OHMSVILLE

MISSION BOOKLET

Robot Car Discovery

Two eyes, two wheels, and no code anywhere.

OHMSVILLE.COM/MANUALS/ROBOT-CAR-DISCOVERY

Contents

Robot Car Discovery

Two eyes, two wheels, and no code anywhere.

A line-following car needs no code anywhere, and this booklet is the six circuits that prove it. What a motor costs the battery under load, what a gear train buys back in torque, a base resistor that keeps a switch alive off a stalled motor's inrush, two relays wired so one pull reverses a wheel, one photocell reading a line as a shadow against paper, and two of those eyes steering two wheels toward the darker one — a car that decides which way to turn using nothing but light and a relay's own coil.

What a Load Costs

BEFORE

Something has to turn this car's wheels. Before it drives anything, find out what a motor costs the battery once you give it real work to do.

AFTER

Bare-shaft the motor spins near 4,100 rpm on 20 mA; bolt on a propeller and it settles lower, near 2,900 rpm, but the current jumps to 169 mA — eight times as much, just from the drag of moving air. A loaded motor is a generator fighting itself, and the load decides how much the battery gives up.

HOW PEOPLE GOT THERE

1838 Moritz von Jacobi tested one of the earliest practical electric motors by bolting it to a boat and carrying passengers across Saint Petersburg's Neva River in 1838 — a motor proving itself not by spinning free, but by moving a load, in public.

Moritz von Jacobi, electric boat trials, Neva River, Saint Petersburg, 1838.

Gears, and What They Buy

BEFORE

The bare motor spins about 3,800 times a minute — too fast to bolt straight to a wheel, and too weak at the shaft to pull the car's own weight without help.

AFTER

Through a 48:1 gearbox the same motor turns a wheel about 79 times a minute — 0.27 m/s — with 48 times the pull at the axle. It costs 36 mA of the gearbox's own friction, twenty times what rolling the car itself takes; the gears are not free, but the car does not move at all without them.

HOW PEOPLE GOT THERE

1888 Frank Sprague's electric streetcars in Richmond, Virginia ran their motors through a 12:1 gear reduction to the axle — the detail that turned a motor spinning far too fast for a wheel into one that could pull a loaded car, the same trade this gearbox makes at a different ratio.

Frank J. Sprague, Richmond Union Passenger Railway, in service 1888.

Safe, and Useless

BEFORE

A base resistor is what keeps a transistor's base current from cooking it, or your fingers. Pick a value that's safe by any measure — now find out what the motor does.

AFTER

10 kΩ caps the base current at about 8 mA, safe to touch even with damp skin. The motor needs roughly 20 mA at the shaft just to break its own bearing friction from a dead stop — the same resistor that makes the switch safe makes the motor never turn. Safe and useless, in this circuit, are the same 10 kΩ.

HOW PEOPLE GOT THERE

1893 Cutler-Hammer was founded in 1893 on exactly this kind of tradeoff — rheostats and starters whose whole job was limiting how much current reached a motor. Too little current and the motor stalls; too much and it burns. The company built a business on finding the value in between.

Eaton (Cutler-Hammer) company history; Grace's Guide to British Industrial History; Wisconsin Historical Society records on Cutler-Hammer, founded Milwaukee, 1893.

Both Ways

BEFORE

Two relays, and a motor that has to go both ways. Get the pair the wrong way round and the car will not go anywhere — it will turn on the spot, which is worth seeing once before you fix it.

AFTER

Wired correctly, the motor reverses clean at rest — the same speed either direction. Reverse it while it's still spinning and it fights its own back-EMF instead: stall current jumps past 900 mA and the coil is gone in about 12 ms. Transistors decide which way the current goes; the relay contacts only carry it, 18 mA each. With both relays off, the motor's own terminals short to the same rail — braked, not coasting.

HOW PEOPLE GOT THERE

1924 Norman B. Laing's 1924 patent for a two-solenoid reversing controller did what this build's two relays do: one coil drives forward, the other reverse, and when neither is energized the motor's own terminals short together and it brakes itself instead of coasting.

Norman B. Laing, US Patent 1,486,386, 'Electric Controller,' filed 17 January 1923, granted 11 March 1924.

One Eye

BEFORE

One eye, one wheel. Watch what a car does when only half of it is wired: it does not go slower, it goes round, and the circle is exactly half its own axle.

AFTER

The eye's own resistance does the deciding: about 10 kΩ in the workshop's everyday light, rising to about 157 kΩ once it's covered. That swing is enough that the relay coil crosses its own pull-in threshold near 76 lux in the dark, and does not drop back out until the light climbs past about 212 lux — the same photocell, no extra parts, deciding when its own wheel runs.

HOW PEOPLE GOT THERE

1949 W. Grey Walter's robot tortoises, Elmer and Elsie, steered toward or away from light using a single photocell wired straight to a steering motor — no program, one sensor deciding one behavior, the same trick this chapter wires by hand.

W. Grey Walter, Elmer and Elsie (robotic "tortoises"), Burden Neurological Institute, Bristol, 1948–49.

The Line Follower

BEFORE

Two eyes, two wheels, full speed on a track with one tight corner. Each eye only ever fully drives its wheel or fully stops it — watch what a car with no middle setting does when its own correction is always too hard.

AFTER

The car follows the line, and nothing on it is programmed. Left eye to left relay to left wheel, right eye to right relay to right wheel, own side to own side — lose the line under one eye and that wheel stops while the other keeps turning, which pivots the car back onto the line by itself. Nothing here decides left from right. The wiring does.

HOW PEOPLE GOT THERE

1953 Barrett Electronics built the first automatic guided vehicle in the early 1950s — a tow tractor that steered by following a wire buried in the floor instead of a driver's hands. It sensed one channel and drove off it, same as this car; the difference is what it sensed — Barrett's followed a wire's field, this one follows light.

Barrett Electronics Corporation, first automatic guided vehicle (wire-guided tow tractor), Northbrook, Illinois, 1953–54.

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.

Built 2026-09-19 from commit 1184ace.