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MISSION BOOKLET

Flashlight Discovery

The first electrical thing most people ever owned is five circuits in one tube.

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Contents

Flashlight Discovery

The first electrical thing most people ever owned is five circuits in one tube.

A flashlight is the first electrical thing most people ever owned, and it is the whole course in one tube. Five circuits, in the order the tube actually needed them: a bare loop, a filament pushed past what it can take, a diode that needs a resistor where the filament needed nothing, a dial, and two cells stacked to make the beam its brightest.

One Loop

BEFORE

A flashlight is a battery, a switch, and a bulb, wired in one loop and nothing else. Build that loop and read what a bare tungsten filament actually pulls.

AFTER

Cold, the filament measures fifteen ohms and pulls near 560 mA the instant the loop closes; in about fifty milliseconds it heats to roughly 143 Ω and settles at 63 mA. One loop is the whole flashlight.

HOW PEOPLE GOT THERE

1899 David Misell built the first practical flashlight in 1899 — a fiber tube, a rough reflector, a bulb, and a battery, end to end, nothing else in the loop. Conrad Hubert's American Electrical Novelty and Manufacturing Company bought the patent and sold the tube as the 'Ever Ready.'

David Misell, US Patent 617,592, "Electric Device", granted 10 January 1899, assigned to the American Electrical Novelty and Manufacturing Company.

What the Filament Costs

BEFORE

Every old flashlight eventually died the same way — not the batteries, the bulb. Push eighteen volts through a lamp built for nine and watch why.

AFTER

The filament runs past 3,000 K and opens in about four milliseconds. That flash is every dead flashlight bulb anyone has ever thrown away.

HOW PEOPLE GOT THERE

1910 Tungsten filaments started out fragile: Alexander Just and Franjo Hanaman patented one in 1904, and a dropped flashlight could snap it. William Coolidge, at General Electric, worked out how to draw tungsten into a ductile wire by 1910 — tough enough to survive a pocket, right up until it is pushed past what it was rated for, same as the one that just failed on this board.

Alexander Just and Franjo Hanaman's 1904 tungsten-filament patent; William D. Coolidge's 1910 ductile-tungsten process at General Electric, sold as the Mazda lamp (Smithsonian National Museum of American History, lighting collection).

The LED Needs a Resistor

BEFORE

A filament finds its own resistance and stops there. An LED does not — wire one straight to the battery, nothing else in the way, and it is gone in a flash.

AFTER

The red LED wants about 1.9 V across it and no more than 20 mA through it. The 330 Ω resistor is the only thing standing between it and the other seven volts.

HOW PEOPLE GOT THERE

1962 Nick Holonyak Jr., at General Electric, built the first LED to give off light anyone could actually see, on 9 October 1962 — a red glow from a gallium-arsenide-phosphide crystal. Every LED since, including the one on this board, needs the same thing his did: something else in the loop to carry the voltage it cannot drop itself.

N. Holonyak Jr. and S. F. Bevacqua, "Coherent (visible) light emission from Ga(As1−xPx) junctions", Applied Physics Letters 1, 82 (1962).

The Dial

BEFORE

The beam is not one fixed brightness. Turn a knob into the same loop and the LED runs anywhere from nearly full current to almost dark.

AFTER

At the pot's low end the LED draws close to its full 20 mA; turned toward 10 kΩ, the current falls under a milliamp. The beam is a dial, not a fact.

HOW PEOPLE GOT THERE

1843 Charles Wheatstone coined the word 'rheostat' — literally 'current-stopper' — in 1843, for a sliding resistance that could turn a circuit's current up or down without ever breaking the loop. The pot on this board does the same job with a knob instead of a slide.

Charles Wheatstone, "Description of the Rheostat, an Instrument for Measuring and Regulating Electric Currents", Philosophical Transactions of the Royal Society 133 (1843).

The Beam

BEFORE

One battery already lights the LED through this resistor. Stack a second 9 V behind it, positive to negative, and find out what doubling the push does.

AFTER

Two 9 V cells in series make eighteen volts; through the same 1 kΩ resistor the LED pulls about sixteen milliamps — more than twice the seven it drew on one cell alone, and the brightest this beam gets.

HOW PEOPLE GOT THERE

1800 Alessandro Volta stacked disks of zinc, copper, and brine-soaked cloth into a column in 1800, because one pair of metals barely made a current worth measuring — stack more pairs and the push adds. Two 9 V batteries nose to tail, lighting this LED at its brightest, is the same arithmetic in a much smaller pile.

Alessandro Volta, letter to Sir Joseph Banks, "On the Electricity Excited by the Mere Contact of Conducting Substances of Different Kinds", Philosophical Transactions of the Royal Society, 1800.

Colophon

Generated from the modules the bench runs on: every circuit in this booklet is the circuit the simulator solves, and every word beside it is the word the manual panel prints.

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