Microscope temperature regulator and incubator

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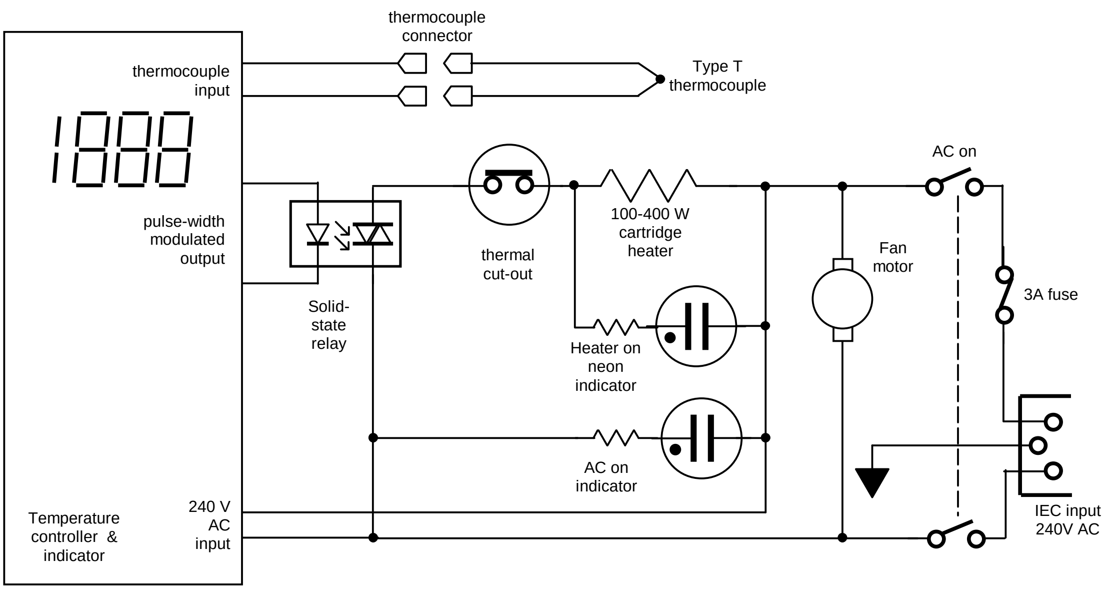
There are often instances where ‘live’ samples need to be observed for extended periods of time, requiring environmental temperature control, typically at 37^{o}C. Of course one can purchase suitable microscope enclosures and temperature controllers, but since the market for these is limited, they are often rather on the expensive side: it is not unusual to see price tags of the order of £5000 or more. So where does the money go? Well most incubators need to be ‘tailored’ to the microscope and need to deal with awkward ‘bits’ that stick out. But it is not that difficult to measure your ‘scope and cut/machine a few pieces of Perspex to put it all together. OK, we’ll come clean: it is not that difficult when you have access to an expert mechanical workshop, as we are fortunate to have.

Having enclosed the microscope, making sure that all uncontrollable source of heat (i.e. the lamps) are outside the enclosure, we are left with the problem of thermostating the whole arrangement. Until a few years ago, this was not that trivial an undertaking and you had to be familiar with temperature feedback loops and their associated delays and time constants, as well as ‘finding’ suitable sources of heaters etc. There was a limit to the number of hair dryers you could steal from your partner and it all became either difficult or, more often than not, a bit of a waste of time (i.e. money…). These days however there is a plethora of ‘intelligent’ controllers which incorporate sophisticated and adaptive feedback loops that ‘learn’ the open loop characteristics of the particular system they control. Similarly, heatsink technology for the semiconductor industry has developed all kinds of intricate shapes/extrusions which can just as easily be used ‘in reverse’.

Here we present a straightforward arrangement which performs very well, controlling the temperature within a typical microscope enclosure to fractions of a degree. It can be assembled from standard components and is housed in an enclosure put together from standard ‘square tube’ aluminium extrusions. OK, it is still good to have access to a workshop, but the amount of work involved is minimal.

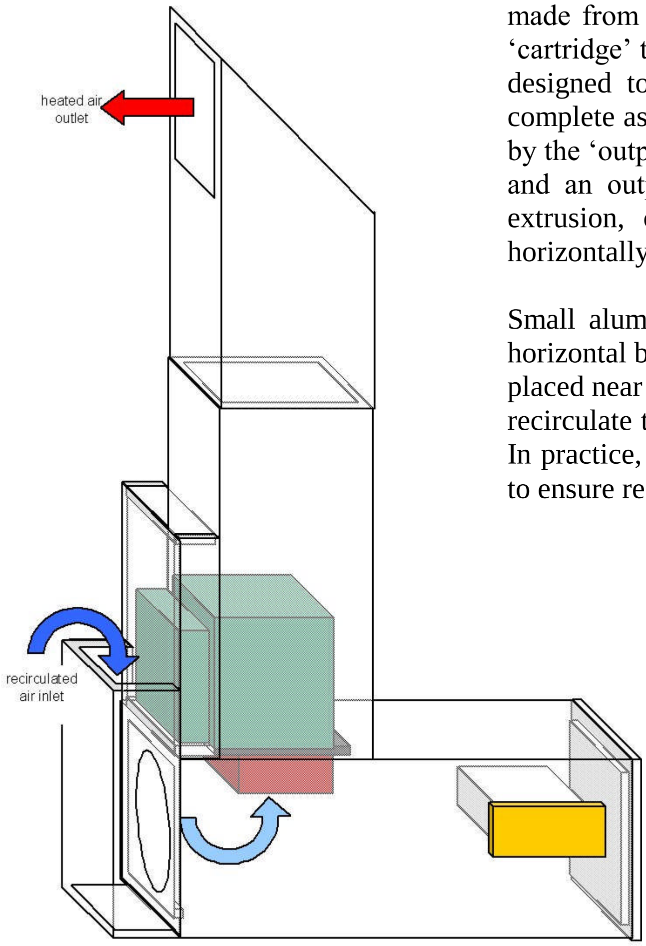
A zero crossing switch (solid-state relay) controls the average power through the heater (typically <100W) average). A thermal cutout switch is essential to prevent overheating. Total component is cost is <£250.

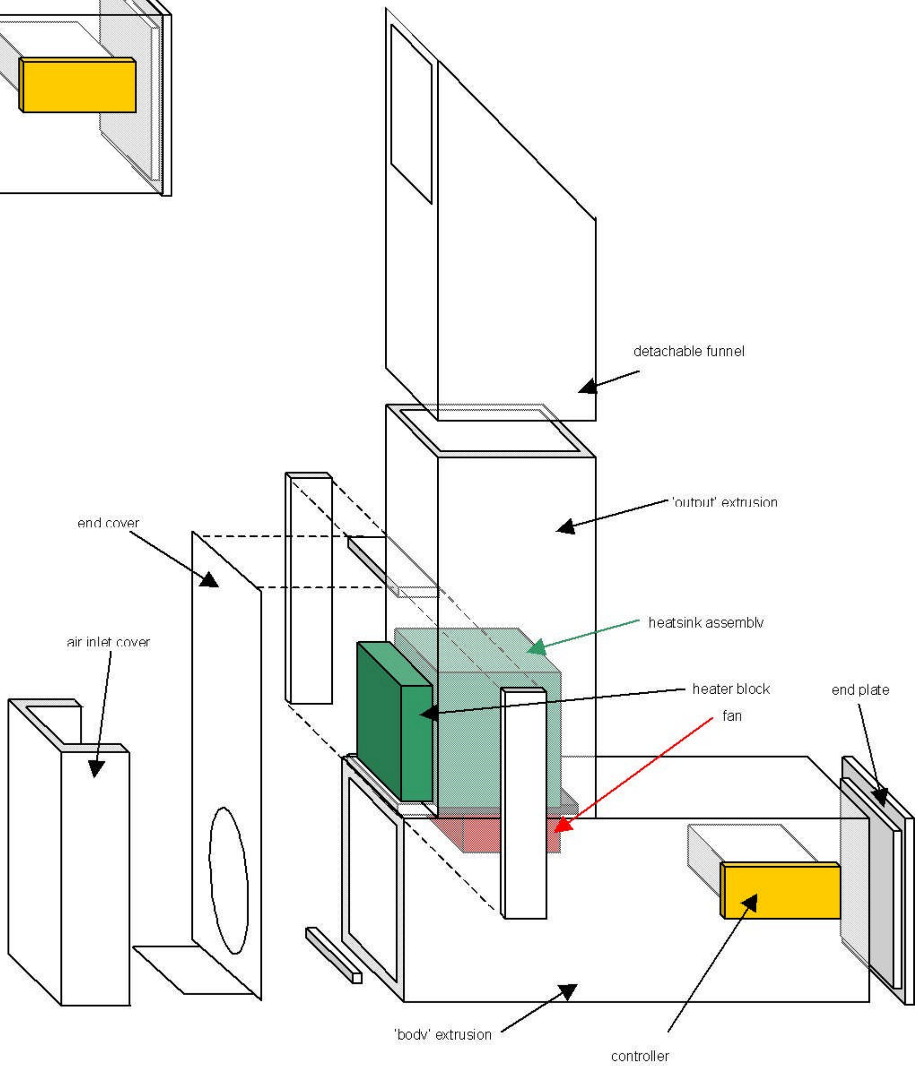


Circuit diagram of microscope ‘incubator’ control system

Assembled and ‘exploded’ views of the microscope incubator controller, made from 4” square aluminium extrusions. A heater block houses two ‘cartridge’ type heaters and is mounted on the side of a heatsink assembly designed to couple directly to a standard 60 mm diameter fan. This complete assembly is mounted on the horizontal extrusion and is covered by the ‘output’ extrusion. A cut down extrusion section forms the air inlet and an output ‘funnel’ is similarly fabricated from the same type of extrusion, cut down at 45 degrees to direct the output air stream horizontally.

Small aluminium blocks surround the heater assembly, with the upper horizontal block holding a thermoucouple connector. The thermocouple is placed near the sample and the complete arrangement is placed such as to recirculate the air within the incubator, thereby minimising heater power. In practice, the heat loss from the incubator is low, but adequate enough to ensure reasonable thermostatic control at the usual 37 degrees.





Electronics and heater/fan etc., all from ‘Farnell’

Solid state relay SR 660 V 25A
H12WD4825PG
part # 321-4837

Temperature controller
N2300/Y2100 part # 988-583

Heatsink assembly 0.14C/W
CC002part # 936-406

Cartridge heaters 1/2" 200W 120-262 part # 711-2592

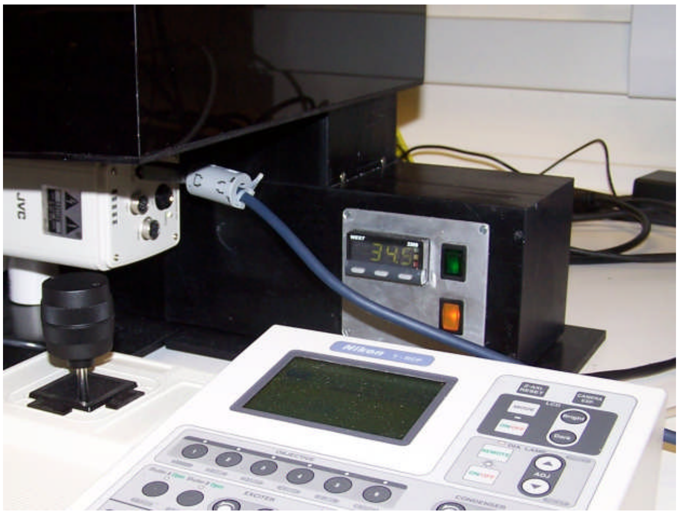
Thermocouple socket IM-T-SSPF
part # 381-0549

Thermocouple plug IM-T-M
part # 708-6404

Fan unit / 80 mm/Papst 8556N
part # 719-810

Neon indicators
part # 149-884

Thermal switch 112 deg
part # 491-494



The microscope incubator and controller used around a Nikon TE2000 inverted microscope.

Top left: the complete incubator.

Middle left: the heater controller assembly below the incubator, with the ‘funnel’ inside the enclosure.Bottom left: view inside the enclosure through one of three access doors.

Above: the rear of the enclosure, with the mercury arc lamp outside.

