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Dipping bird

Most readers will probably recall having seen this funny bird, in one form or another: the Dipping Bird, or Drinking Bird. It is an astonishing gadget which – for some laymen – seems to be a perpetual motion machine. And indeed, it looks like one. The bird balances for a while in a near-vertical position, then gradually bends over to a glass of water, takes a sip, flips back to its original position and starts the show all over again. Indefinitely, so it seems.

What is going on here? The set-up essentially consists of a glass bulb – the bird's body – containing a coloured liquid in which a glass tube is immersed. Its upper end forms a second bulb – the bird's head – which is covered with felt or some other cloth that absorbs water easily. Upon tipping over and 'drinking' the bird's head gets wet and starts cooling down by evaporation. So, the upper bulb becomes the coldest spot in the set-up. As a result, some of the vapour inside starts to condense in the upper bulb. Since the corresponding vapour pressure is lower than it is in the lower bulb, the liquid is sucked upward in the tube, thereby shifting the centre of mass upward – until it tips over, allowing the bird to 'drink'. In the near-horizontal position, some of the vapour will be allowed to pass over the liquid, so that pressure equilibrium

is restored and the liquid flows back down. The show can now start all over again as long as the head is wet. Indeed, even if we remove the glass of water, the bird will carry on for an hour or so.

This is not the full story, however. If the coloured liquid were water, we would need a pretty large temperature difference to raise the liquid by some 10 cm: almost exactly 10 °C at room temperature. So this is not going to work. We need a fluid with a lower boiling point – and, consequently, a steeper vapour pressure curve at ambient temperature. Dichloromethane (CH_2Cl_2) is found to be a good choice. Its boiling point is 40 °C and we need only a bit less than 1 °C to pull the fluid up by 10 cm, which is about the distance required to make the bird tip over.

Now what about the perpetual motion aspects? Where are we putting in energy? Not in the coloured liquid, because the net energy for the closed evaporation-condensation cycle is zero. However, the heat of vaporization of the water needs to be supplied by the environment. In other words: the device works by maintaining a temperature difference between the bird's body and its head. So, after all, our dipping bird turns out to be a simple heat engine. But – let's admit it – quite an elegant one. ■

