy	33	Ground
6	Data bit 4	12-15	Not used	34-36	Not used

TABLE 8–2. Serial (RS-232) Pin Allocations

Pin	Use	Pin	Use
1	Ground	6	Data set ready
2	Transmit data	7	Signal ground
3	Receive data	8	Data carrier detect
4	Request to send	9-19	Not used
5	Clear to send	20	Data términal ready

tucked inside the computer and out of the way. Your desk is less cluttered and there are fewer wires strung about. The major disadvantage is that you can't easily move it from computer to computer, if you have more than one.

An external modem (Figure 8-8) has the advantage of being "portable." You can move it from computer to computer by merely changing the cables from one computer to the other. Also, the controls are on the modem, making it easier to handle and monitor.

An external modem can be "direct connect" or "acoustic." Although the acoustic-type modems have been in use for many years, they are now essentially obsolete. Direct-connect modems are generally preferred. A line connects the modem directly to the telephone outlet in the wall so no external sounds can invade.

Modems come in two common speeds: 300 and 1200 baud, with one baud being approximately one bit per second. For example, a 300-baud modem will transmit and receive data at 300 bits per second. The 1200-baud modem is four times faster, making it generally better. However, it's also much more expensive although improvements in circuit design and error checking have made faster transmission speeds possible at a reasonable cost. While 1200 was the standard speed a few years ago, more people are using modems capable of 2400 baud and faster.

Many modems that handle the higher baud rates can be switched to handle slower speeds. With them, you can communicate with other

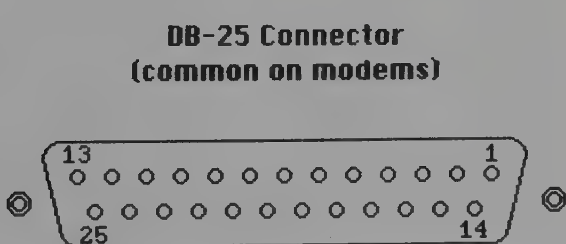


FIG. 8-7 Serial data connector and pin locations.

FIG. 8-8 An external modem.

computers that have only the slower models. A modem that cannot make this change will only save you around $150. You *cannot* work a 300-baud modem on 1200.

If you're planning to hook up a modem, an excellent reference for more information about modems, installing serial peripherals, and direct computer-to-computer communications links is *Increasing Your Productivity Through Computer Communications* by Phillip Good (Chilton Book Company, 1985).

ACCESSORY BOARDS

Many of the smaller computers are designed to operate "as is." There are no expansion slots for additional circuit boards and no easy way to make modifications. Many CPUs can't directly access more than 64K, so there is no way to add more RAM memory without making other modifications (such as bypassing the CPU). There *are* some things that can be done to enhance your computer by increasing power and versatility, such as print spoolers and RAM disks.

Quite often, the accessory board merely plugs into one of the chip sockets. In effect, the board acts as a modified version of that chip. Installing these boards can be complicated and risky but by using a little common sense and following the directions that come with the board, you can install one with very little difficulty.

If you're not careful when installing an accessory board that requires soldering or other physical changes to the main computer circuitry, there is always the chance of causing damage. There could also be electronic conflicts between the computer's circuits and those of the new board. If your system functioned perfectly before the installation and suddenly something isn't working any more, chances are good that you've missed a switch setting or are trying to get the computer to do something it can't.

It's also possible that the board you choose will not be compatible with your system. The easiest way to avoid this problem is to use only known name products that have been proven to be fully compatible.

SOFTWARE

Although the programs you use are not actually devices, there is often an installation procedure to follow. The manual that comes with the software should give you all the information you need to get the program up and working.

Some software is designed to work on a variety of computers. If the program allows it, make at least one backup copy.

MISCELLANEOUS

There is very little that a computer can't do if you install the proper devices and/or use the right software. If can even be made to pretend it's a different computer by using an emulation package that can communicate with other computers through the use of a modem.

Installation of some accessories is as easy as attaching a cable; others require major changes to the hardware or special patches to the software. A few require custom software to get them to work.

Your dealer should inform you of the difficulty in installing a particular device. A part of the sale is to provide to the customer the initial assistance needed for the installation along with special software or software patching programs. Also, magazines that specifically cover your computer often have a wealth of information concerning modifications.

SUMMARY

Adding options and devices to your system is sometimes as simple as plugging a cable from the device to the back of the computer. Other times, it requires you to open the computer and make some physical changes to the existing circuitry.

Before making a purchase, you should have some idea of just how difficult it is to handle the installation; you also need to determine if you have the necessary knowledge, skills, and equipment. If a more permanent modification is required, are you willing to make this kind of change to your system? Will you even have to go through the bother of changing things back?

Before beginning the actual installation, read through the instructions completely then go through the steps of installation in your head. Do you understand what to do, when, and why?

If you're having trouble, read through the instructions again. Most of the time, the information you need is right there.

Chapter 9

Dealing with the Technician

No matter how well you maintain your computer or how much you learn about repairing it, there will be times when you will have no choice but to call in a professional. Certain repairs demand the use of special and often expensive equipment; others require special knowledge beyond the scope of any single book.

This book is meant to reduce to a minimum those times when you have to hire a professional. For those times when you have to consult a professsional, your advance preparations will save the technician time and you expensive fees.

MAIL ORDER

If you make purchases through the mail, you get a discount price but are expected to take care of everything by yourself. The only responsibility that many mail order companies accept is that the equipment is "as advertised."

Mail order companies simply don't have the technical staff on hand to take care of questions and problems. Mail order can save you some money, but if you have any doubts about your technical knowledge, you would probably be better off working with a local dealer.

RESPONSIBILITIES OF THE DEALER

If you buy an entire system from a dealer, he or she should see to it that everything functions as a unit *before* turning it over to you. It should not be handed over as nothing more than a pile of boxes. Also, ask the dealer to put in writing the promises he or she makes for the support of the products you buy.

While many dealers include training in the purchase price, this isn't meant to make you a computer expert but is to familiarize you with the computer and its software. A small fee for this training may be charged, depending on the complicated piece of software. Expect to pay a fair price for detailed training and instruction, but also expect the dealer to answer basic questions—without charge—concerning purchases you have made.

If you have a problem a few weeks or months after installing the equipment at home, you should feel welcome to call in with questions. (Service during the warranty period is obvious.) The more the buyer works with the computer, the more questions he or she will have. The dealer should provide competent technical assistance after the sale, including both technical questions and repair.

Simple questions should be answered for free, but questions that involve some instruction or other lengthy personal attention may require a fee. Repairs of any size, of course, will cost unless you're under warranty.

If your dealer does not keep a technical staff in the shop, he or she should at least be able to guide you to a competent technician or to serve as a liason with the manufacturer. The exception to this is when you are dealing with one of the national chain stores, such as K-Mart.

YOUR RESPONSIBILITIES

If you bought your computer through the mail, don't expect your local dealer to answer all your questions and take care of all your problems free of charge.

Even if you didn't purchase your system from a particular dealer, you can build a working relationship by giving him your other business. The next time you're in the market for a printer or software, stop in and see the dealer you plan to use for help. You might have been thinking about getting some training on how to operate one of your programs. Perhaps the dealer has a course available.

THE TECHNICIAN

With the information in this book, you should be able to provide a considerable amount of information to the technician. Your goals are to reduce the cost of repair and the amount of time that repair will take.

Before calling, try to find out if the malfunction has been caused by operator error. Also try to gather as much other information as you can. A fair part of the technician's day is simply guiding the customer through the right questions, which can be frustrating if he hears a lot of "I don't know" answers.

You have every right to ask about the qualifications of the person who will be working on your computer. Is the technician new to the business? Is his training more along the lines of television repair? Has she had schooling that concerns computers?

Don't be afraid to make suggestions or helpful comments since it's possible that you know something special about the circumstances. Anything that makes the technician's job easier will be appreciated.

TERMS FOR REPAIR

Two-way communication is important in any transaction. Both parties should understand fully what is promised and what is expected before a repair begins.

You should have some idea of the terms and the cost before you hand your computer over. An experienced technician will usually be able to give you a fairly accurate estimate in writing. If further testing and diagnosis reveals that the problem is something more expensive, be sure to have it in writing that the dealer will call you before going ahead.

Along with the price estimate, you should have a time estimate. (How long will your computer be tied up? Can you get a "loaner"?) and a warranty. (It should be *at least* 30 days on both parts and labor.)

When the work is complete, ask for an itemized list of what was done and the cost. This is your protection for any warranty service.

SOLVING PROBLEMS

No matter how good the technician is or how reputable the company is, there will be times when problems still arise. Occasionally, a mistake will be made during repair.

If the work is not done to your satisfaction, say so. Talk to the technician who did the work first. Chances are good that the problem is something he or she can handle. If not, go to the service manager and then to the general manager.

SUMMARY

Before making a purchase, determine whether you'll need the fast and expert advice that can be provided by a local dealer. You can save money by using a mail order company, but you are unlikely to get much help if you run into problems with the installation.

You have to decide whether or not you can handle the job. If you have doubts, you might be better off going with a local dealer.

Both the dealer and you have responsibilities. The dealer should be willing to stand behind the products carried. The staff should be competent enough to give sensible advice as to which products will best suit your needs. You should be armed with as much information as possible concerning your computer's malfunction.

Chapter 10
Troubleshooting Guide

Finding the source of malfunctions isn't as difficult as you might think. It is nothing more than applying a logical process of elimination.

For example, assume that the computer or peripheral is completely dead. If the wall outlet is good, then the problem is definitely with the device. By checking the power supply (see Chapter 6), you'll have eliminated as the cause either the power handling circuitry or the rest of the computer. Continue this process and eventually you'll have located the offending module.

Always begin with a check of the obvious. Is the computer plugged in? Is the wall outlet good? Is the fan filter clean?

The symptoms will help to guide you to the source of the trouble. There are just so many things that can cause a particular malfunction. If a program refuses to load but everything else seems functional, the symptoms indicate that the most likely problem is with either the software or the drive (Chapters 3 and 4). Less likely, but possible, are things related to the drive. The power supply might not be providing sufficient power for the drive to operate properly (easily checked by testing the input to the drives). The program goes from the drive and into RAM memory, which means that a faulty loading can be a result of a RAM failure.

A quick troubleshooting guide is provided below. It gives you a starting place. The actual symptoms will help you to reduce the number of possibilities.

Keep in mind that a troubleshooting guide is only the beginning of complete diagnostics. Sometimes the problem will be found quickly using nothing more than the troubleshooting guide. Other times, more complicated steps are needed (see Chapter 2).

TABLE 10–1. Troubleshooting Table

Symptom	*Possible Problem*	*Cure*	*Chapter*
Power light does not come on	Light faulty	Replace bulb	6
	No power	Check obvious Check power supply	6
	Bad keyboard cable	Replace cable	6
	Bad keyboard	Replace keyboard	6
	Bad main board	Replace main board	5
Bell does not beep	Bad speaker	Replace speaker	
	Bad main board	Replace main board	5
Drive LED does not come on	LED bad	Check LED	4
	No power to drives	Check power	4, 6
	Disk drive bad	Check disk drive	4
	Drive controller card or chip bad	Replace card or chip	4
	Main board bad	Replace main board	5
Cannot load programs		Check for obvious	
	Power supply bad	Check power supply	6
	Bad diskette or tape	Try backup	
	Wrong DOS version or system program	Change DOS or system program	
	Incompatible program	Use another program	3
	Heads dirty	Clean heads	7
	Head load pad bad (single sided only)	Check or replace	4
	Drive or cassette not working	Check with diags Check drive Replace drive	4
	Bad drive cable	Check drive cable	4
	Heads misaligned	Realign	4
	Drive speed	Check and reset	4
	Bad memory	Check memory (diags) Replace if necessary	5, 6
	Bad main board	Replace motherboard	5

TABLE 10–1. Troubleshooting Table (*continued*)

Symptom	*Possible Problem*	*Cure*	*Chapter*
Cassette problems		Check obvious	
	Tape bad	Try another tape	
	Connections bad	Check connections	4
	Heads dirty	Clean heads	7
	Heads misaligned	Realign	4
	No power	Check power	4, 6
	Machine bad	Check machine	4
Keyboard does not work	Keyboard not plugged in	Plug it in!	
	Keyboard faulty	Check keyboard	6
	Keyboard cable bad	Test cable	6
	Main board bad	Replace main board	5
Colors are wrong or poor display	Monitor or TV out of adjustment	Adjust monitor	6
	Bad main board	Replace main board	5
	RF Modulator bad	Replace	6
No display	Monitor not turned on	Turn it on!	6
	No signal to monitor	Check cables	6
	No power to monitor	Check power	6
	Bad monitor	Check monitor	6
	Bad main board	Replace main board	5
Printer Problems		Check obvious	
	Bad connectors	Check connectors	2, 6
	Miswired	Check wiring	8
	Printer bad or jammed	Check printer	6
	No printing	Check power	6
		Check connectors	6
		Check printhead and ribbon	6

Helpful Tables and Charts

Diskette Specification Standards

Tracks per inch	48 TPI
Tracks (number)	40 per side
Track width	.0108 - .0128
Track density	6,000 bits per inch
Temperature (operation)	50 to 112 F 10 to 44 C
Temperature (storage)	−40 to 140 F −40 to 60 C
Humidity	
(operation)	20% to 80%
(storage)	5% to 95%
Disk speed (standard)	300 rpm

Standard Power Supply Specifications

Input power	@ 100-130 volts AC (120 nom) @ 60 Hz; 2.5 amps	
DC output (65 watts)	+ 5 VDC ± 3%	5 amps
	− 12 VDC ± 6%	3.5 amps
	− 12 VDC ± 10%	.25 amps

Parallel Pin Allocations—Standard Centronics

Pin	Use	Pin	Use	Pin	Use
1	Strobe	7	Data bit 5	16-17	Ground
2	Data bit 0	8	Data bit 6	18	Not used
3	Data bit 1	9	Data bit 7	19-30	Ground
4	Data bit 2	10	Not used	31-32	Not used
5	Data bit 3	11	Busy	33	Ground
6	Data bit 4	12-15	Not used	34-36	Not used

Serial (RS-232) Pin Allocations

Pin	Use	Pin	Use
1	Ground	6	Data set ready (+5 V on Kaypro 10)
2	Transmit data	7	Signal ground
3	Receive data	8	Data carrier detect
4	Request to send	9-19	Not used
5	Clear to send	20	Data terminal ready

Power Connector Voltages

Meter Used ______________________

Setting Used 12 VDC and 120 VAC (if needed)

Pin	*Value*	*Pin*	*Value*
1	____________	6	____________
2	____________	7	____________
3	____________	8	____________
4	____________	9	____________
5	____________	10	____________

Main Board Resistance Check

Meter Used ______________________

Range Used ______________________

Pin	*Ohms*	*Pin*	*Ohms*
1	______	6	______
2	______	7	______
3	______	8	______
4	______	9	______
5	______	10	______

Keyboard Pins

Pin	*Wire Color*	*Use*
1	______	______
2	______	______
3	______	______
4	______	______
5	______	______
6	______	______

Personal Record

Your Computer ______________________ Serial # ______________

Your Monitor ______________________ Serial # ______________

Your Printer ______________________ Serial # ______________

Your Disk Drive ______________________ Serial # ______________

Your Cassette Drive ______________________ Serial # ______________

Your Hard Drive ______________________ Serial # ______________

Your Modem ______________________ Serial # ______________

Other ______________________ Serial # ______________

Other ______________________ Serial # ______________

Other ______________________ Serial # ______________

Other ______________________ Serial # ______________

Local Dealer ____

____

Local Dealer ____

____

Users' Group ____

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Appendix
Using a VOM

A multimeter is such a handy device that no home should be without one. With it, you can check just about anything electrical in and around your home or office, including your computer system.

Almost all multimeters will read volts (usually in both AC and DC), ohms, and milliamps—hence, the name VOM from the initials of the three basic settings (see Figure I-3 in the Introduction). Each of these is divided into a number of different ranges. For example, you might be able to set your meter to read DC volts in the .5-volt range, in the 3-volt range, in the 15-volt range, or in the 600+-volt range. You might be able to read ohms (resistance) in the ×1 range, the ×10 range, the ×100 range, or the ×1000 range.

There are two general types of VOM: one uses a digital readout—set the range and just read the number on the display; the other uses an analog scale and a needle that swings across the meter face—usually with a number of different scales. Before you make your reading, be sure that you know which scale you will be using.

To use a VOM, all you have to do is keep the basic principle of electricity in mind, namely, that for electricity to flow, there has to be a complete circuit.

READING VOLTAGE

Most meters have built-in protective circuits to help prevent damage to the meter (and to you) if you use the wrong range for a reading. Even so, it's important that you set the meter to the correct setting and to the needed range within that setting. (You don't want to probe the 120-volt AC wall outlet with the meter set to read 1/2 volt DC.)

Set the meter to read volts in the 120-volt AC range. Your particular meter might have an actual 120-volt setting or it might read something else, such as 150 volts. Simply use the range on your meter that is closest to and greater than 120 volts in the AC volt setting. Look at the meter itself and determine which scale you'll be using (see Figure 2-4 in Chapter 2).

Hold the probes *only* by the insulated handles. Never touch the metal part, especially not while probing potentially deadly current. Now take your meter to a wall outlet and carefully insert the probes into slots of a wall outlet, one probe into each slot. Look at the reading. You should get somewhere very close to 117 volts.

This same setting and scale is used to test for AC coming into your equipment. For example, if the equipment is completely dead, the problem is either with the incoming power or with the computer itself. The meter can be used to eliminate the wall outlet and then can be used to eliminate the cords and fuses by testing for AC at the input to the equipment power supply itself.

If you try to measure the incoming voltage across a fuse by touching the probes to each side of that fuse, you'll get no reading. In a sense, that fuse is like a solid piece of wire, and by probing on the two sides of it, you are touching the probes to the same wire. There is no circuit and, thus, no current flow.

The VOM in the DC setting can check the power supply output. Using the AC setting, you've determined that power is indeed getting to the computer or other device. Switch over to DC and you'll quickly carry the process of elimination one more step. If power is getting to the power supply but the power supply output is dead, then the problem lies with the power supply. On the other hand, if all power supply output readings are normal then the problem is with the device or with one of the circuit boards within that device.

READING RESISTANCE

Cables, wires, and cords have a long life, but they don't last forever. Your VOM gives you a quick and easy way to test those wires and connectors by measuring continuity. In simple terms, does the wire continue or not? If there is a break in the wire or a separation between the wire and connector, the wire does not continue (no continuity).

A continuous wire will have a resistance reading of very near zero (unless it's very long). Set your meter to read in the ×1 range or a similar low range. Shut off all power that could be flowing through the wire being tested then touch the red probe to one end of the wire and the black probe to the other. If you get a reading near zero, the wire is fine. If you get a reading of high resistance or infinity, there is a break in the wire and it will have to be replaced.

You can also test for short circuits this way. For example, take the cable that carries the signal from the computer to the monitor and disconnect it. Touch the black probe to the center pin on one side and the red probe to the center pin on the other. A reading of zero again means that the wire between is good, and a reading of high resistance means that the wire between the two pins is bad.

Now touch one probe to the center pin and the other to the blades at the side of the cable. (These are connected to the grounding braid inside the cable.) You should be getting a reading of infinity, showing that there is no contact between the wire of the center pins and the grounding braid. A reading of anything else means that the two parts of the cable are shorted out.

Note that you should do this test without touching the metal of the probes. There is no dangerous current flowing, but the resistance of your body will cause you to get false and inaccurate readings.

In the last section, you were told that you can't check for current flow by touching the probes to each side of the fuse. However, this is just how you go about checking the fuse itself.

The most accurate—and usually the only—way to check for continuity is to disconnect at least one side of the component being tested. For example, if you are trying to test for continuity in a wire, and the wire is still connected at both ends, your meter will end up reading the total resistance of that circuit, not of just the wire. To test the wire only, one end will have to be disconnected from the circuit. The same rule applies to almost all continuity checks.

Once again, you're testing continuity (see Figure 4-26 in Chapter 4). With the power off, touch the probes to the fuse, one to each side. A reading of zero ohms means that the fuse wire is good. A reading of infinity means that the fuse has blown.

CIRCUIT BOARD RESISTANCE CHECKS

In Chapter 5, you were given directions on how to read the circuit board resistances across the connector pins. The purpose of this is to give you a means of comparing the circuit resistance of the board.

As mentioned there, the readings you get don't really matter, nor does it matter which circuits you are testing. All you're after is a means to compare the readings while the computer is functioning normally with the readings taken when the computer is giving you trouble.

The circuit board is a vast collection of components. Along with all the resistors, capacitors, and other components that are obvious, inside each of the chips are other "components." (IC stands for integrated circuit, which means that a number of components are built inside the chip [integrated].)

By now, you should have created a table of readings for each circuit board in your computer. At the moment, this may seem like a lot of work for a set of measurements that mean nothing. Later on, you could be glad that you spent the few minutes needed.

For example, if the reading between pin 4 and ground is 100 ohms when the computer is operating perfectly and is 500,000 when something seems to be malfunctioning, the fault is somewhere in the board. Since it generally costs less—both in time and money to replace the entire board, this is all you need to know.

Identify the malfunctioning board and replace just that board (and don't forget the trade-in value of the old board). Instead of spending hours, you'll have quickly tracked the problem to a particular board. Usually swapping out that board requires a quick trip to the dealer for the replacement board and just a few minutes to make the physical swap.

OTHER USES

As mentioned in the opening of this Appendix, the VOM can be one of the best investments you ever made in tools for use around the house. You can use it to test batteries, including any batteries used in your computer system, your car, motorcycle, boat, or flashlight.

You can test AC outlets in your home. You can also test switches (by using the AC setting to test for voltage and in the resistance setting to test for continuity across the switch). You can even use the VOM to test your stereo. If the fuses are constantly blowing, it could be nothing more than a short circuit in the wires that go to the speakers. Test them for continuity. You should read zero ohms across any single wire and infinite ohms between any pair of wires.

The VOM you choose doesn't have to be fancy or expensive. Even the least expensive meters are accurate enough for general use around the home.

Glossary

AC: Alternating current measured in cycles per second (cps) or hertz. The standard value coming through the wall outlet is 120 volts at 60 hertz. This voltage passes through a fuse or circuit breaker that can handle about 15 amps (check for yourself to know). Most computer power supplies can tolerate an AC value of between about 105 volts and 135 volts. The power supply changes this to the proper DC levels required by the computer.

access: A fancy term for "to get at."

acoustic: Having to do with sound waves. For example, an acoustic modem sends and receives data as a series of audible beeps. (A direct connected modem is better since it is not prone to interference or false signals due to room noise. Acoustic modems are essentially obsolete.)

A/D: Analog to digital; converting analog signals, particularly a varying voltage, into the digital information the computer needs.

address: Where a particular piece of data or other information is found in the computer. See Chapter 5. Can also refer to the location of a set of instructions.

ANSI: American National Standards Institute.

ASCII: This acronym stands for American Standard Code for Information Interchange. This code assigns binary (on/off) values to the 7-bit capability of the computer. The eighth bit signals the end of the character or functions as a parity bit to check for errors. ASCII is the standard code used to send data and other binary information, such as through a telephone modem.

asynchronous: Often abbreviated "asynch." Refers to communications mode in which each character is balanced individually (e.g., with a stop bit). Communications occurs in only one direction at a time; one command must be completed before the next is performed.

audio: A signal that can be heard, such as through a speaker.

backup: A copy of a program or data diskette. Make them often to protect yourself.

bank: The collection of memory modules that make up a block of RAM memory, often in increments of 16K or 64K and usually done with eight ICs.

BASIC: One of the most common first computer languages learned by many users. Sometimes the BASIC used by a computer resides in ROM. Other times, it has to be loaded in from a diskette or cassette tape. Although all BASICS are similar, they are not necessarily compatible between different computers.

baud: Used to describe the speed of transmission. The signal is split into a certain number of parts per second. Thus, 300 baud will send 300 units per second. Generally, each unit is a bit, which means that 300 baud basically means that 300 bits per second are being sent.

BCD: Binary coded decimal.

BIOS: Basic Input/Output System, to handle communication between the computer and the devices connected to it.

bit: A single pulse (on/off) of information used in binary code. The word "bit" is actually the abbreviation for "binary digit."

boot: To load a program into the computer. The term comes from "bootstrap," which in turn comes from "lifting oneself by one's own bootstraps." It means that the computer is loading itself and is setting the computer to operate without other operator intervention.

buffer: A segment of memory or a device used to store data temporarily while the data is being transferred from one device to another. A common example is a printer buffer. This device stores the incoming data at full computer speed and sends it to the printer at a speed the printer can use (such as 40 characters per second or about 300 baud).

bug: An error in a program.

bus: The pathway for the various signals used by the computer. Sometimes spelled "buss."

byte: A collection of bits that makes up a character or other designation. Generally, a byte is eight data bits, the binary representation of a character.

capstan: A shaft or spindle, usually made of metal and usually driven by a motor. One use is as a part of the tape transport in a cassette tape machine.

card: A circuit board.

carrier: The reference signal used for the transmission or reception of data. The most common use with computers involves modem communications over phone lines. The modem monitors this signal to tell if the data is coming through. Generally, if the carrier isn't getting through, neither is the data.

cassette: Either the device or the cartridge that is used in the device that stores and feeds information into the computer. The operation is very similar to that of an audio cassette. They are often used as a low-cost alternative to disk drives.

catalog: A term sometimes used to describe the allocation track of a diskette. Stores the titles given to the files saved on the diskette and tells the computer and drives how to get to those files. The directory serves as a "Table of Contents" for the files saved on the diskette. The catalog sorts data that identifies the files by name, by size, by the kind of file stored (text file, binary file, etc.), and often the date the file was created. Information recorded on this track gives the computer the data it needs to find that file on the diskette.

chip: Another name for an IC or integrated circuit.

circuit: A complete electronic path.

circuit board: The collection of circuits gathered together on a sheet of plastic. The circuit board is usually made by chemically etching metal-coated phrenolic plastic. Often the circuit boards in a computer are multilayered, which increases the efficiency but makes repairs to the tracings on the board difficult.

COBOL: Common Business Oriented Language.

common: The ground or return path used in this book to make measurements with the multimeter. The black probe.

composite color: A system in which the signal to the color monitor is complete in itself (as opposed to RGB, where each primary color is carried as a separate signal).

continuity: Describes a complete and unbroken path. Testing for continuity is to determine if a wire or other electronic path is complete and can conduct.

CP/M: Control Program for Microcomputers. One of the first, and still one of the most common, operating systems for microcomputers. Developed by Gary Kindall of Digital Research.

CPS: Characters Per Second, e.g., the speed of a printer.

CPU: Central Processing Unit. Correctly refers to the main processing IC of the computer but is sometimes used to describe the entire main computer assembly.

CRC: Circle Redundancy Check. A means of checking the integrity of a data transfer.

CRT: Cathode ray tube; basically, a fancy name for a television or monitor screen tube.

crystal: A small device located on various boards that vibrates at a particular frequency. One use is as a reference frequency for timing circuits.

cylinder: Tracks that can be accessed without head movement. For example, most double-sided drives access tracks on each side of the disk, such as track 30, side 1 and track 30, side 2, before moving on. The two tracks together make up one cylinder.

daisywheel: A circular printer element that holds all the characters to be printed (usually 96). The characters are on the end of thin arms all coming from the center, somewhat like the petals of a flower, which gives this print wheel its name.

data: Information.

DC: Direct current, such as that provided by the power supply. (Also found in batteries.)

DCE: Data Communications Equipment.

debug: To rid a program of errors or bugs.

default: An assumption the computer makes when no other parameters are specified. For example, if you type the command for the directory or catalog without specifying the drive to search, the computer automatically goes to the default drive (normally, the last one selected) and assumes that this is what you want. The term is used in software to describe any action the computer or program takes on its own with imbedded values.

density: The amount of information that can be packed into a given area on a diskette. Diskettes are usually rated as being single density, double density, or quad density.

DIN: Deutsche Industrie Normenausshus. A kind of plug used primarily in Europe but also fairly common elsewhere.

directory: The allocation track on a diskette. See "catalog."

diskette: The flat, magnetically coated media used most often in computers for the storage of data.

DOS: Disk Operating System. The set of commands that allows the computer to access the data on the diskettes.

drive: The device used to read and write on diskettes. If the drive is "fixed" drive, it is commonly called a hard drive or "Winchester drive." The drive can also be electronic, using RAM instead of the magnetic media.

DSDD: Double sided, double density. Describes the diskettes used in a double-sided drive.

DTE: Data Terminal Equipment.

Dvorak: A relatively new keyboard layout that increases efficiency and typing speed. Named after its inventor, August Dvorak.

edit: To make a change or modification in data.

emulate: A fancy word for "pretend to be." Often used to describe a device that is designed to make the computer seem to be another computer or terminal.

execute: To start a program or instruction set.

FAT: Files Allocation Table. An area on the diskette used to allocate space for files. The information included in the table indicates which sectors on the diskette are free and which are used.

FCC: Federal Communications Commission. Regulates the kind and amount of radio frequencies that can be emitted by computers and computer devices.

ferric oxide: The iron substance (Fe^2O^3) most often used as the magnetic medium on diskettes. Essentially, it is nothing more than rusted iron.

file: Any collection of information saved on a diskette. The file can be data, a program to run, or both.

firmware: The ROM of the computer.

flippy: A diskette with notches and index holes cut into both sides allowing the diskette to be used on both sides by a single-sided drive (by flipping the diskette over).

font: A style of lettering. Many matrix printers are capable of using a variety of print styles, changeable through software.

footprint: The amount of room the computer equipment takes up on the work table.

format: A command within DOS that assigns various tracks and sectors to new diskettes. Also called "initializing." Also a particular manner in which something is laid out, such as in a program.

FORTRAN: FORmula TRANslation.

ground: The common or return side of a circuit (see "common").

handshake: When two devices "talk" to each other to determine the rate of data transfer. Very important when one device is slower than another, such as a printer compared to the computer. In a sense, the printer tells the computer to stop transmitting until the printer catches up again.

hardware: The computer and computer devices.
head: The read/write head of the disk drive.
Hertz (Hz): A measure of frequency. One cycle per second (cps). Frequency is also measured in units, such as kilohertz (KHz: thousands of cycles per second) and megahertz (MHz: millions of cycles per second).
hub ring: A plastic reinforcing ring applied to the spindle access hole of a diskette. This ring adds strength and improves centering.
IC: Abbreviation for integrated circuit. This is a package of electronics often encased in black plastic with pins coming from the bottom. Pin 1 is the first pin on the right on the side with the notch or other marking.
IEEE: Institute of Electrical and Electronic Engineers.
index hole: Small holes on the diskettes near the hub access hole used by some computers to find the beginning of a sector. Not used by all computers.
interface: A fancy term to say "connect." Used to describe any connection from hardware to hardware, from hardware to software, or even from hardware and/or software to user.
I/O: Input/output. Where data enters or leaves the computer.
K: With computers, usually used to describe an amount of memory. Normally "K" denotes 1000 (such as in kilohertz above). Due to the electronics involved, 1K of memory is actually 1024 bytes; 64K is actually 65,536 bytes.
keyboard: Primary means of manual input to a computer.
LCD: Liquid Crystal Display. More and more devices are using LCD technology for displays due to the versatility available and the lower power consumption.
LED: Light Emitting Diode, such as those used in the drives to indicate that the spindle is turning.
light pen: An instrument designed to read areas on the screen by pointing at them. Used to input data to the computer in a manner similar to that of a mouse (see "mouse") in addition to or instead of a keyboard.
logic probe: A tool used to detect pulses in electronic circuits for diagnosis.
matrix: A pattern of dots in computer printers used to make up letters, numbers, and other symbols.
microfloppy: Microfloppies are generally 3 1/2 inches or less in diameter, as opposed to floppies (8 inches in diameter, although the term is often used to describe any similar media regardless of size) and minifloppies (5 1/4 inches in diameter).

minifloppy: Still another name for a diskette. Describes a 5 1/4-inch floppy.

modem: A device for transmitting data over telephone lines. The name means "modulate-demodulate."

monitor: A television-like device to display characters and other symbols. (By using an RF modulator, a standard television set can be used as a monitor although the quality of video reproduction is generally of lower quality than with a dedicated monitor.) Also called a display, CRT, or VDU.

mouse: A hand-held device rolled across a surface. It is used to input data to the computer and is often used to quickly get from one spot on the screen to another. The name comes from the small size of the device, from the tail-like cable, and from the two buttons that resemble eyes.

MS-DOS: A disk operating system developed by Microsoft; one of the most popular in use. Called PC-DOS when used in the IBM PC.

multimeter: A testing device to measure volts and ohms across a variety of ranges. Often called a VOM.

nanosecond: Used to measure the operating speed of modern computers, particularly RAM chips. One nanosecond equals one billionth of a second. A 150 ns RAM chip then has an operating speed of 150 billionths of a second (or .15 millionths of a second).

NEC: National Electrical Code.

NEMA: National Electrical Manufacturer's Association.

network: Two or more computers connected together, usually to share information or a device. For example, two computers can be networked so that both use a single hard drive.

null modem: A device used to directly connect two computers without modems or phone lines.

ohm: Unit of measurement of resistance.

operating system: DOS, C/PM, or some other system that allows the computer to operate.

parallel: A means of data transfer with the information being sent a byte at a time (see "serial").

parity: A means of error checking. Parity checking can be even, odd, or none. Even parity checking means that the number of one bits (on) must be even in the byte. Odd parity means that the number of one bits in a byte must be odd. None means no parity checking is done.

P.E.T.: Polyethylene terephtalate, the generic name of the material used to make diskettes. Common trademark name is "Mylar" (owned by Dupont).

pixel: Shortened form of "picture element" or a single dot on the screen. Used to describe the clarity or resolution of a monitor.

platen: The rubber roller of the printer.

port: A place where cables are connected to the computer or other device. Sometimes called an interface.

program: A set of instructions the computer can understand and act upon to perform some useful task.

prompt: A symbol on the screen indicating a state of readiness in the computer (e.g., A>,], >, !, or *). It's waiting for you to do something.

queue: Data waiting to be processed. For example, text being held in a buffer waiting to be printed. Pronounced "cue."

QWERTY: Describes a standard typewriter keyboard (due to the placement of the letters at the upper left of the keyboard).

resolution: The clarity of the image on the screen. Sometimes used to describe printer image quality.

sector: An area on the track of the diskette assigned to hold a certain amount of information. The amount of data held per sector depends on the computer, disk drive, and DOS being used.

serial: A means of data transfer in which information is handled a bit (or pulse) at a time, with each bit following the others.

soft sector: A method of setting up a diskette so that data is written first to a sector whose position is determined by a code stored on disk.

software: Computer programs usually on diskette or cassette.

solder: In electronics, a mixture of tin and lead usually with rosin in the core of the solder wire to act as a flux. (Do not use acid core solder or any acid flux on electronic circuits.)

source: Where a signal originates.

spindle: The device in the disk drives that is inserted into the center hole and causes the diskette to spin.

spooler: A kind of printer buffer.

SSSD: Single sided, single density.

stepper motor: Used to move the read/write heads across the surface of the diskette.

stop bit: Signals the end of a byte.

switching power supply: A kind of power supply often used in microcomputers. Power levels are determined by the rapid switching on and off of regulators, transistors, and other digital components.

system board: The main circuit board of the computer. Sometimes called the "motherboard." (Correctly, motherboard applies only to Apple computers.) Also called the "main board."

target: Where a signal is to terminate. For example, if you are copying a file, the target is the diskette on which the file is to be copied.

terminal: In a computer system, a device through which data can be entered or retrieved. Can also be the end point of an electrical connection. Sometimes used to describe a monitor (i.e., video terminal).

TPI: Tracks Per Inch. Common is 48 TPI, with 35 to 40 tracks being used.

track: One of the concentric rings on a diskette.

TVI: Television interference. Computers and some computer devices emit radio frequencies that can cause interference of normal television operation.

VOM: Volt-ohm-milliammeter. Commonly called a multimeter.

write/protect: The notch cut into the diskette allows a switch in the drive to activate the recording head. With this notch covered, the recording head is disabled, making recording onto the diskette impossible.

XON/XOFF: A method used to time data transmission. (The "x" signifies "transmit.")

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page numbers followed by t indicate information found in tables.

CHILTON'S GUIDE TO

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Gene B. Williams

If you can change a light bulb or the needle on your stereo, you can tackle about 95% of all repairs on your small home or business computer. As author Gene B. Williams clearly demonstrates, most common repairs are so simple that they can be completed in a few minutes with a screw driver or pliers and a multimeter. Why pay a technician $60 an hour (and suffer several days' downtime) to turn a screw or find out if power is getting to the disk drive?

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