Repairing HP9800 Desktop Calculators – Part 6

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Tools and Test Equipment

Obviously in order to repair the machine you need to dismantle it, but before I describe that procedure, a few words about the tools and test equipment that are necessary (or at least useful).

1 Tools

The basic tools needed to take an HP9800 apart and perform electronic repairs include:

Screwdrivers : Flat-blade, Phillips and Pozidriv screwdrivers are needed in various sizes. To prevent damage to the screw heads, make sure you know the difference between Phillips and Pozidriv, and use the correct one.

Spanners and Nutdrivers : The HP9800 machines are assembled with most American UNC fasteners. Therefore you need imperial-sized spanners to fit the nets. It is useful to have open-ended spanners, ring spanners and nutdrivers covering the range 3/16" to 3/8". A couple of such tools not found in most sets are an 11/32" open-ended spanner which is essential for removing the rear panel of the machine and a 1/8" nutdriver to remove the end cover from the card reader motor in the HP9810 and HP9820.A 9mm open-ended spanner can be used in place of the 11/32" one (11/32" = 8.73mm) if you can't get the latter, but the right tool is a lot better.

Hex keys : There are not many hex-headed screws in these machines, but there are some, and a set of imperial-size hex keys is necessary.

Pliers : Not to be used as a substitute for a spanner, these are needed for forming wire leads and similar applications

Small side cutters ; Most likely you will have to replace some components, and you will need to cut off the excess lead length on the new ones.

Small external circlip pliers : External circlips are used on the spindles in the mechanical sections of these machines, you will need to remove them.

Tweezers : Very useful for fitting small parts in the mechanical sections of the machine. Get non-magnetic stainless steel ones, there is nothing more annoying than a pair of tweezer that will not drop the part where you want it (Actually, there is, It's a pair of magnetic or magnetised tweezers that also manages to move other parts around for you).

Soldering iron and solder : The PCBs in these machines are generally double-sided (although a few are multiple-layer) with plated-through holes. I would seriously recommend a temperature-controlled soldering iron to avoid damaging the PCBs. Some thin (22swg or thinner) resin-cored solder is needed to fit the replacement components. Of course this is the 'real' lead/tin solder

Desoldering tool : Either a desoldering pump ('Solder Sucker') or braid, whichever you prefer. Remember that in most cases the PCB is much more valuable than the component that you are removing and it may be worth cutting the pins off the component and removing them one at a time from the PCB.

Drill : Either a hand drill of the wheelbrace type or a small electric drill, and a selection of twist drill bits. The connectors on the rear of the machine are riveted to an internal bracket, and if these need replacement you have to drill out the rivets.

UNC taps and dies ; Some of the screws were initially assembled with a locking adhesive, and in some cases, particularly in the keyboard assembly, they screw into tapped bushes in a brittle plastic moulding. I would recommend that you clear out the threads after removing them by running a tap into the hole and a die over the screw. Strictly these should be thread-clearing rather than thread-cutting tools, but in practice it makes little difference. You need (at least) sizes 4-40 and 6-32 UNC.

When we come to repairing the HP9810 and HP9820 card reader, and to a lesser extent the internal printer, I will, unfortunately, recommend the use of small machine tools.

It is well worth buying good quality tools. They will last a lot longer and more importantly will not 'chew' screw heads, damage PCBs, and the like. You are working on a valuable machine, it is worth taking care of it. I have often said 'I am not rich enough to buy cheap tools'.

2 Card reader roller puller

If you are repairing an HP9810 or HP9820 it is very likely you will have to replace the drive roller in the card feed mechanism, To remove the roller without damage you need a special puller tool, which unlike the tools mentioned above is not available commercially. It can be made in a reasonably well-equipped home workshop. Some means of doing coordinate drilling and light milling, for example a small lathe with a vertical slide, is very useful.

The puller consists basically of a steel 'cage' which fits around the old roller with a bolt to press on the end of the spindle and thus force the roller off.

The top plate of the tool is a piece of 1/4" thick steel measuring 2.5" by 2". Taking one corner as the 'origin' and the shorter edge as the 'Y axis', drill 4mm holes at (0.25, 0.25), (1.25, 0.25), (2.25,0.25), (0.25, 1.5) and (2.25,1.5) (all dimensions being in inches, of course). Then drill a 10.6mm hole (which is the tapping size for M12) at (1.25,1.5). and tap it M12. Although I have specified metric fasteners throughout this tool, it can obviously be made with any bolts of a similar size (for example1/2" UNC in place of M12, 6-32 or 8-32 UNC in place of M4) if the hole sizes are adjusted to suit.

The bottom plate is 1/8" steel of the same dimensions. Drill five 4mm holes at the same coordinates and a 1/8" (or 3.2mm) hole at (1.25,1.5) and then mill a slot from that hole to the nearest long edge. In use, the card reader spindle will be slipped into this slot with the bottom plate 'behind' the roller and an M12 bolt running in the tapped hole in the top plate will press on the end of the spindle

The plates are joined by 5 pillars made from 3/8" steel rod. Each pillar should be 2" long (the exact length is not too critical, but it is obviously important to make them all the same length). Each end of each pillar and drilled centrally at 3.5mm and tapped with an M4 thread (this is easy to do on a lathe with a drill bit held in a tailstock chuck).

The puller frame is assembled using M4 bolts in the obvious way. I found that hexagonal-socket ('Allen') cap-head screws were the easiest to use here.

It is worth making 2 puller bolts. One is simply an M12 bolt around 60mm long with the end faced off to make it perpendicular to the axis. The second is a bolt prepared in the same way and then a 3.3mm hole is drilled along the axis (from the end furthest from the head) to a depth of about 0.5", If you have a 'D-bit' to make a flat-bottomed hole then use it, otherwise a twist will is adequate.

In use, the latter bolt is used first with the reader spindle fitting into this hole. This will guide the spindle and hopefully prevent it getting bent. Once the roller has moved, if it still won't slide off by hand, the plain bolt can be used to move it further along the spindle.

3 Test equipment

Unfortunately you can't see the logic signals in the HP9800 machines directly, so you need a few items of electronic test equipment:

Multimeter : This needs to have DC voltage ranges covering the outputs of the power supply and AC voltage range to check the output of the power transformer. Resistance ranges to check for continuity and short circuits are essential too. Other ranges my be nice to have, but they are certainly not essential

Logic probe : Even with a logic analyser (see below) it is very useful to have a simple instrument that indicate it a point is stuck high or low. Most of the signals in the machine are at TTL levels and just about any logic probe will handle those, being able to monitor the 16V signals on the PMOS RAMs is very useful. However remember that even if your logic probe indicates a signal is changing, it doesn't tell you anything about the *timing* of the signal. One solution to this was HP's excellent 'LogicDart' which is a very useful instrument for debugging these machines and means a separate logic analyser is unnecessary in many cases. However this is not an easy instrument to obtain

Logic analyser : As you know, the HP9800 machines are bit-serial with most of the signals changing all the time. You need to be able to display the relative timing of several of these signals at once to trace most faults. This means a logic analyser. The machine clocks at 8MHz, so just about any analyser is fast enough, but the more channels the better. It's useful to be able to trace the processor microcode which takes 8 channels and possibly display some other signals at the same time.

Oscilloscope : This is not a particularly useful instrument for debugging the digital side of these machines, but it can be useful when repairing the analogue sections of the magnetic storage system

Bench power supply : This is by no means essential, but an adjustable DC power supply going up to at least 24V can be useful for checking motors, lamps, solenoids, etc.

Insulation tester : Although I have never found an insulation breakdown in any HP desktop calculator, you may wish to check the insulation of the mains transformer and related components for your own safety. A high-voltage insulation tester (commonly called 'Megger') is useful for this.

Again, it is worth buying good-quality test equipment. If the instruments give you misleading information you can spend a lot of time looking for faults that aren't there or conversely missing the faults that are there.

I should also point out that no piece of test equipment is a 'magic box' that will tell you just what is wrong with an HP9800 machine (or anything else for that matter). All it can do is provide you with evidence as to what is actually going on in the machine. It is up to you to interpret that evidence and find the fault.

4 Safety

I will credit my readers with some common sense which means this section will not contain warnings that soldering irons get hot, or that it's a bad idea to try to balance a power transformer on your nose. I shall concentrate on the less-obvious hazards not just to you, the repairer, but also to the machine itself[1].

The only real danger to the repairer is the mains supply. The outputs from the power transformer are at a fairly low voltage (although I suspect the 52V between the ends of the winding in an HP0910 or HP9820 could give a 'tingle') and are isolated from the mains. The voltages on the logic PCBs are, of course, much too low to be harmful.

The mans voltage wiring is mostly out of the way on the inside of the rear panel of the machine where it is unlikely to be a danger. However the power switch on the front of the keyboard is of course connected to the mains and is much easier to touch. When I describe how to dismantle the machine I will recommend removing this switch form the keyboard chassis so that mains and logic are kept well apart.

It is almost impossible to operate this switch when it is removed from the keyboard without touching the terminals, and for this reason I do not recommend trying to use it during testing. If you have switched mains sockets on your workbench, I recommend turning the machine on and off there. Otherwise,

[1] It is perhaps worth pointing out that HP9800 machines are a lot rarer than enthusiasts who would like to repair them...

make up a special mains lead with a double-pole switch (breaking both the live and neutral wires) and optionally a neon indicator in the middle. Make sure the earth wire is connected straight through, of course. Use that switch to turn the machine on and off for testing.

Even with the mains switch turned off or unplugged at its in-line connector, many of the components on the rear panel are still connected to the mains. Therefore, unplug the mains lead from the input connector before working on any part of the rear panel.

The main hazards to the machine also relate to high (or at least higher-than-normal) voltages. Although the power supply has crowbar protection circuits, it is well worth checking the supply before using it to power the logic boards and I will describe the procedure later on.

Another source of high voltage is, of course static electricity. The TTL logic ICs used in the HP9800s are not likely to be damaged in this way, but the ROMs and the PMOS RAMs can be, and of course these ICs are difficult to replace (the ROMs being custom-programmed for the machine and the RAMs being long out of production). When you remove a memory board from the machine. put it in an anti-static (conductive) bag. Use an earthed soldering iron when replacing components on these PCBs, and if possible work at an anti-static workstation. It is probably a good idea to avoid stroking your cat when repairing the HP9800 memory system[2].

5 Practical hints

5.1 Don't mix up the screws

When you take one of these machines apart, particularly when you come to work on the mechanical sections you will soon have quite a number of nuts, bolts, washers, clips and the like. Purchase one of those plastic boxes with many compartments – the older ones with fixed partitions are best, I've found the movable partitions tend to come loose at the worst possible time – and put associated hardware, for example the rear panel fixings, or the parts from the printer motor, in a particular compartment. If you still think you may forget what went where, you can put a little slip of paper in the compartment to label it.

[2]What? You don't have a cat? No wonder you are having problems with your HP9800

5.2 Finding your way around

When you first look inside an HP9800 you'll see a mass of PCBs and will wonder how you will ever find anything.

The PCB ejector handles are colour-coded. The guides for the PCB are the same colours as the handles which simplifies getting the PCBs back in the right places. And the colours give the last 2 digits of the PCB part number using the resistor colour code. There is one exception to this code. The older HP9810 display PCB is an 09810-66541 while the later one is 09810-66542. Both of them have yellow and brown ejector handles (and the guides are yellow and brown in all machines). Since the 2 PCBs are entirely compatible, it made more sense to keep the handles matching the guides.

Directional arrows such as 'rear' or 'LHS' on the schematics assume the machine is in the normal operating position in front of you.

The ICs on each PCB are numbered as follows. Looking at the PCB, and with the edge connector fingers pointing down, IC1 is the one nearest the top left corner. The numbers then increase to the right along the top row of ICs, then carry on with the left most IC in the second row and so on. If in doubt, check that the IC number is the one you expect or even trace a few of its connections.

5.3 Managing without extender boards

The plug-in PCBs in an HP9800 machine are so close together that it is impossible in most cases to conenct probes to IC pins when the PCB in in the machine. Of course some signals are brought out on the test connectors, and some IC pins, particualrly those near the top edge of the PCBs, but there are many importat signls your can't get to.

While a set of exender boards would be very useful, it is possible to manange without them by removing the PCB under investigtion and soldering short lengths of wire to the connections of interest. A peice of multi-core cable or 'rainbow' ribbon cable about 10cm-15cm long and dismantled into its individual wires is ideal for this. Put the PCB back in place and connect test equipment to the free ends of (some of) the wires. Make sure the wires do not 'short' to anything they shouldn't, including the chassis of the machine. Turn on the machine and make the measurements, then turn it off, and based on the results of the measurements resolder the wires to new locations to check more signals I generally find that 2 or 3 attempts will locate the fault.

5.4 Expander signals are not TTL level

The signals between the expander U2, and the And-Or-Invert gate U3 on the **Data Path** PCB are not at normal TTL levels, they are the inputs to the 'totem pole' output stage of U3. They cannot easily be monitored, and shorting the inerted signal to +5V will damage U3. This is fairly clear from the data sheets on these devices, but you may not think to check this.

5.5 Make notes

I find a notebook to be very useful when repairing such a machine. Record anything that's not obvious (such as the order of parts and washers on a bolt, wiring colours if you have to desolder anything, and so on). Also record any measurements (voltages, etc) if you want to be able to refer to them later.

I suppose you could use a portable computer for this, but a (paper) notebook seems more convenient.

Dismantling the Machine

It is now time to take the machine apart. I shall begin by describing how to dismantle the machine into its major modules (since the HP9810 and HP90280 have very similar construction, they will be described together) and then how to dismantle the keyboard and rear panel (these sections are very similar in all the machines). A final section explains how to dismantle the optional ROM modules.

1 Dismantling the HP9810 and HP9820

Start by removing any ROM modules and opening the printer cover. Remove the 4 countersunk screws under it. These retain the top plate of the machine which can now be bowed up by pulling up on the printer cover and sprung out of the side plates. Put the top cover aside.

Next remove the keyboard which is anchored by 4 screws under the machine. Stand the machine on its back and remove the 2 screws right at the front edge and then the 2 further back. The former tap into metal bushes in the relatively weak plastic front strip, the latter into metal posts on the keyboard chassis. By removing them in this order, the plastic parts are not subjected to undue stress. Put the machine the right way up again and lift the keyboard assembly to free it from the printer paper guide. Unplug the keyboard cable from the **Backplane** under the front of the printer, then unplug the in-line connector leading to the mains switch and put the keyboard assembly aside for the moment.

Before removing anything further, look at the layout of the machine. On the left is the memory box containing the memory and memory control PCBs. Moving to the right, we see the 4 CPU PCBs. The peripheral section is to the right of that, containing the printer and **Card Reader Interface** PCB, with the **I/O Backplane** behind them. Finally, on the right are the 3 power supply PCBs under a metal heatsink cover. The **Display** PCB is at the front on the left side of the machine, the card reader mechanism is in front of the power supply.

As you dismantle the machine, look for 'obvious' problems such as burnt, broken or missing components. It is quite likely that you will find a crumbly powder inside the machine, which is the remains of the original card reader drive roller. You may also find a sticky black substance on the **Backplane** at the front of the printer, which is the remains of the platen roller. Repairing these mechanical problems will be covered later.

You can dismantle each section independently of the others, but let's start at the left and work rightwards. On top of the memory box are 6 screws. Remove the 4 along the front and rear edges, leaving the 2 at the left side. Using the ejector handles, free the **Memory Backplane** from its edge connectors and lift out the memory box. Remove the remaining 2 screws on top and the corresponding pair on the bottom and remove the side cover. Take the memory PCBs out of the memory box. You may wish to put these PCBs back in the memory box after inspecting them, if not, then store the ROM and RAM PCBs in anti-static bags.

Back on the main chassis, remove the 4 CPU PCBs, the **Display** PCB and the **I/O backplane**. Unplug the edge connector at the front of the **Card Reader Interface** PCB and unplug this PCB from the **Backplane**. Free the stud from the power supply casing and lift the PCB out. Unplug the head connector (a little PCB with 5 pins that plugs into the **Card Reader Interface** PCB) to completely free the Card Reader Interface PCB. Remove the 4 fixing screws and take out the complete printer unit.

The heatsink on top of the power supply area has 7 screws on it. First remove the 4 pan-head ones (these screw into heatsink brackets on the PCBs). Then remove the 3 countersunk screws at the right side and take off the cover. Remove the 3 PSU PCBs; the **+/-12V PSU** PCB must be removed before the **+16V/+20V/+24V PSU** PCB.

Remove the 4 fixing screws and lift out the card reader mechanism.

The next section to remove is the complete rear panel. Unscrew the 4 screws holding the chassis-mounted edge connectors inside the power supply area of the machine; these carry the transformer secondary winding connections. Loosen the 11/32" nut at each side that holds the rear panel to the side panel, then remove the 3 countersunk screws on the underside of the machine at the rear edge. Pull the panel off rearwards, feeding the switch cable through the cardcage metalwork.

You may not have to dismantle the machine any further, but if you wish to remove the **Backplane** for cleaning or repair, continue as follows. Unplug the **ROM Module Backplane** cable from the left edge of the **Backplane**. Remove the 2 screws holding the ROM module hosing to the cardcage and the 2 nuts holding it to the left side panel. Take out the ROM module housing and backplane, if you wish to remove the backplane from the housing, it is held on by 5 screws.

Next undo the 2 screws holding the 2 sections of the cardcage together. Loosen the nuts holding the left section to th left side panel and slide the T-bolts along the slots. Remove the screws holding this section to the base of the machine and remove it. Remove the right hand section in the same way. Finally, remove the remaining **Backplane** retaining screws and lift it out.

After cleaning these parts, and doing any repairs that are needed here, refit the **Backplane**, card cage metalwork and **ROM Module Backplane**, but leave the other parts of the machine dismantled for the moment.

2 Dismantling the HP9830

Begin by removing the top cover which is held on by obvious screws, Under it you will see pair of hold-down bars over the top of the PCBs. Undo the single screw and unhook the upper hold-down bar from the PSU heatsink. Then lift out the other bar.

The keyboard assembly should be removed next. Stand the machine on its back and remove the 4 screws on the underside of the machine near the front. This is one of the few times where it is better not to remove the screws in a diagonal pattern, instead remove the 2 screws on the front edge first (these screw into metal bushes in the relatively fragile plastic front of the machine) and then remove the 3 further back (which screw into metal pillars on the keyboard chassis). With the machine the right way up, lift the keyboard up to clear the eject lever of the cassette drive and then unplug the **Keyboard Cable** from the backplane (just in front of the **Display** PCB. Unplug the in-line connector on the mains switch cable and put the complete keyboard aside.

Look at the layout of the machine. The **I/O backplane** is right at the back, with a cable connected to the top edge leading to to the rear panel connector, Of the main PCBs, the **PSU** PCB is the rearmost one, with a heatsink bracket screwed to the cardcage metalwork. In front of this are a number of PCBs taking up the full width of the machine, these contain the memory and memory control circuitry. The next area consists the **Ext ROM Selector** and **Internal Ext ROM** PCBs on the left and the CPU PCBs to the right. In front of the cardcage metalwork, the **ROM backplane** is on the left, in the centre are the tape control and **Display Driver** PCBs, with the tape drive itself to the right. Finally at the very front is the **Display** PCB.

Remove all the PCBs from the **Main Backplane**. Most of them come out without difficulty, but 3 require comment. The printer cable must be unplugged from the top of the **I/O Backplane** before it is pulled out; there's a fixing screw in the middle of the **Display** PCB and the **PSU** PCB heatsink is fixed to the chassis by 2 screws. As you remove each PCB, inspect it for burnt, damaged or missing components, and put the ROM and RAM PCBs in anti-static bags.

Remove the **ROM backplane**, the tape drive and the tape eject lever assembly, In all cases the fixing screws are obvious,

The next part to remove is the rear panel. Start by removing the nuts holding the mains switch cable clips in place. Slide the T-bolts out of the slot. Slacken the 2 nuts that hold the rear panel to the sides of the machine. On the underside of the machine, remove the 3 screws at the rear edge, then with the machine the right way up pull the panel rearwards and unplug the secondary winding edge connector from the rear of the backplane. Remove the rear panel entirely, feeding the switch cable under the card guide metalwork.

It is not normally necessary to remove the **Main Backplane** or card guides, but if you wish to do this, either to fully clean the machine or to replace edge connectors on the backplane, continue as follows. Remove the ROM door assembly and then the side card guides which are each retained by 2 screws from the rear of the machine. There is an air deflector plate at the left side of the machine which will come off when you do this. Loosen all 8 nuts that hold the card guide metalwork to the sides of the machine and slide the T-bolts along the slots, clear of the flanges on the card guides. Spring the casing apart slightly and remove the front card guide assembly. Then remove the 2 guides for the I/O modules at the rear of the machine (5 screws each, a long screwdriver is needed for the ones holding the guides to the base of the machine). There are now no fasteners retaining the rear metalwork, spring the case apart again and remove it. Finally remove all the screws holding the **Main Backplane** in position and remove it.

It is possible to remove the **Main backplane** without removing the guides by simply removing the fixing screws and sliding it out towards the front of the machine. However, a machine in need of backplane repairs is likely to need fully cleaning too, so it's probably better to remove the guides

After cleaning the machine or repairing the **Main Backplane**. refit the latter and the card guide metalwork to the casing – and don't forget to put the T-bolts in the side slots before fitting the guides. Leave the rest of the machine apart for the moment.

3 Keyboard dismantling

There are 2 good reasons for dismantling the keyboard. Firstly to clean out the years of accumulated dust, coffee, and the like. And secondly to remove the mains switch so that the mains can be kept well away from the rest of the machine while you are tracing and repairing faults.

The first part to remove is the **Keyboard Encoder** PCB. Put the keyboard upside-down on your bench with the display window section of the bezel overhanging the edge. In an HP9810 or HP9820 machine, unplug the keyboard cable from the end of the encoder PCB (The HP9820's cable will be completely free now, the HP9810 one is attached to the LEDs on the keyboard) and carefully ease off the **Connector** PCB between the **Keyboard Encoder** PCB and the keyboard itself. On an HP9830, there is a single PCB which connects the **Keyboard Encoder** PCB to the **Keyboard** and also carries the cable to the **Main Backplane**; ease it off. Finally remove the screws and lift off the **Encoder** PCB.

The plastic keyboard bezel is held in place by 6 screws. Four are easy to see at the sides of the keyboard, the other 2 are reached through holes in the **Keyboard** PCB. Loosen the 4 at the sides so they have about 1/4" of play, then remove the last 2 screws. The one at the rear can be extracted using tweezers or long-nose pliers working between the keyswitches, the one at the front has to be shaken out. Remove the remaining screws and the bezel. The bezel is quite brittle now, and should be stored with care.

Back on the keyboard chassis, remove the front casing strip (6 screws) – on an HP9830, desolder the power-on indicator wires from the keyboard PCB. Undo the 2 screws and separate the mains switch from the keyboard.

The keyboard will need cleaning, they always do. On an HP9810 or HP9820 (with the 'transformer' keyboard), pull out all the keycaps and their plungers. Slide the springs off, and note that double-width keys have 2 springs, each somewhat weaker than the one used on a normal key. The normal and double-width keycaps can be pulled off their plungers for cleaning, but it is better to clean the narrow keycaps on their plungers to avoid damage. Remove the screws holding the keyboard PCB to the chassis and lift it off. Remove all the plastic key housings.

On an HP9810, there are 10 status LEDs in plastic housings on the keyboard chassis. These housings are retained by C-clips. To replace an LED, remoce the C-clip and slide the housing out of the chassis. The housing will then separate into 2 halves, exposing the LED and its connections. It should be noted that the 3 LEDs associated with the ROM module keys are in longer housings than the remainder. Therefore if several LEDs are removed at once, keep a note as to shich housing parts came from each LED.

On an HP9830, pull off all the keycaps. If you want to go further, it's necessary to desolder all the keyswitches from the PCB and then remove the PCB from the chassis (the fixing screws are easy to spot)., Then unclip all the switches from the chassis. When reassembling, it's easiest to fit the PCB to the chassis and then to clip the switches in place one at a time making sure the pins go through the holes in the PCB before soldering that switch in place.

You now have the incredibly boring job of cleaning all the keycaps and the other parts of the keyboard. Then reassemble the keyboard unit itself, but do not refit the mains switch, front casing strip, bezel or encoder PCB at this stage.

On an HP9830, this is a good time to test the power-on bulb. If it is burnt-out, solder a new 5V 60mA wired-ended bulb to the terminals on the front casing strip.

The keyboard bezel will have turned very brittle with age and it is likely to be cracked. If so, remove the display window so it will not get damaged during the bezel repairs (it is held on by small screws on the bottom flange).

The best way I have found for repairing the bezel is to put the pieces together and apply a suitable solvent (such as dichloromethane (methylene chloride), which is sold under the trade name 'Plastic Weld') along the cracks with a small brush (a natural bristle brush is best since it will not dissolve in the solvent). Then cut a piece of cotton fabric to cover the cracked area on the underside of the bezel. Put this over the cracks and 'paint' it with the solvent/ When the plastic has softened, force the fabric into it. When it has dried it should be strong enough for use, but still treat it with care.

4 Dismantling the rear panel

The rear panel should be dismantled to inspect the mains wiring and components and also to clean and lubricate the cooling fan. Again the procedure is similar on all models.

Begin by removing both fuseholder caps and the cartridge fuses. Inspect and test the latter. If either are blown, particularly if they are shattered or blackened, there may be a serious power supply fault.

On an HP9810 or HP9820, the mains filter is likely to be a single module. There may be a metal shield in front of it, which should be removed first. Then remove the nut and bolt holding the filter to the bracket so the filter can be moved clear.

On an HP9830, it is common to have separate filter inductor and capacitor units. Undo the 4 screws holding the front shield plate over the filter assembly, unclip the inductor and capacitor from their Terry clips and put the plate aside. Unscrew its 4 mounting pillars.

On all types of machine, unbolt the power transformer from the rear panel. Then undo the 4 nuts at the corners of the connector plate, these screw onto studs on the metal bezel. Remove the bezel completely. the connector panel is now free, but of course it is wired to the cooling fan.

The original fans used in these machines are very easy to dismantle and repair. Take out the 4 screws on the front plate (these are not the screws holding the complete fan to the rear panel of the machine, of course). Lift off the front plate complete with the fan blades and motor. There may be an earth wire on one of the fan housing screws, if so, remove that screw. All the electrical parts can now be removed from the rear panel.

The fan motor is held to the front plate by 2 screws under the label. Feel for them with a screwdriver, then remove them and the plate. Remove the circlip and washers from the end of the fan spindle then slide the rotor/blades out from the bearings. There will be spacer washers on the other end of the spindle too, make sure you don't loose any.

Back on the rear panel, remove the fan housing and grille. There are plastic bumpers at each end of the panel, which are held on by screws, remove them. If they have deteriorated, it is probably best to leave them off and simply put the screws back in their holes.

As with the keyboard, these parts will need cleaning. Inspect the parts for damage, broken connectors, and similar faults. Then reassemble the complete back panel. When reassembling the fan, put a little light machine oil on the bearings. Check the setting of the voltage selector switches, and fit good fuses of the correct rating in the holders.

It's time for the first electrical tests. If you have an insulation tester, check the resistance between the live and neutral pins of the mains input plug and between those pins and the earth pin. If you have an insulation breakdown, suspect the mains filter components. Connect the mains switch, removed from the keyboard, to its in-line connector and turn the switch on. If you are worried about the live mains on the switch terminals coming into contact with something it shouldn't, put the switch in a little plastic bag which you can fix to the cable with a cable tie.

Now check for continuity – not a 'dead short' though – between the live and neutral pins of the mains connector. If it is open-circuit, suspect the mains switch first of all. It is easy to check if the appropriate pins on the connector are linked together with the switch is turned on. If not, then it's time to replace the switch, I have never managed to successfully repair one of these. If the switch is good, check the rear panel components including the mains transformer primary windings.

Check the insulation between the live or neutral pins and the ground pin again. If you have a breakdown this time, the most likely problem is, unfortunately, the mains transformer. But I've never had this.

Time to apply mains at last. Use the switched cable I mentioned earlier if you don't have switched mains sockets on your workbench, and if either fuse had blown hard, you might want to connect a 100W mains light bulb in series with the mains input at this point. Turn on the power. The fan should start running and the bulb (if used) should remain dark. If not, suspect a short-circuit somewhere, possibly shorted turns in the mains transformer. Fortunately, though, this is rare. Using an AC voltmeter, check the output voltages of the transformer.

Assuming everything is correct, disconnect the mains input, unplug the switch at the in-line connector, and refit the rear panel to the machine. Reconnect the switch so the transformer can be powered up again.

5 Dismantling a ROM module

Since the ROM modules contain only custom mask-programmed ROM chips, it is unlikely that you will be able to repair a defective one. However you may wish to dismantle a ROM module to make one good one from 2 defective ones of the same type, to repair the bias potential divider, or just for interest.

It is clear that HP never intended these modules to be dismantled. They are held together by barbed metal studs forced into the plastic housing. But they can be dismantled with little damage as follows :

Put a suitable tool, such as a flat-bladed screwdriver between the 2 halves of the case at one corner, near the stud. Heat the stud's head with a soldering iron, applying a little solder will aid the heat transfer (the solder will not stick to the stud, which is aluminium). When the plastic softens, use the screwdriver to force the casing apart at that corner, remove the soldering iron and hold it open until the stud cools.

Repeat this procedure for the other 3 studs and separate the case halves. Remove the extractor handle (if it hasn't already fallen out) and lift out the PCB noting which way round it was fitted.

Push the studs out of the case half. I find it easier to reassemble these modules with #4 * 5/8" self-tapping screws, which will screw into the plastic in place of the original studs.