



MISSION BOOKLET

The Joke Shop

Every gag in the shop is a lesson wearing a mask.

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The Joke Shop

Every gag in the shop is a lesson wearing a mask.

Seven gags, and every one of them is a lesson wearing a mask: a buzzer under a palm, a pressure pad under a cushion, a 555 with a megohm in it that chirps once every five and a half minutes, two eyes that only open in the dark, a tone that reads how damp somebody's hands are, a relay that remembers being touched, and a coil that makes four hundred volts the instant you stop asking it for eighteen milliamps. The page before them all is the one about which of those can hurt you, with the arithmetic, and the answer is none of them — which is exactly why it is worth knowing how the sum is done.

What bites and what does not

What bites is energy, not volts. The biggest spike in this whole mission is the one the kickback pen makes: 396 volts across a relay coil, measured, for about half a millisecond. The energy behind it is half of 0.25 henries times 17.96 milliamps squared, which is 40 microjoules. That is a snap and nothing else, and it is the same class as the piezo out of a lighter.

Now the other end. A camera flash capacitor is 100 microfarads charged to 300 volts, and half of C times V squared makes that 4.5 joules — about a hundred and ten thousand times the coil. Mains is worse again, because it is not energy-limited at all: it will supply amps for as long as you are holding on. Neither is in this kit and neither is coming. Nothing in the Joke Shop stores more than the 8.5 millijoules in a 470 microfarad capacitor at six volts, and nothing in it runs off anything but the 9 volt block.

So the rule the shop runs on: a gag may be loud, sudden, startling and annoying. It may not store energy. Every build in this mission carries its

The Handshake That Bites

BEFORE

Two plates for somebody to hold and an igniter hidden under your thumb, and not one battery in the whole build. Safe: 0.6 microcoulombs, gone in half a millisecond, carrying 0.72 millijoules — a car door. Not safe: nothing here, and that is the point of putting the highest voltage in the shop first.

AFTER

A piezo makes a fixed lump of charge, and the load decides what voltage that becomes. Through a dry finger's megohm the same 0.6 microcoulombs reads 1 199 volts; through an LED it reads 1.70. The number that decides whether something hurts is the energy, and this one is under a millijoule.

HOW PEOPLE GOT THERE

1880 Jacques and Pierre Curie found in 1880 that squeezing a quartz crystal put a charge on its faces, and a year later that the effect

The Handshake

BEFORE

The oldest gag in the shop is a buzzer under a palm. Build the whole thing first: nine volts, a hidden pressure pad, and a sounder that only needs a closed loop. Safe: 16 milliamps through a buzzer and nothing stored anywhere. Not safe: nothing here — this is the one you can hand to anybody.

AFTER

A buzzer with its own oscillator inside needs nothing but nine volts the right way round and a gap to close. A finger, a transistor or a relay contact all close a gap the same way.

HOW PEOPLE GOT THERE

1928 Soren Sorensen Adams sold the Joy Buzzer from 1928: a clockwork spring wound under a disc in the palm, with no electricity in it at all. The electric version came out of what was already on the bench, a doorbell buzzer and a pressure switch, and it is the one that is still easy to build.

S. S. Adams Co. of Neptune, New Jersey; the Joy Buzzer patent is US 1,845,735, filed 1928, granted 1932. It is a spring mechanism, not a shock device, which the packaging never made clear.

The Cushion

BEFORE

Under a seat cushion goes the same pressure pad, but this time it has to carry a tone rather than a buzz, and somebody has to be able to set how rude it sounds. Safe: nine volts, 27 milliamps through the speaker, and 4 microjoules in each of the two 0.1 microfarad capacitors. Not safe: nothing here.

AFTER

The button went into the supply rail rather than into a signal path, so the whole oscillator only exists while somebody is sitting on it: 135 hertz at one end of the knob, 683 at the other, and nothing at all when they stand up.

HOW PEOPLE GOT THERE

1930 The JEM Rubber Company of Toronto is generally credited with the whoopee cushion around 1930, after a sheet of scrap rubber got sat on. Sam Adams reportedly turned it down as too vulgar and then sold his own. The cushion is pure pneumatics; the electric one is a switch and an oscillator, which is a much easier thing to hide.

7 Widely repeated trade accounts of the JEM Rubber Company; the Adams refusal is company lore rather than a document, so the text says "reportedly".

The Chirp Nobody Can Find

BEFORE

Now the opposite of loud. Something that makes one small noise so rarely that nobody can work out where it came from, and that keeps doing it long enough to be worth hiding. Safe: the same 16 milliamps, and the most the 470 microfarad ever holds is 8.5 millijoules. Not safe: nothing here — the only thing a gag made of time can hurt is an afternoon.

AFTER

A 555 with a megohm in its charge path and a kilohm in its discharge path: 326 seconds of silence and a third of a second of chirp, which is the pad beacon with one resistor changed.

HOW PEOPLE GOT THERE

1971 Hans Camenzind drew the 555 alone, on contract for Signetics, out of two comparators, a flip-flop and a discharge transistor. He designed it as a timer for serious equipment. Within a decade it was on every hobby magazine in the world, and the first thing a lot of people ever built with one was something that made a noise at somebody else.

Hans Camenzind, Much Ado About Almost Nothing (2007), his own account of the design.

Eyes in the Corner

BEFORE

This one has to do nothing at all in a lit room and start up on its own when the lights go out, or it gives itself away the moment somebody walks in. Safe: about 20 milliamps an LED, and the biggest thing stored is the relay coil's 40 microjoules. Not safe: nothing here — the worst it can do is depend on where you leave it.

AFTER

The photocell divider drives a relay, and what the relay's contact carries is the chip's supply rather than the lamps: in a lit room there is no nine volts on the 555 at all, so both eyes read zero. In the dark, one eye is lit exactly when the other is not.

HOW PEOPLE GOT THERE

1960 Cadmium sulphide cells were cheap by about 1960 and they went into everything that had to notice the dark: street lights, camera meters, night lights. The cell switches nothing by itself. It only changes its resistance, from a few thousand ohms in a lit room to hundreds of thousands in the dark, so every one of those products put a relay or a transistor behind it to do the work.

Clairex and RCA photoconductive cell data sheets of the 1960s; the span is a period, not a date.

The Sweat Meter

BEFORE

Two plates and two fingers, and a tone that climbs when the hands get damp. It is the shop's most famous gag and its most dishonest one, and the manual says which. Safe: nine volts across a megohm of skin is about 9 microamps, far below anything a finger can feel. Not safe: nothing here — the danger in this build is believing it.

AFTER

The plates stand in for the 555's timing resistor: dry skin near a megohm gives 71 hertz, a hundred kilohms of sweaty grip gives 668. It measures how damp somebody is, which is the whole history of the polygraph.

HOW PEOPLE GOT THERE

1921 John Larson built the first polygraph in Berkeley in 1921, reading pulse, breathing and skin resistance together. Skin resistance falls when you sweat, and you sweat when you are nervous, which is not the same as when you are lying. Courts have mostly said so ever since; the machine kept being used anyway.

10 John A. Larson, *Lying and Its Detection* (1932); *Frye v. United States*, 293 F. 1013 (D.C. Cir. 1923), on the admissibility of the test.

Do Not Touch That

BEFORE

A gag that catches somebody after they have gone: it has to fire on one touch and then keep going, so whoever comes back finds it still sounding. Safe: the same 9 microamps through the plates. Not safe: nothing here.

AFTER

Two transistors take a dry finger's few microamps up to the 17.97 milliamps the coil needs, and then the relay's own contact feeds its own coil. It holds itself in after the finger lifts, and only the slide switch lets go.

HOW PEOPLE GOT THERE

1941 A relay that feeds its own coil is one bit of memory, and it is how the first computers stored numbers: Konrad Zuse's Z3, finished in Berlin in 1941, held every bit in a relay, about two thousand of them. The same hinge that remembers a one is the hinge that remembers somebody touched the plates.

Raúl Rojas, "How to make Zuse's Z3 a universal computer" (IEEE Annals of the History of

Computing, 1998).

The Pen

BEFORE

Last, the one the whole mission has been circling. A coil, a switch, and what a coil does when its current is cut. Safe: 396 volts for half a millisecond, carrying 40 microjoules — a snap, and the safety page has the arithmetic. Not safe: a capacitor bank, a flash unit, or anything on mains, which is why none of the three is in this kit.

AFTER

Open the coil's path and it makes whatever voltage it takes to keep 17.96 milliamps going: 396 volts, measured. Put the 1N4001 across it and the same release peaks at 0.73. One part is the difference between a gag and a circuit you can build things on.

HOW PEOPLE GOT THERE

1910 The bite in the pen is the same physics that fires a spark plug. Charles Kettering's ignition of 1910 opened a coil's circuit on purpose with breaker points, and the collapsing field made the thousands of volts the plug needed. The diode across the coil is the opposite decision: give the current somewhere gentle to go.

12 Kettering's Delco ignition system, first fitted to the 1912 Cadillac (Smithsonian, National Museum of American History).

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 2026-09-20 from commit 4842175.

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