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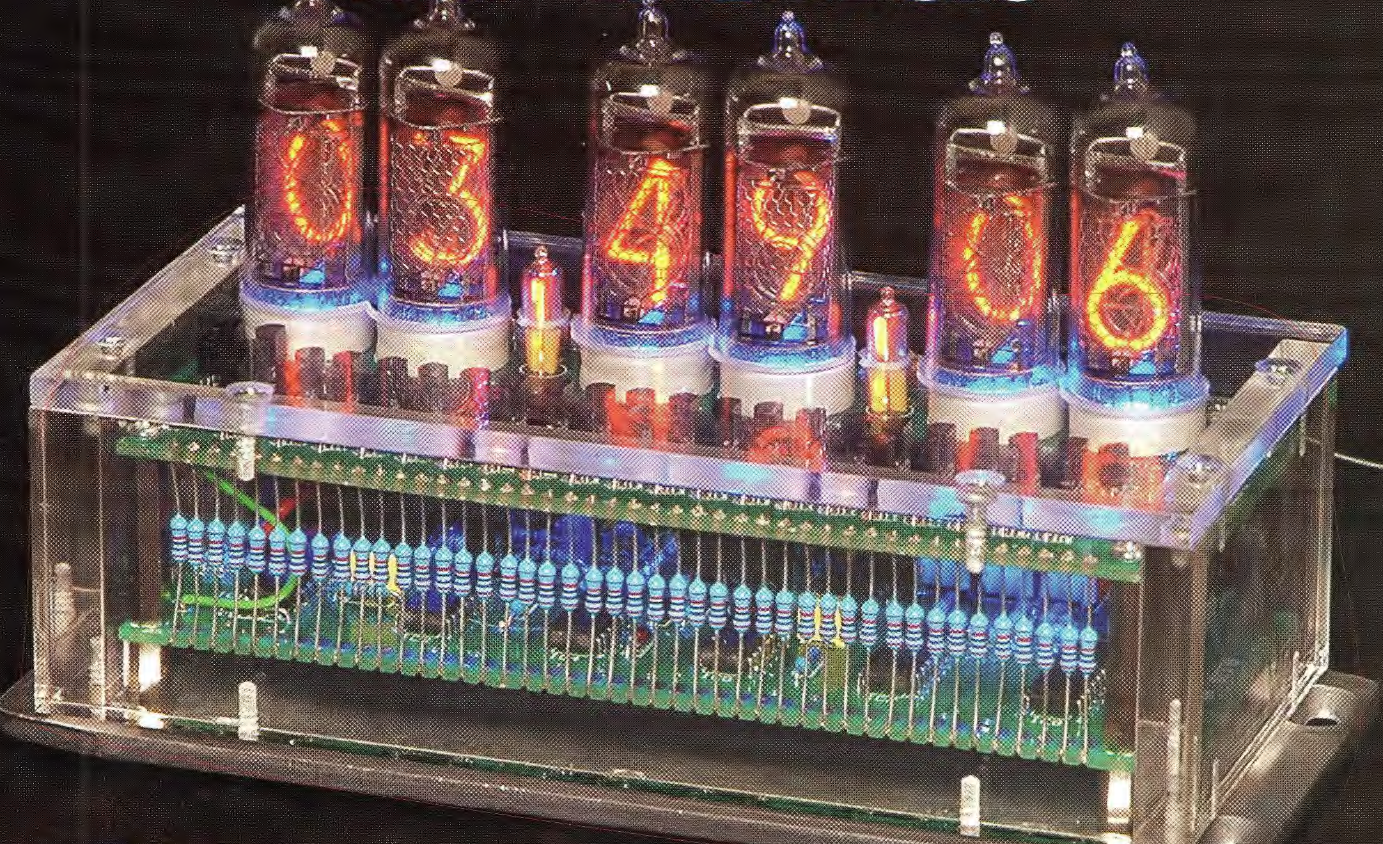
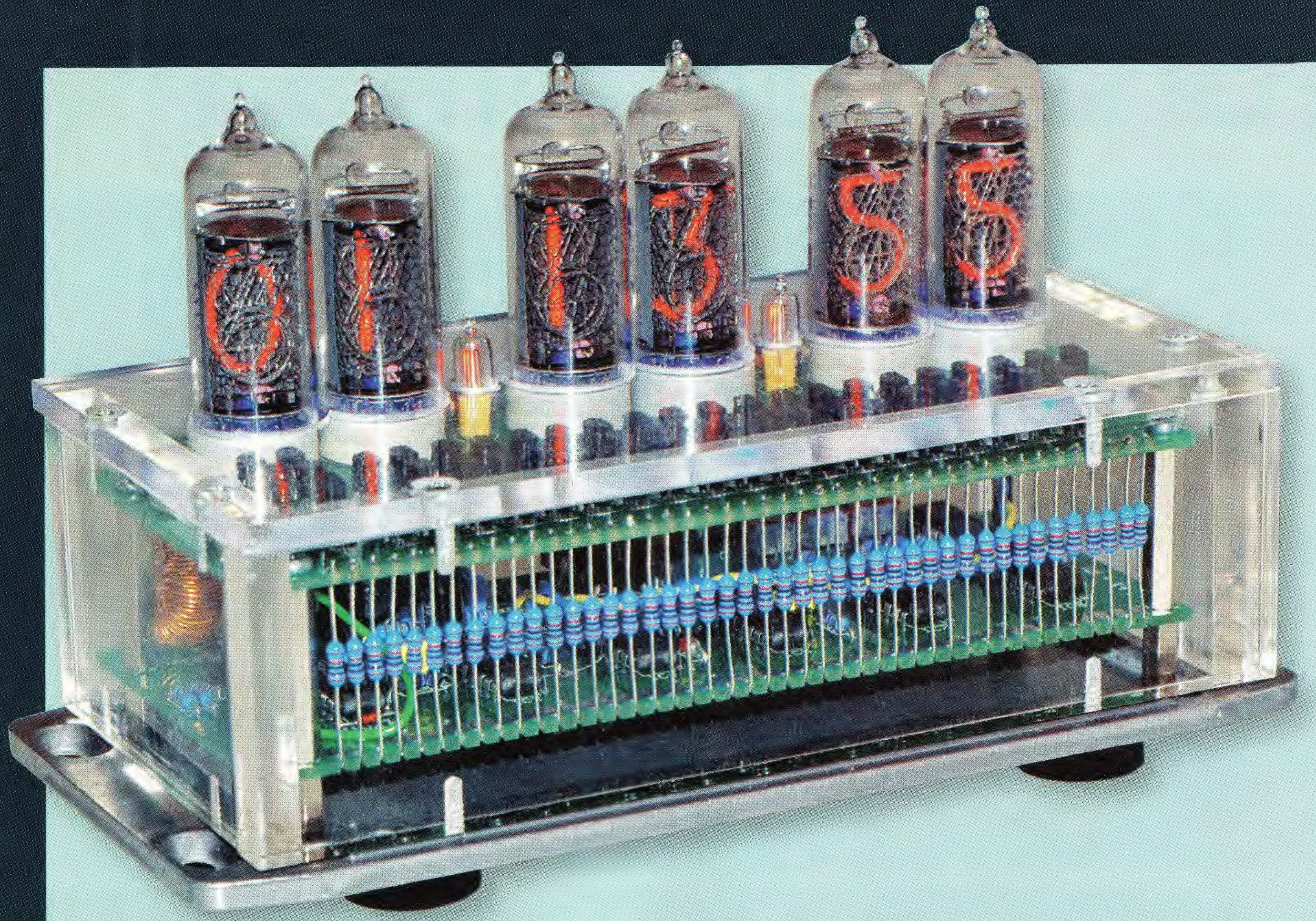
Retro NIXIE CLOCK to build!





Nixie Clock

Eye-Catching Retro Project To Build

We have been wanting to produce this Nixie Clock project for a long time and now it has finally come to fruition. It has the warm, fascinating glow of Nixie tubes with their hypnotic counting action, mixed with a cool blue glow from a high-brightness LED from underneath each tube. It makes an eye-catching display, both during the day and at night.

Pt.1: Design by DAVID WHITBY


Two different cases will be available – either a see-through Perspex case as shown at left or a white powder-coated diecast aluminium case as shown above. By the way, the photos really don't do the brightly glowing Nixie & LED displays justice.

IF YOU DO A GOOGLE search for "Nixie Clock" you will immediately find over 200,000 results. Many of these refer to actual Nixie clock designs or clocks that enthusiasts have built. Some are quite eye-catching, some are downright ugly and some are truly weird. We feel quite safe in stating that none looks as good or is as well-designed as the Nixie Clock we are presenting here.

Not only does it function as a classic 6-digit 12-hour clock, with hours, minutes and seconds display, it also uses blue LEDs to throw light up through the Nixies – a neat juxtaposition of the nostalgic warm neon discharge with the cool blue present. It keeps accurate time with crystal control and the retro "Nixie" tubes with their moving and glowing individual numbers give it the atmosphere of an earlier techno age.

What is a Nixie?

A Nixie is, or was, one of the first numeric displays. It has 10 individual electrodes, from 0-9, placed one behind another. Each electrode is lit with a neon discharge to display a particular number. Before Nixies, alphanumerical displays were mainly electromechanical indicators or incandescent filament devices which the compact, silent and reliable Nixie soon outshone.

The Nixie was invented by the Haydu brothers in the USA in 1952 who later sold the design to Burroughs Business Machines. It appeared in vast numbers in the late fifties and sixties as the display of choice for calculators and other business machines, various kinds of test equipment and early computers. They displayed the trading information at the New York Stock Exchange and showed crucial data in those epic control rooms during the space race.

The Nixie name came from an original prototype drawing which was entitled "N I X 1" meaning Numerical Indicator eXperimental 1. The name stuck and has been used ever since. Nixies were made in a vast range of different shapes, sizes and colours and tubes with many different symbols apart from numbers were manufactured.

From the early 1970s, they were rapidly displaced by 7-segment LED and vacuum fluorescent displays, and ultimately by liquid crystal displays (LCDs). Funnily enough, today's plasma displays can be regarded as an evolution from Nixies – they are both gas discharge displays.

Nixie tubes have not been manufactured for many years and are becoming rarer and more expensive, so if you want a lasting and useful piece of retro technology, now is definitely the right time to build a Nixie clock.

Circuit description

Now let's take a look at the circuit – see Fig.1. Big, isn't it? But this is relatively low-tech stuff with not a microprocessor in sight.

As shown, there are six Nixies, with their cathodes each driven by a high-voltage transistor, 44 transistors in all.

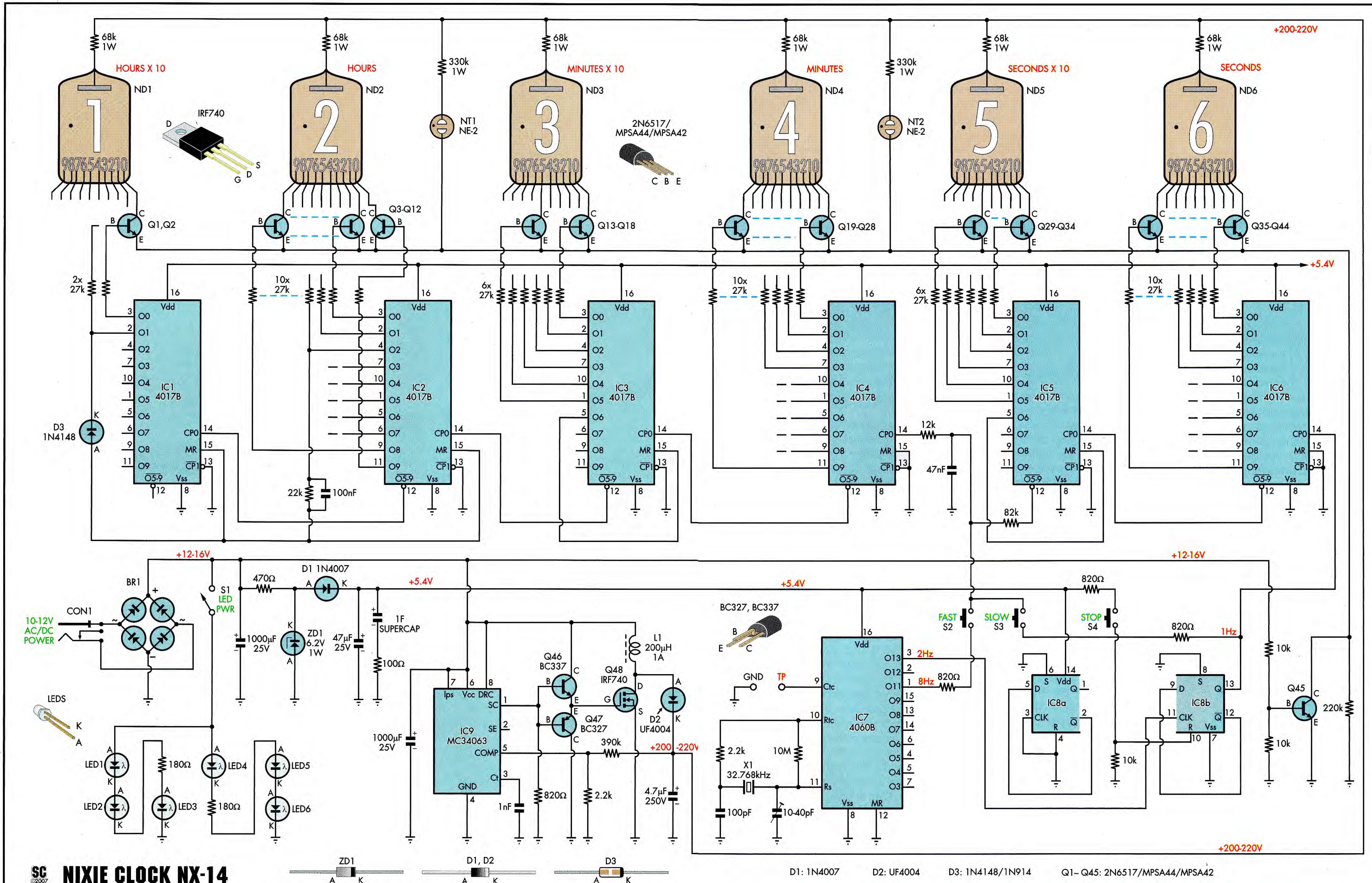


Fig.1: the circuit uses six Nixie tubes, each driven by a 4017 decade counter via high-voltage transistors. Switchmode controller IC9 and its associated parts provide the high-voltage (200-220V) DC supply for the Nixie anodes.

NOTE: THE SWITCHMODE INVERTER CIRCUIT (IC9, Q46-Q48, L1 & D2) PRODUCES A VOLTAGE OF 200-220V DC

Parts List

2 double-sided PC boards, code NX14L & NX14U
6 1N14 Nixie tubes
2 NE-2 neon indicators
1 32.768kHz watch crystal
1 200μH 3A inductor (L1)
1 miniature toggle switch (S1)
3 momentary pushbutton switches (S2-S4)
1 2.1mm DC connector (CON1)

Semiconductors
6 4017 decade counter/dividers (IC1-IC6)
1 4060 oscillator/divider (IC7)
1 4013 dual D flipflop (IC8)
1 34063 switchmode controller (IC9)
45 2N6517 high-voltage NPN transistors (Q1-Q45)
1 BC337 NPN transistor (Q46)
1 BC327 PNP transistor (Q47)
1 IRF740 N-channel Mosfet (Q48)
1 1N4007 rectifier diode (D1)
1 UF4004 fast recovery diode (D2)
1 1N914, 1N4148 diode (D3)
1 6.2V 1W zener diode (ZD1)
1 W02/4 bridge rectifier (BR1)
6 blue LEDs (LED1-LED6)

Capacitors
1 1F Supercap
2 1000μF 25V PC electrolytic
1 47μF 25V PC electrolytic
1 4.7μF 450V PC electrolytic
1 100nF MKT polyester
1 47nF MKT polyester
1 1nF MKT polyester
1 100pF ceramic
1 10-40pF trimmer

Resistors (0.25W, 1%)

1 10MΩ	1 12kΩ
1 390kΩ	3 10kΩ
2 330kΩ 1W	2 2.2kΩ
1 220kΩ	4 820Ω
1 82kΩ	1 470Ω
6 68kΩ 1W	2 180Ω
44 27kΩ	1 100Ω
1 22kΩ	

Nixie Tubes: How They Work

Nixies work on the same principle as the simple neon indicator. A neon indicator consists of a small glass tube filled with inert neon gas and containing two metal electrodes. When a sufficiently high voltage is applied between the electrodes, the gas around the negative electrode (the cathode) ionises and envelops the electrode with an orange glow.

The voltage required for ionisation of the gas is dependent on the electrode spacing and the temperature. Typically it is more than 80V for small neon bulbs and more than 150V for average size Nixie tubes. In practice, higher voltages are used, with a series resistor to limit the discharge current to a safe value.

Two small neons are used in this clock design, between the hours and minutes and between the minutes and seconds tubes.

A Nixie tube has a see-through metal mesh anode at the front and 10 different shaped cathodes (0-9) behind the anode, each being terminated to a different wire lead or pin on the tube. The number-shaped cathodes are not necessarily placed in direct order behind the anode but are placed to give minimum obstruction of each digit by the ones in front of it.

The anode is connected to +HT via a current-limiting resistor and the particular cathode is pulled down to 0V when it is to be lit. By the way, "HT" is old-timer talk for "high tension" or high voltage.

From Russia with love

There's another throwback to the sixties with this clock. It uses Russian 1N14 Nixies. The Russians kept making these long after western countries had ceased manufacture, as they were shut out from a lot of new technology from the west during the Cold War.

In turn, each high-voltage transistor is driven from the respective output of a 4017 CMOS counter chip. The counter chips are clocked by a 32.768kHz watch crystal driving a 4060 oscillator/divider chip. Apart from the high voltage DC-DC inverter, that is pretty well all there is to it.

Let's start in the bottom lefthand corner of the circuit, with the power supply section. The whole circuit runs from a standard 12VAC plugpack or it can run from a 12V car battery. Nixie car clock, anyone?

The incoming 12VAC is connected to a full-wave rectifier bridge (BR1) and a 1000μF 25V electrolytic capacitor. The resultant 12-16V DC rail powers a high-voltage SMPS (switchmode power supply) which employs an MC34063 chip (IC9).

A 6.2V zener diode (ZD1) provides a regulated 5.4V supply for all the CMOS chips via diode D1. Also across this supply is the 1 Farad Supercap which can keep the clock "ticking over" for six hours or more during power failures. This is without running the Nixie tubes of course and when power is restored, the Nixies light up with the correct time displayed.

When external power fails or is disconnected, diode D1 isolates the Supercap supply from the other power supply components to avoid their load current.

High-voltage supply

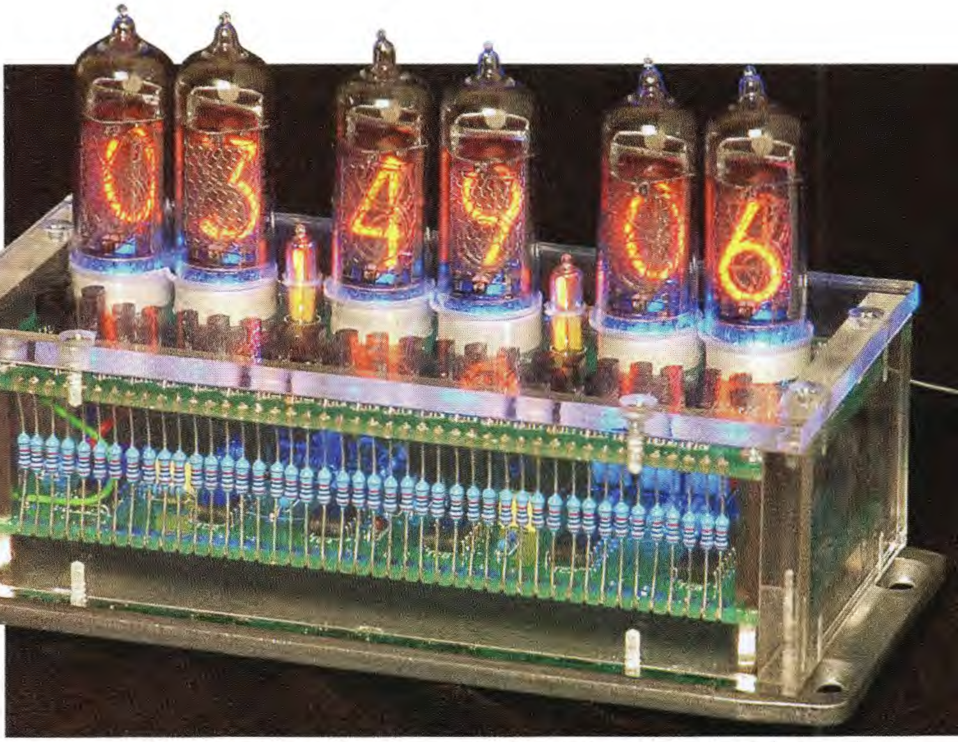
The high-voltage supply consists of the MC34063 switchmode controller chip (already mentioned), together with inductor L1 and a few other components. **It might look quite innocuous but it produces around 220V, enough to give you quite a boot if you touch the wrong parts of the PC boards.**

The MC34063 runs at about 40kHz, as set by the 1nF capacitor at pin 3. It drives a pair of complementary transistors, Q46 & Q47, which in turn drive switching Mosfet Q48.

The circuit is a boost or up-converter which works by switching a current at high frequency through inductor L1 and using the stored energy to charge a capacitor via fast recovery diode D2, during the Mosfet off times. A resistive feedback network consisting of the 390kΩ and 2.2kΩ resistors connected to pin 5 maintains the output DC voltage at between 200V and 220V.

For those who might have studied the MC34063 datasheet and are puzzled by the unconventional driver connections, note that the output transistors within the MC34063 are not connected in the standard way. Instead, they connect the drive waveform to Q46 & Q47 via their "eb-bc" junctions. This odd configuration was found to give the highest efficiency in this high-voltage step-up circuit.

Higher frequency DC-DC converter chips such as those from Maxim were tried but proved to be ultra-sensitive to PC board layout and had higher EMI than the MC34063.



Once again, this night-time photo doesn't do the clock justice. The glowing colours from the Nixie displays and the blue LEDs are actually quite a lot brighter and more dynamic than this photograph shows.

Crystal oscillator

This is the time standard for the clock and it uses a 32.768kHz watch crystal and a 4060 CMOS oscillator-divider (IC7). The crystal is connected via a 2.2kΩ current-limiting resistor while the 10MΩ resistor is there to provide bias for the internal inverter stages. The 100pF capacitor and the 10-40pF trimmer capacitor provide the correct capacitive loading for the crystal and enable very fine adjustment of the frequency, for accurate time keeping.

The output frequency at the final stage of the 4060 (pin 3) is 2Hz. This is fed to the second section of a 4013 dual D flipflop (IC8b) which divides by two to produce 1Hz pulses to operate the clock counter chain.

Time-setting

Time setting is done by three momentary-contact pushbutton switches: S2 (FAST), S3 (SLOW) & S4 (STOP).

When pressed, the STOP button holds the reset pin of IC8b high, via an 820Ω resistor, to stop the count for precise seconds setting.

The SLOW button connects 1Hz pulses from IC8b into the minutes counter (IC4) overriding the tens of seconds counter (IC5) due to the voltage divider action of the 82kΩ and 12kΩ resistors. The FAST button works the same way but connects 8Hz pulses from the 4060 into the same point; ie, pin 14 of IC4.

Main clock counter chain

The clock counter uses six 4017 CMOS decade counter/dividers (IC1-IC6), one for each Nixie tube. The 4017s each have 10 high-going outputs, giving 60 available outputs of which 44 are required to implement the 12-hour clock. Each of these 44 outputs has a 27kΩ resistor to the base of a high-voltage TO92 transistor (Q1-Q44), with each collector connected to the relevant Nixie tube cathode.

Note that these transistors need to have a breakdown voltage rating of at least 300V and those supplied for the clock kit are MPSA42, MPSA44 or 2N6517, all of which were originally designed for TV video amplifier stages.

Clock counting sequence

Now we need to discuss the interconnections of the 4017 decade counter/divider chain to make it count and indicate as a 12-hour clock.

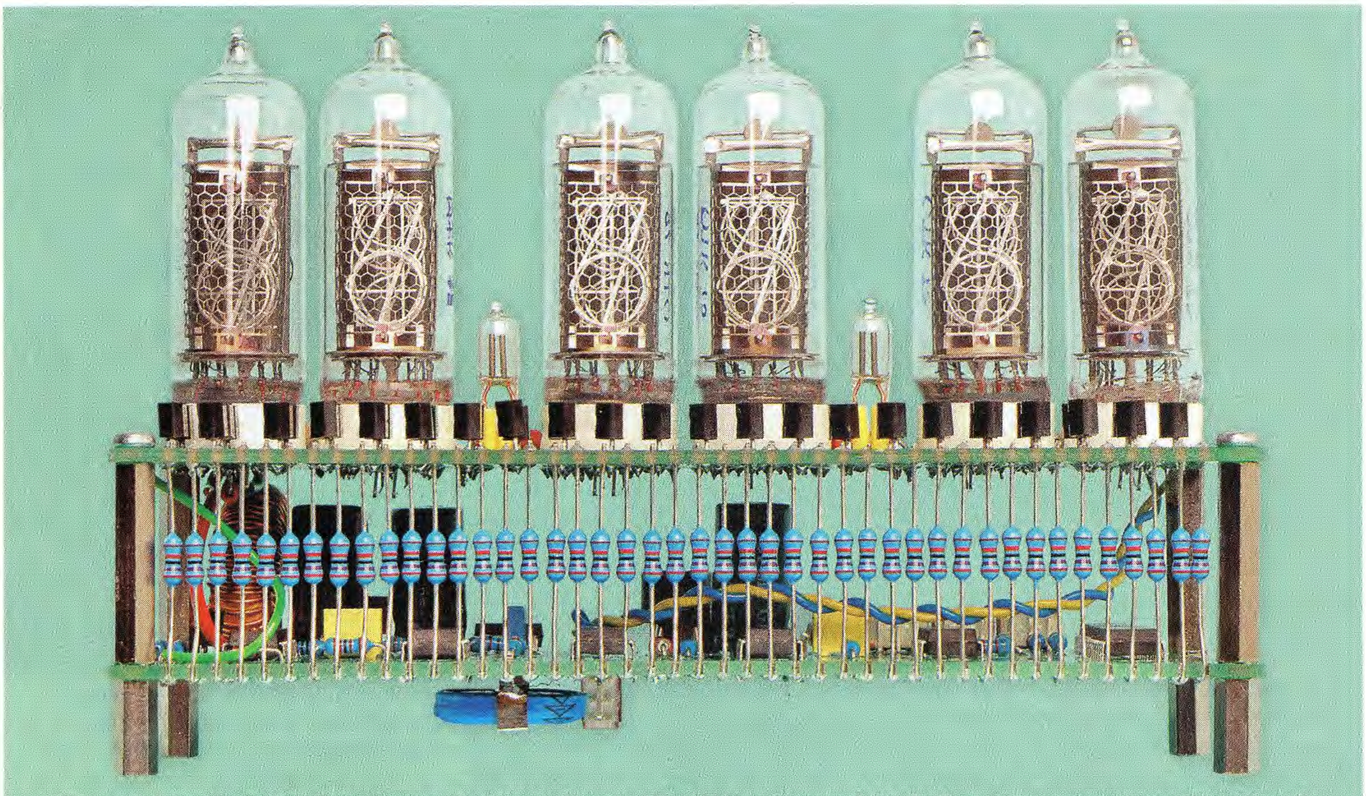
SECONDS STAGE: the 1Hz output from IC8b is connected to the clock input (pin 14) of the seconds counter (IC6), which causes its outputs to go high in turn at 1-second intervals from 0-9. The carry-out output of IC6 (pin 12) is connected to the clock input (pin 14) of the tens of seconds counter (IC5) which has its "6" output connected to the reset (pin 15). It therefore resets itself at the "6" count, thus giving a total seconds count of 59 which is then reset to 00 to start the next minute.

MINUTES STAGE: the tens of seconds carry-out output at pin 12 of IC5 is connected via series 82kΩ and 12kΩ resistors to the clock input (pin 14) of the minutes counter (IC4). Its outputs go high in turn at 1-minute intervals from 0-9 and its carry-out output (pin 12) drives the clock input of the tens of minutes counter (IC3). The tens of minutes counter resets at "6" in the same way as the tens of seconds counter.

The seconds and minutes counters together count to 59 minutes and 59 seconds then reset to 0000, passing the last carry-out to the hours counter (IC2).

HOURS STAGE: the hours counter counts from 0-9 but because the clock must start at 1 o'clock (not 0 o'clock!) the Nixie is wired so that the numerals read 1 for O0, 2 for O2, etc, up to 9 for O8 and then 0 for O9 when the carry-out is passed to the tens of hours counter IC1 to read "1" (the highest readout for a 12-hour clock).

The hours counter (IC2) counts from 0-9 (1-9-0 on the Nixie tube) only when the "1" output of the tens of hours counter (IC1) is low. At the same time, the "2" output will be low, causing D3 to conduct and prevent the resets to pin 15 of IC1 & IC2 from being activated. When the tens of hours counter reaches "2", both hours counters are reset to 00. This results in a reading of



The unit is built on two double-sided PC boards, with the Nixie tubes and the high-voltage transistors all soldered directly to the top board. The full constructional details are in Pt.2 next month.

"12" on the hours Nixie, corresponding to 12.00.00 or 12 o'clock.

If you would prefer not to have the "0" reading on the tens of hours Nixie, you can simply omit transistor Q1 from the PC board.

Two circuit features remain to be described and the first is transistor Q45 which has its collector connected to the emitters of all 44 Nixie cathode driver transistors. Normally, Q1 is biased on from the 12-16V DC rail via a voltage divider consisting of two 10kΩ resistors. While that 12V supply is present, the Nixies are all driven by the 44 high-voltage transistors.

However, during a power failure the 12V DC supply rail collapses and Q45 turns off, so negligible drive current can flow from the 4017 counter outputs to the bases of the 44 high-voltage transistors. This reduces the current drawn by the counters to an absolute minimum and extends the back-up time provided by the 1F Supercap.

The blue LEDs which provide the up-lighting for the Nixie sockets are run in two series groups of three together with 180Ω current limiting resistors. If you want to turn them off (unlikely, we think), S1 does the job.

Mechanical design

This completes the circuit description so now let's have a brief look at the mechanical design of the clock.

In essence, there are two double-sided plated-through hole PC boards which are stacked together and separated by four 25mm hexagonal metal spacers. The lower PC board carries the power supplies, crystal oscillator and all the dividing/counting circuits. The 1 Farad super capacitor is mounted underneath this board, along with four 10mm hexagonal spacers for mounting the whole assembly to the base of the clock housing.

The upper PC board holds the six Nixies and their associated current limiting resistors, the two neon bulbs and their resistors and the 44 high-voltage driver transistors. Provision is also made on this board for the optional up-lighting kit, consisting the six high-intensity 3mm blue LEDs, two current limiting resistors and the light off/on switch S1.

The two boards are connected together by 44 vertical 27kΩ resistors (the base resistors for the high-voltage transistors). The clock can be supplied with either a see-through Perspex case or a white powder-coated diecast aluminium case – see photos.

Next month, we will give the construction details and show how to install the blue LED uplighting. **SC**

Nixie Clock

Building This Eye-Catching Retro Project

Pt.2: Design by DAVID WHITBY

Last month, we gave some of the history of Nixie tubes and described the design of the NX14 clock and its circuit. This month, we give the assembly details and describe the optional blue LED up-lighting which we think that most constructors will definitely want, together with the attractive see-through Perspex case.

THE NX14 NIXIE CLOCK is built on two double-sided, plated-through-hole PC boards, each measuring 147 x 60mm.

The upper PC board is coded NX14U and holds the six Nixies and their associated current limiting resistors, the two neon "hours" and "minutes" bulbs with their resistors and the 44 high-voltage driver transistors. This board also takes the optional six 3mm blue LEDs and their two current limiting resistors.

The lower PC board

We'll start assembly with the lower board – see Fig.1. It is coded NX14L and carries the power supply, crystal oscillator and all the dividing/counting circuits. The 1F (yes, one Farad!) super capacitor is mounted underneath this board along with four 10mm mounting spacers and the mini toggle off/on switch for the blue LEDs (if required).

In the kit, both PC boards come packed with their own components, separated into the different component types to simplify assembly. After checking the board for faults such

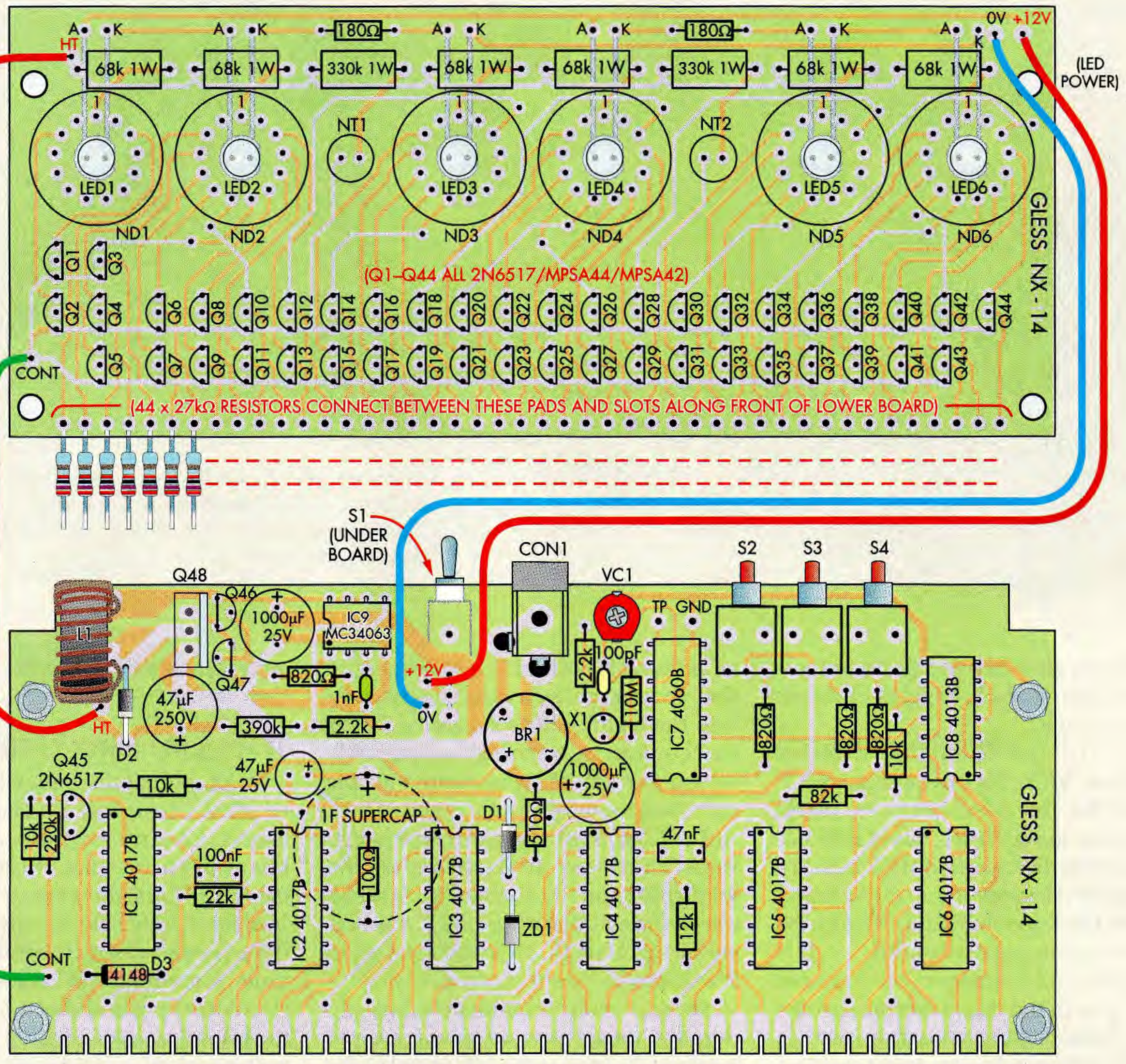


Fig.1: install the parts on the two PC boards and run the wiring connections as shown here to assemble your Nixie clock. Note that the six blue LEDs for the optional up-lighting (ie, LEDs 1-6) are installed on the rear of the top board – see photo. Switch S1 and the 1F supercap are installed on the rear of the bottom board.

as bridged tracks or blocked plated-through holes, begin by installing all 17 resistors in the board.

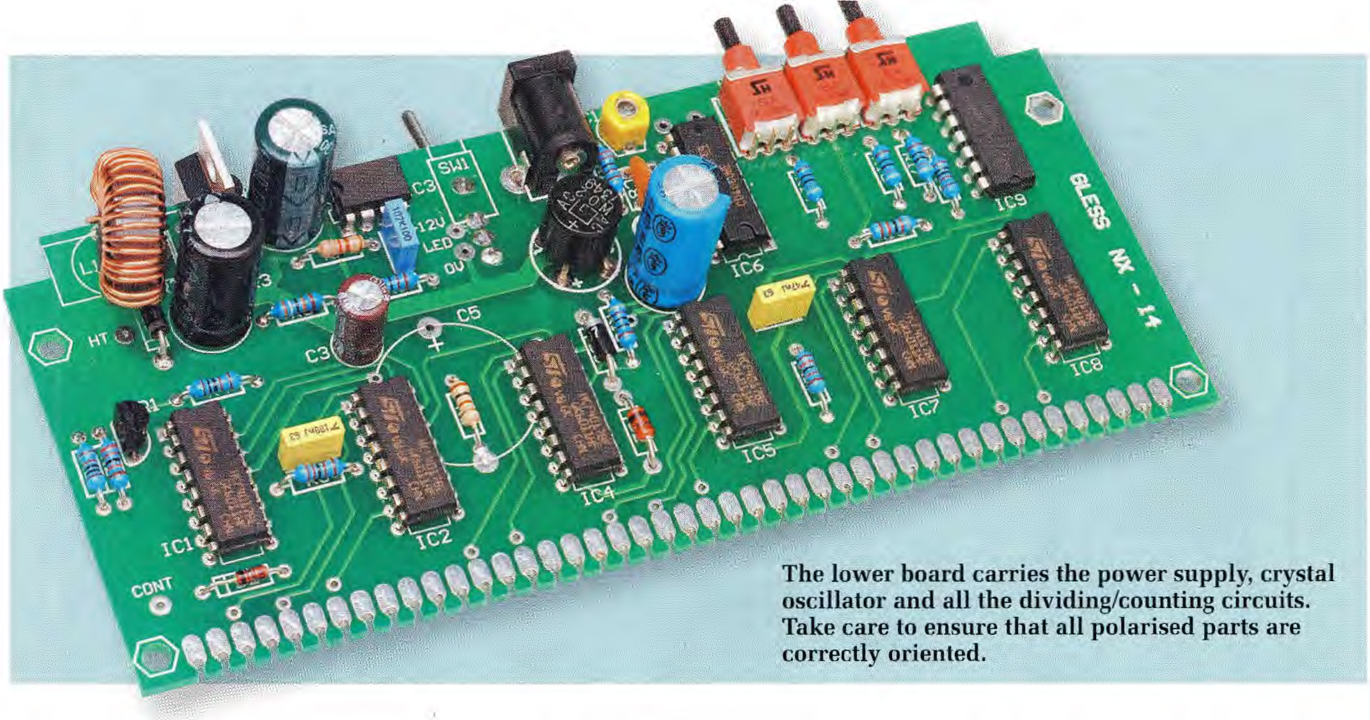
Before soldering the resistors and cutting their pigtails, double check that you have the right values in the right holes. If you are unsure of any of the resistor values, double check them with a digital multimeter as the colour codes can be difficult to read.

Next, install the three diodes and the zener diode. These are all different, so take care to place them in the correct positions and with the right polarity. D3 (1N4148 or 1N914) and ZD1 will be in small glass packages while the other two are in black plastic encapsulation. These might look the same but they are not! D1 is a common 1N4007 1A power diode while D2 is a UF4004 1A high speed switching diode, for the high frequency HT power supply. Make sure you read the labelling before you install them. **If you get these mixed up the HT supply may not work at all or it might get very hot.**

The three small plastic TO92 transistors can go in next and once again, these are three different types so take care to place each of them in their correct positions. It is particularly easy to mix up Q46 and Q47 which are mounted next to each other in the HT supply area. Q46 is a BC337 and goes nearest to the edge of the PC board while Q47 is a BC327 which goes next to it but faces the other way.

Don't fit Q45 at this stage. It's the same type as used on the upper PC board; it could be a 2N6517 or MPSA42 or MPSA44. Similarly, the only other transistor (Q48 – IRF740 power Mosfet) is not installed at the moment. This disables the "bitey" HT generator until after the clock DC supplies and circuitry are tested. It's not good idea to have 200-230V around while testing the CMOS clock circuitry and handling the board!

Next, fit the small non-polarised capacitors. These are the three small rectangular MKT capacitors (1nF, 47nF and 100nF) and a small 100pF ceramic capacitor near the crystal oscillator (IC



The lower board carries the power supply, crystal oscillator and all the dividing/counting circuits. Take care to ensure that all polarised parts are correctly oriented.

7). They're all fairly straightforward – all you have to do is to get each value in right place.

Next, fit the oscillator trimmer capacitor, VC1. It's not polarised but should be installed with its metal screw slot going to 0V, for stable adjustment with a metal tool. The last of the small components are the small 32.768kHz watch crystal (X1) and the two test-point pins behind IC7.

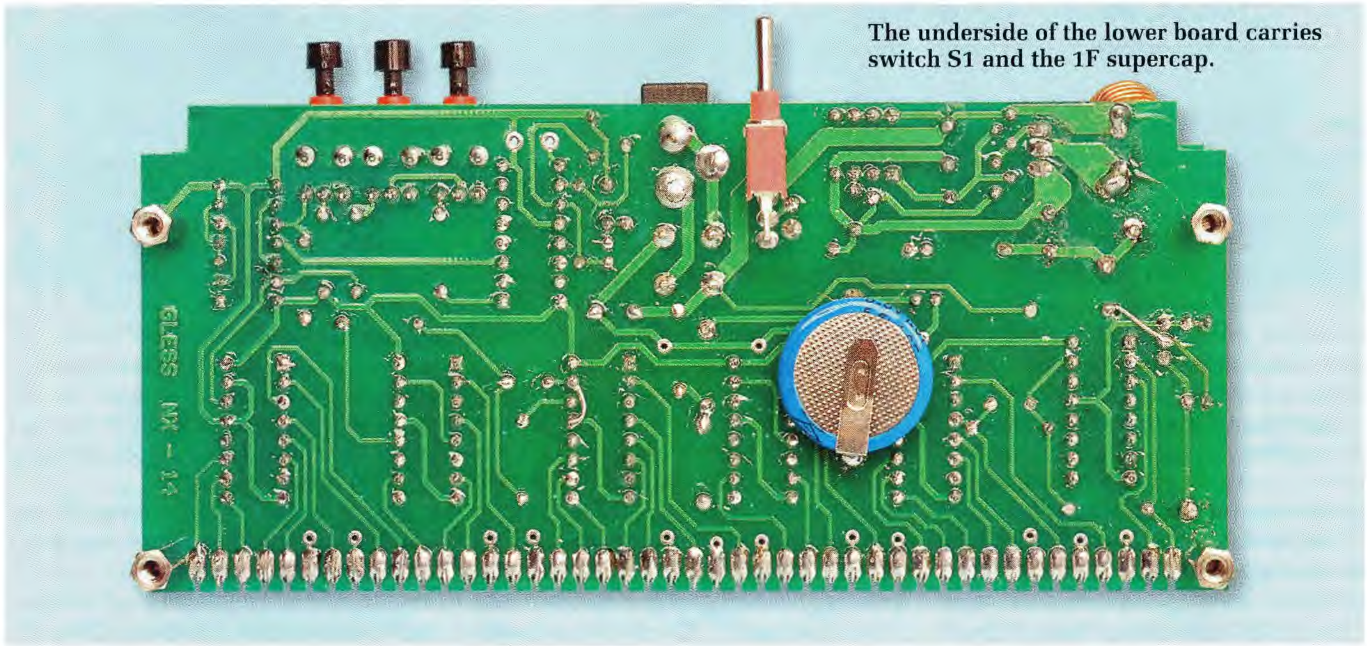
Now install the larger components, starting with the diode rectifier bridge (BR1). Take care to match the markings with the PC board component overlay. Install the power socket (CON 1) and switches S1, S2 and S3, making sure that they are all pushed all the way into the board before soldering. Then fit the four electrolytic capacitors which are polarised and must go the right way around.

The CMOS ICs can go in next, starting with the six 4017s (ICs 1-6), the 4060 (IC7) and the 4013 (IC8). Double-check the orientation of the ICs before soldering. Note that IC7 and IC8 face in the opposite direction to ICs1-6.

Several components are not soldered in until the main power supply is tested. These are the MC34063 (IC9), L1, the 1F supercap, S1 (the blue LED switch) and the previously mentioned Q48.

Testing the lower board

It doesn't matter if you do this before or after you assemble the upper PC board. After thoroughly checking the board to ensure that you have everything in the right place, connect the lead from the 10V AC plugpack into the power socket on the PC board. That done, measure the DC voltage between the 0V test pin and the "+" terminal of the bridge rectifier BR1. This should be between 11V and 14VDC, depending on the AC mains voltage.



The underside of the lower board carries switch S1 and the 1F supercap.

The upper board carries the six Nixie tubes, the two Neons and the 44 segment driver transistors. Make sure the Nixie tubes are seated correctly before soldering their leads.

Next, check the voltage between 0V and pin 16 of IC7 – it should be between 5.4V and 5.5V. If all is OK so far, check that the crystal oscillator is working. If you have an oscilloscope or frequency counter, look for 32.768kHz at the test point. Otherwise, using a multimeter, look for 2Hz (5V) on pin 3 of IC7 or 1Hz on pin 13 of IC8 (on an analog meter you can see the pointer flicking at these rates). This will confirm that all is well up to the input of the clock counter/divider chain.

If you do have a frequency counter this would be a good time to set the oscillator to exactly 32.768kHz.

The only simple way to test the counting/dividing circuitry is with the display in the finished clock so now you can fit the remainder of the HT supply components – ie, IC9, L1, the 1F supercap, S1 (the blue LED switch) and Q48.

The HT supply

With the HT components installed, wire the supplied coloured leads to the board. A 22kΩ 3W test resistor will be supplied in the kit to make testing the HT supply safer. Connect this temporarily between the red HT wire and the blue 0V wire.

Be careful: the HT is around 220–230V DC! This can give you a strong shock if you come into contact with it, so don't handle or work on the project when the plugpack is connected to the PC board. Wait at least two minutes after disconnecting the power for the 4.7μF 250V capacitor to discharge before handling or working on the board.

So having taken all care, connect the power and measure the HT voltage. It should be between 200V and 230V DC across the 22kΩ test resistor. If all is well, then remove the power, wait two minutes and fit the 1F supercap and the blue LED switch S1 (if required) to the underside of the PC board.

The 1F supercap is polarised, so take care to get it the right way around. The markings are sometimes not obvious – the negative lead is the one that is folded over from the metallic patterned side of the capacitor. A self-adhesive pad will be supplied with the supercap for insulation and spacing. Its terminal pins need to be soldered on the underside of the PC board.

S1, the blue LED switch, is also mounted under the PC board but soldered from the top side.

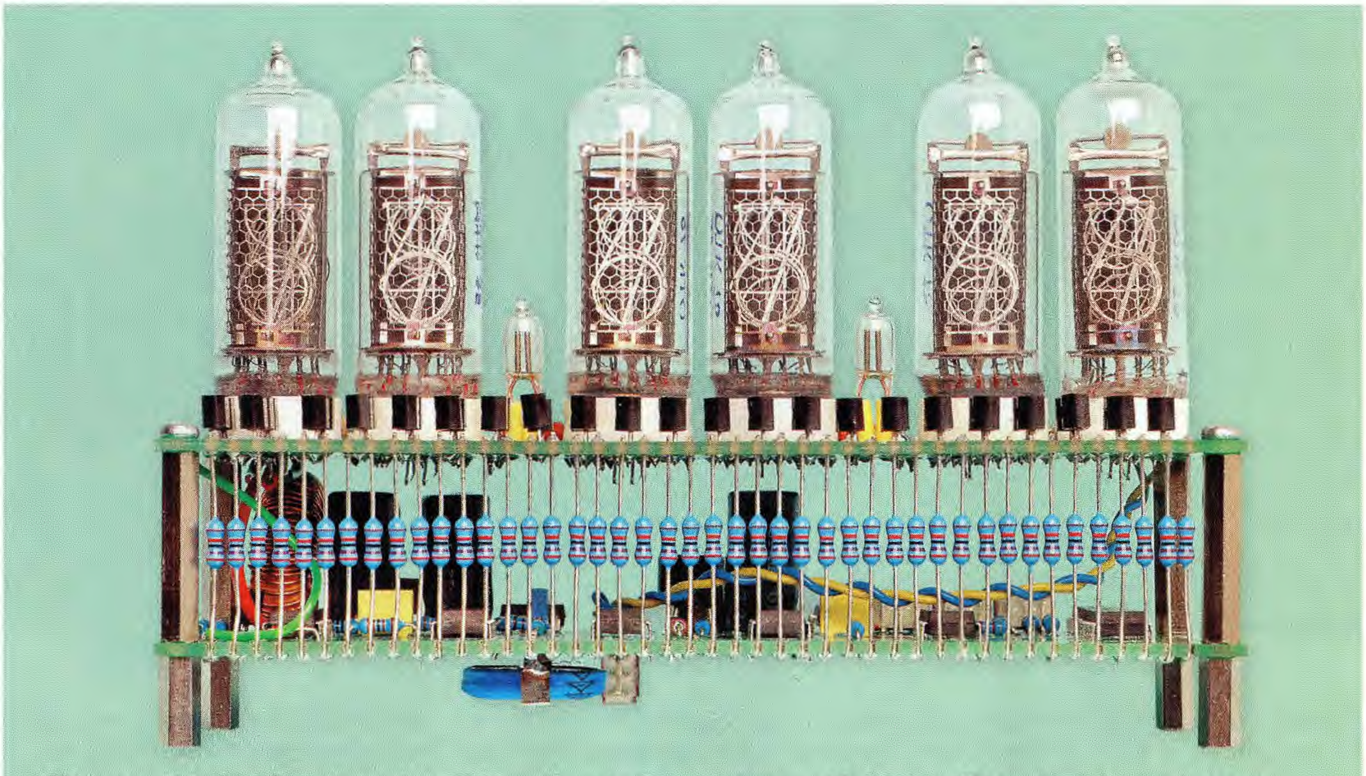
This completes the construction of the lower PC board so now let's move on to the upper PC board.

The upper PC board

As before, solder in the resistors first. There are six 68kΩ 1W, two 330kΩ 1W and two 180Ω 0.25W resistors (if the blue LEDs are used). Incidentally, the 1W resistors are used not because we need their power rating but because of their higher voltage rating (the HT can exceed the voltage rating of lower-wattage types).

After the resistors, fit the 44 high voltage transistors, which may be 2N6517 or MPSA42 or MPSA44 types. All have the same pinouts and all mount with their flat side parallel with the righthand edge of the PC board.

To make a neat job of fitting the transistors use a piece of stiff, flat sheet material such as cardboard, larger than the PC board and temporary spacers made from two 3mm x 8mm screws and nuts (supplied in the kit). Fit



The top and bottom boards are fastened together via 25mm spacers, with the 44 27kΩ resistors strung between them. The bottom board sits on 10mm spacers.

the screws from under the PC board through the two mounting holes closest to the Nixie tubes and fasten with the nuts. Place all the transistors as far as they will go into the PC board in the direction shown on the component overlay and using the flat sheet to hold all the transistors into the PC board, flip the PC board and sheet over so that the board is upside-down, supported by all the transistors and the spacer screws. Carefully solder one outer lead on each transistor and then you'll be able to lift up the PC board without any transistors falling out.

Straighten any wonky transistors before finishing the soldering and cutting their excess pigtails. Then remove the temporary screws and nuts (the 3mm screws are used in the final assembly).

You can now fit the two neon tubes to their appropriate positions on the board (N1 and N2). Their height above the board is up to you but as they represent full stops around the bottom of the Nixie digits, they should be nounted about 8-10mm above the surface of the PC board.

Neons are not polarised but do operate from a high enough voltage to warrant short lengths of spaghetti insulation over the wires feeding down to the PC board. At short lengths, their wires are more than strong enough to have them stand up without any other support.

Fitting the Nixie tubes

A significant part of the visual appeal of the clock is the alignment of the Nixie tubes themselves. Having six Nixies at different heights and/or angles certainly would ruin the impact. First though, you have to get the Nixie wires into their respective holes. That might seem easy but in fact, it's quite difficult. The best method involves cutting the leads first.

First straighten the leads as best you can and then locate the anode lead. This has a grey/white coating on it, inside the glass envelope. Hold the tube with leads facing you. Leave the anode lead uncut and then going clockwise, cut each lead 3-4 mm shorter than the one before it until you have cut 12 leads. The result will be a spiral pattern of ever decreasing lead length.

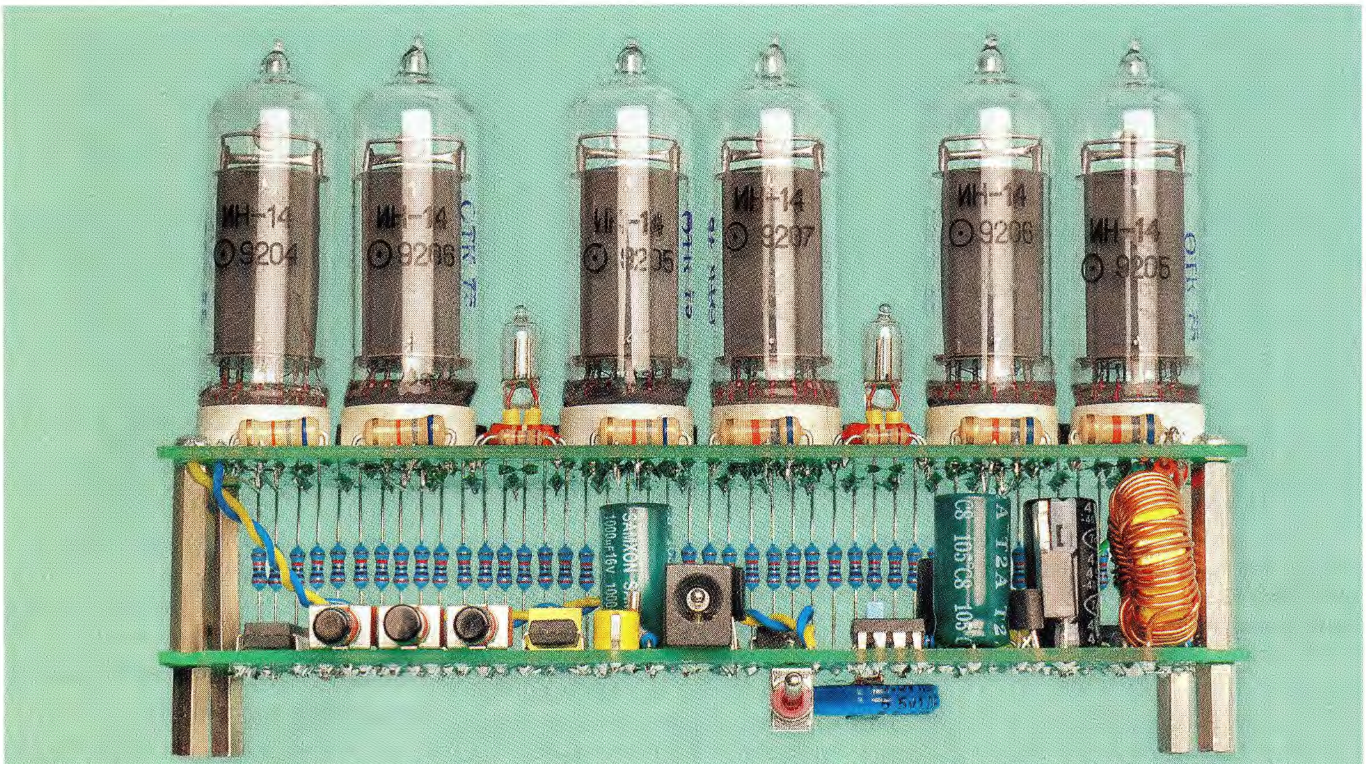
Now fit the tube to the PC board by inserting the anode lead (the longest) into the hole marked 1, which is closest to the resistors. You can then simply push the tube down a little until the next lead reaches the PC board surface and place that in the next hole. Continue working around until all the leads are in. This method also works nicely if the white plastic bases have come off any of the Nixies (you'll need to put the base back on before putting the Nixie on the PC board!).

When the tube is in place, hold it firmly down onto the PC board surface and as vertical and straight as possible before soldering the leads. Solder the anode lead and one directly opposite it first, check that the tube is still vertical and then solder another two at right angles to the first. Don't solder any more until all the tubes are inserted and soldered the same way.

Now check the tubes for alignment with the PC board and with each other. With only four leads of each Nixie tube soldered so far, it is easy to straighten the tubes by unsoldering the appropriate lead and then gently adjusting the tube position by hand. When all tubes are correctly lined up, your can solder the rest of the leads.

Fitting the blue LEDs

The blue LEDs are optional but they give the Nixie clock real character. The



This rear view of the unit shows the three pushbutton time-setting switches, the DC power socket and the on/off switch for the optional LED uplighting.

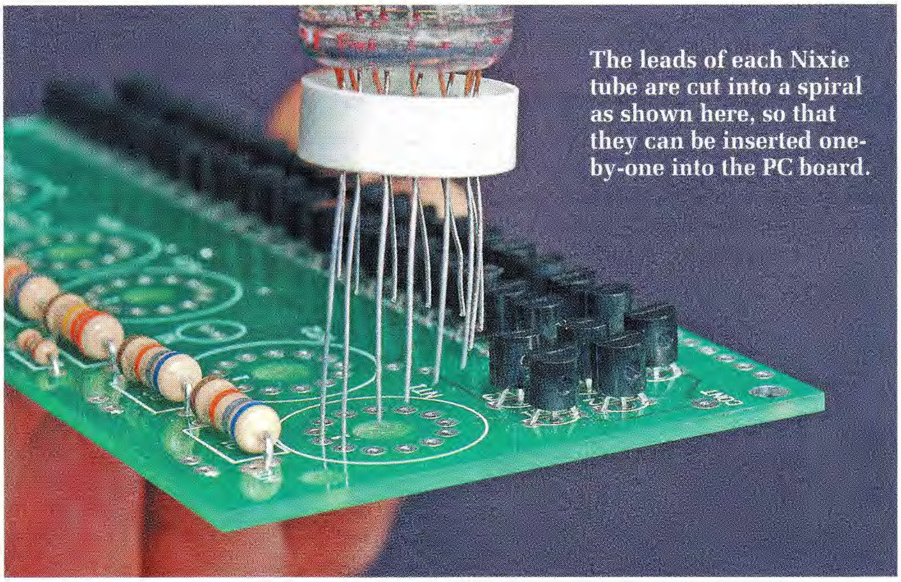
LEDs poke up through the upper PC board from underneath, through the white Nixie bases (which have been drilled to suit) and rest against the bottom of the Nixie tubes themselves.

The LED leads are bent into a very broad "U" shape as shown in the photos and the leads are soldered to the copper side of the PC board. Because they clear the board by 2mm or so, we didn't bother insulating the leads, except those which go above inductor L1. Here we used some short lengths of plastic wire insulation.

The LEDs are a friction fit inside the white Nixie bases so no further support is required.

Inter-board connections

Apart from the 44 resistors connecting the two boards together, there are four PC board inter-connecting wires to be soldered into place. The LED power wires (two of them) connect to the bottom board next to the LED switch and to the top board at the back right corner (see the component overlay). These must be long enough to allow comfortable soldering while the two boards are still disassembled – say about 80mm long.

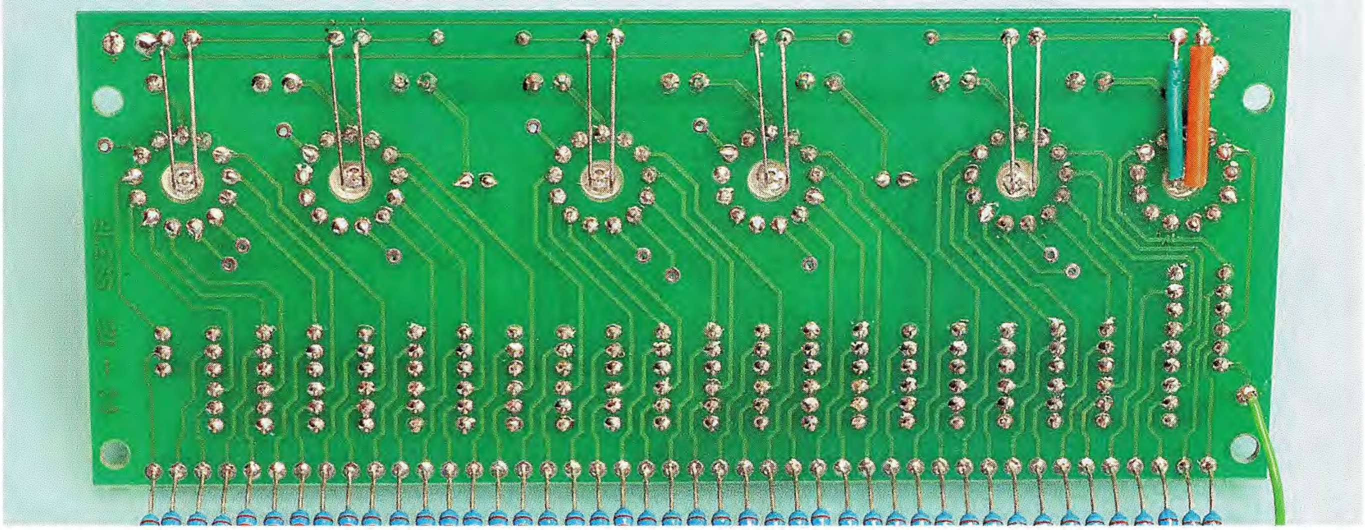


The leads of each Nixie tube are cut into a spiral as shown here, so that they can be inserted one-by-one into the PC board.

The other two wires, marked "CONT" and "HT" on the overlay, are shorter but must also be long enough to solder. The "CONT" wire can be around 35-40mm long, the "HT" wire about 70mm.

The two PC boards are fastened together using four 25mm hexagonal spacers which have male (external thread) and female (internal thread) ends. The female end goes towards the top PC board and is held in place by a 3mm round-head screw, while the male end passes through the bottom PC board, where an 8mm internal thread spacer screws onto it. The lower end of this 8mm spacer sits on the clock case bottom and is held in place by a 3mm countersunk-head screw from the outside of the case. Don't put the case bottom on just yet because you need to solder the resistors in place.

Make sure that the upper board is



Here's how the optional blue LEDs are fitted to provide the uplighting. Keep the LED leads clear of the Nixie tube solder joints and be sure to insulate the two leads shown with plastic sleeving – see text.

oriented so that the Nixie tubes are towards the back and the two rows of transistors are towards the front. Orientation of the lower PC board is more obvious – the switches and power socket are all toward the rear. This means that the resistor holes on the edge of the upper board line up with the row of slots on the lower board.

Now you get to solder the row of 44 27kΩ metal film resistors between the two boards. It is not as hard as it looks due to the slot and hole design on the PC boards.

If you are using the transparent Perspex case for the clock, take extra care and get the row of resistors as straight as you can and all in line for best appearance. Start at one end with the first resistor, by feeding one lead up into the end hole from under the upper PC board.

That done, centralise the resistor between the boards and solder it in place on the top board, from above. Drop the other resistor lead into the slot on the lower board then bend the lead down over the board and solder and cut it. Using the first resistor as a guide for position, continue to fit and solder all the other resistors in the same way.

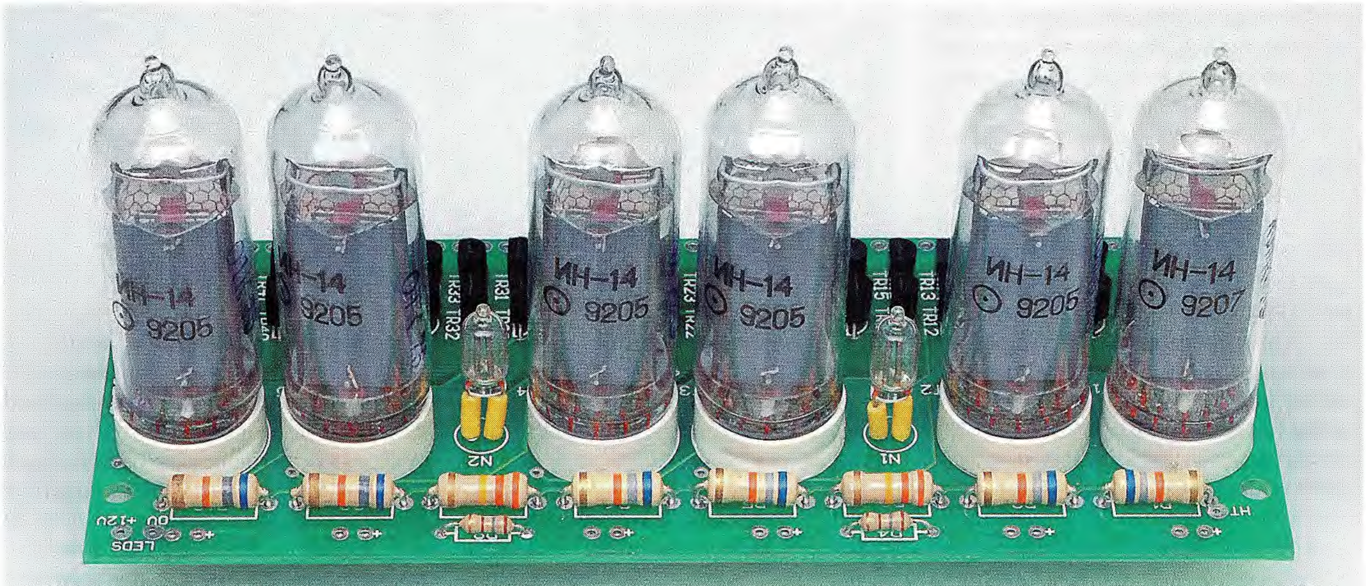
That completes the electronic assembly of the clock. All that's left is to screw it to the base with 3mm countersunk head screws and after testing, fit the case according to the supplied instructions.

Separating the boards

If you have a problem and you need to check or change any of the components on either PC board simply remove the screws from the upper PC board and gently open out the boards until the components are accessible.

Time-setting

The three time-setting buttons at the rear of the lower PC board are: left (S4) stop, centre (S3) slow and right (S2) fast. If you overshoot by a little when setting the time, the Stop button can freeze the display until the moment it is correct. SC



This is the rear of the top board assembly. The two neons tubes are mounted 8-10mm above the board surface and are fitted with short lengths of spaghetti insulation to insulate their leads.