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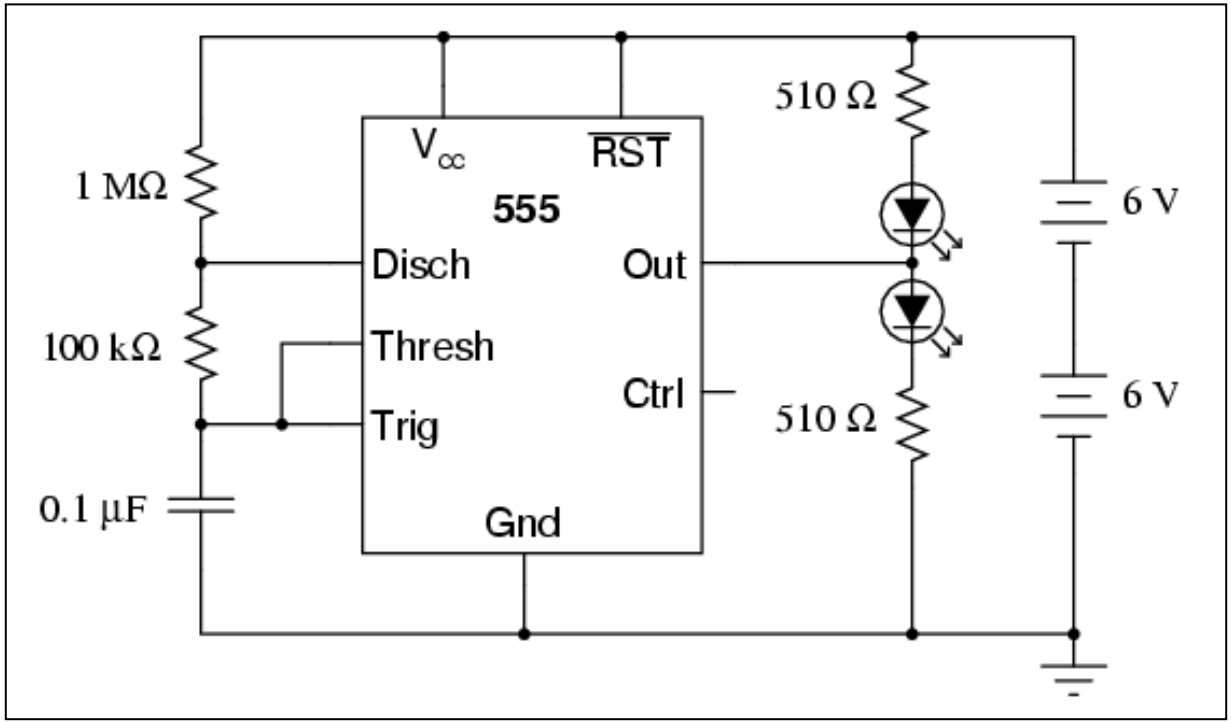
Lesson 13

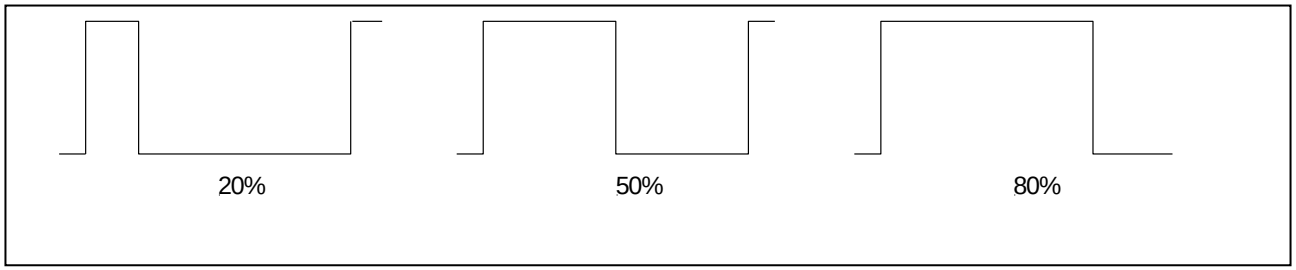
Special Function ICs
Timers & Comparators

Timers: Every now and again we need to generate an accurately known frequency with accurately known "duty cycles" (more later). We've needed roughly 30 BILLION "now and agains" since the 555 timer was introduced in 1971.

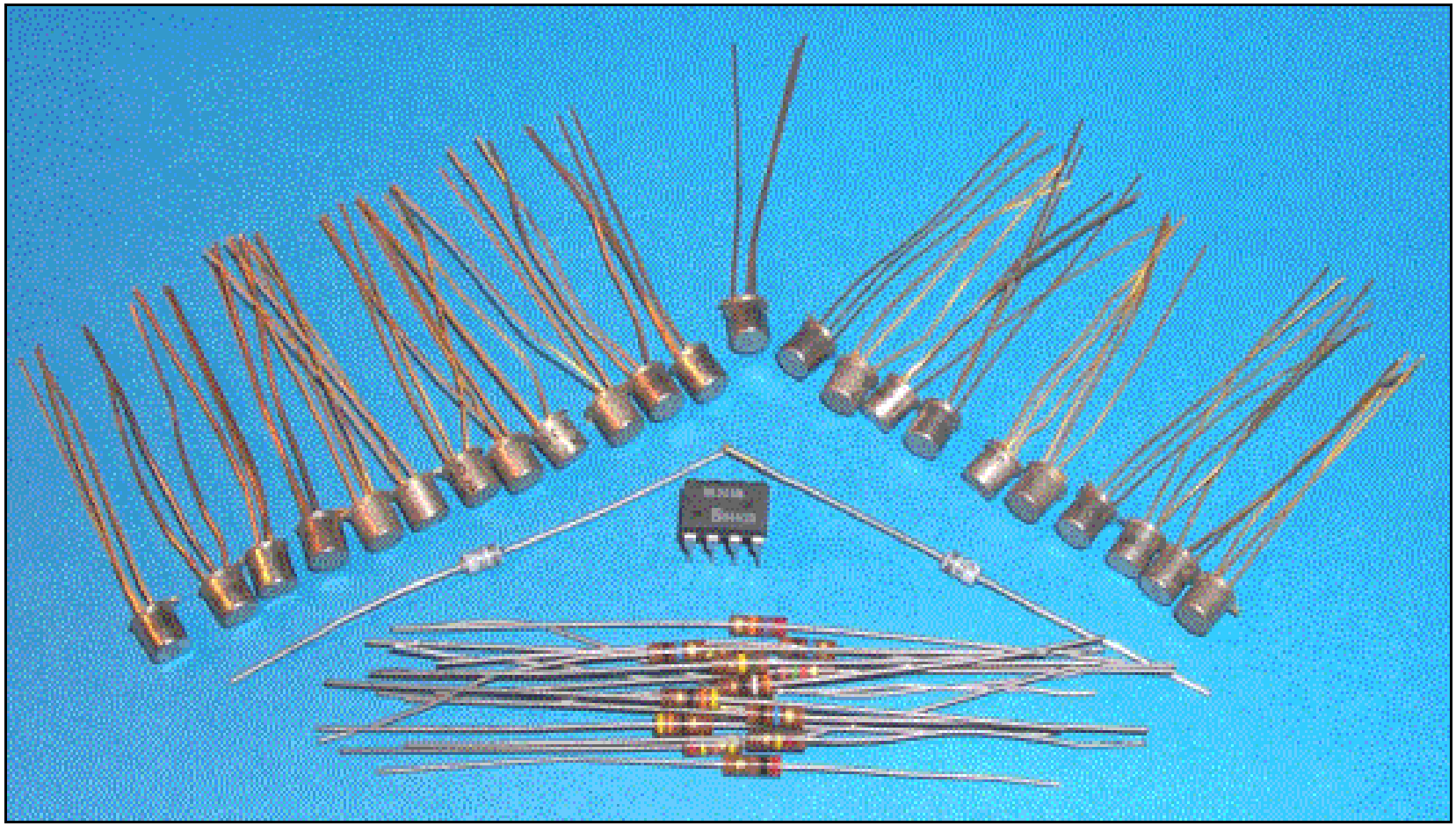
The 555 is one of those workhorse little integrated circuits that just came along at the right time in the right place. Hans Camenzind at Signetics (now out of the IC business) just made this little "clock" circuit that is a do-everything timing chip.



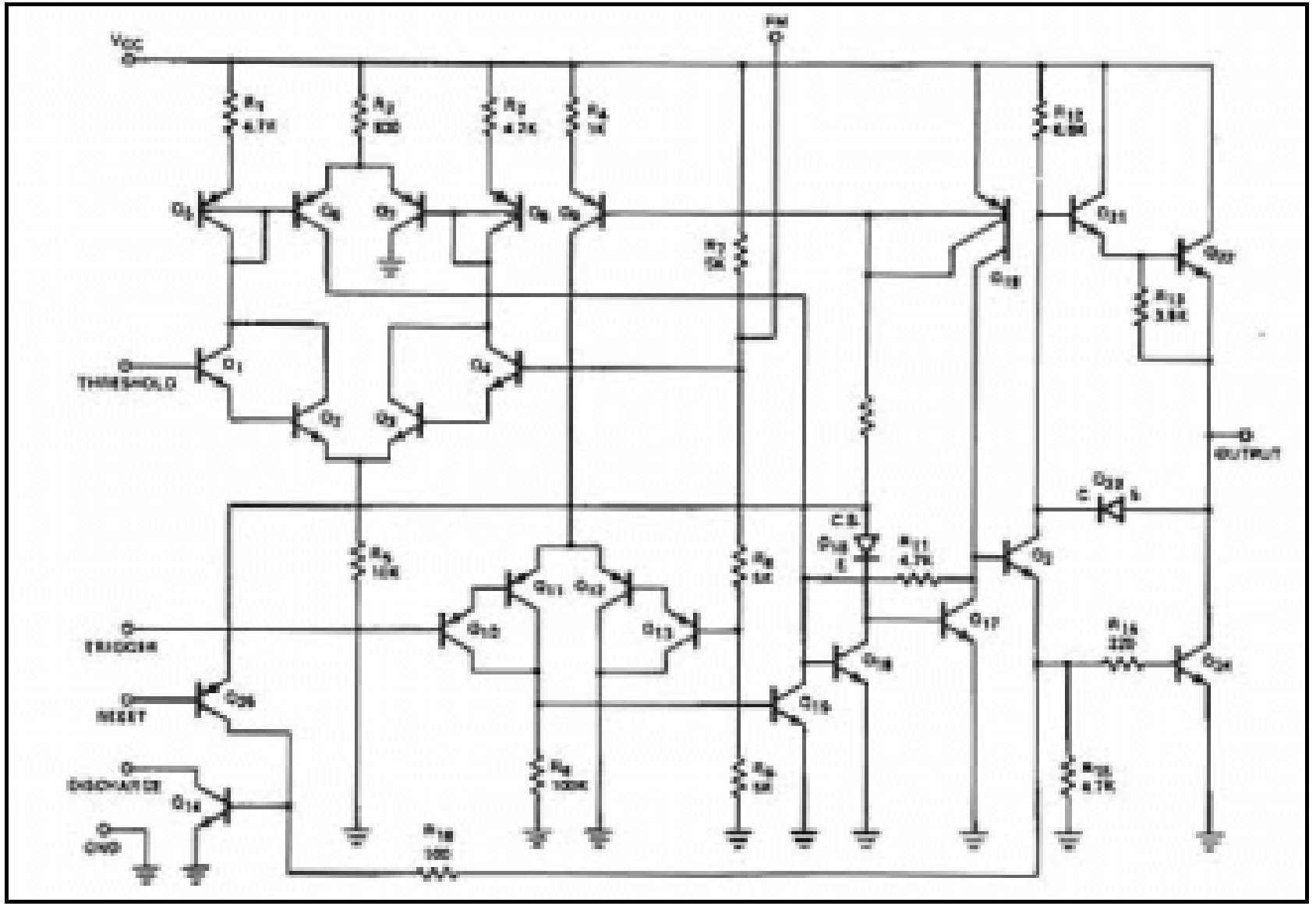
The two resistors on the left of this picture (1MΩ and 100kΩ) set the "duty cycle", or the ratio of "on" to "off" at the output. Here we see three "square" waves, one at a 20% duty cycle (it is on for 20% of the time and off for 80% of the time), a 50% true square wave, and an 80% duty cycle. Again, the ratio of the two resistors sets which of these duty cycles we have.



This little "chip" is made possible by replacing all these parts (23 transistors, 15 resistors, and 2 diodes) by the little black package in the middle of the picture. Remember, in 1971, "integrated circuits" still hadn't made tremendous inroads into the discrete (i.e. individual components) designs of the day.

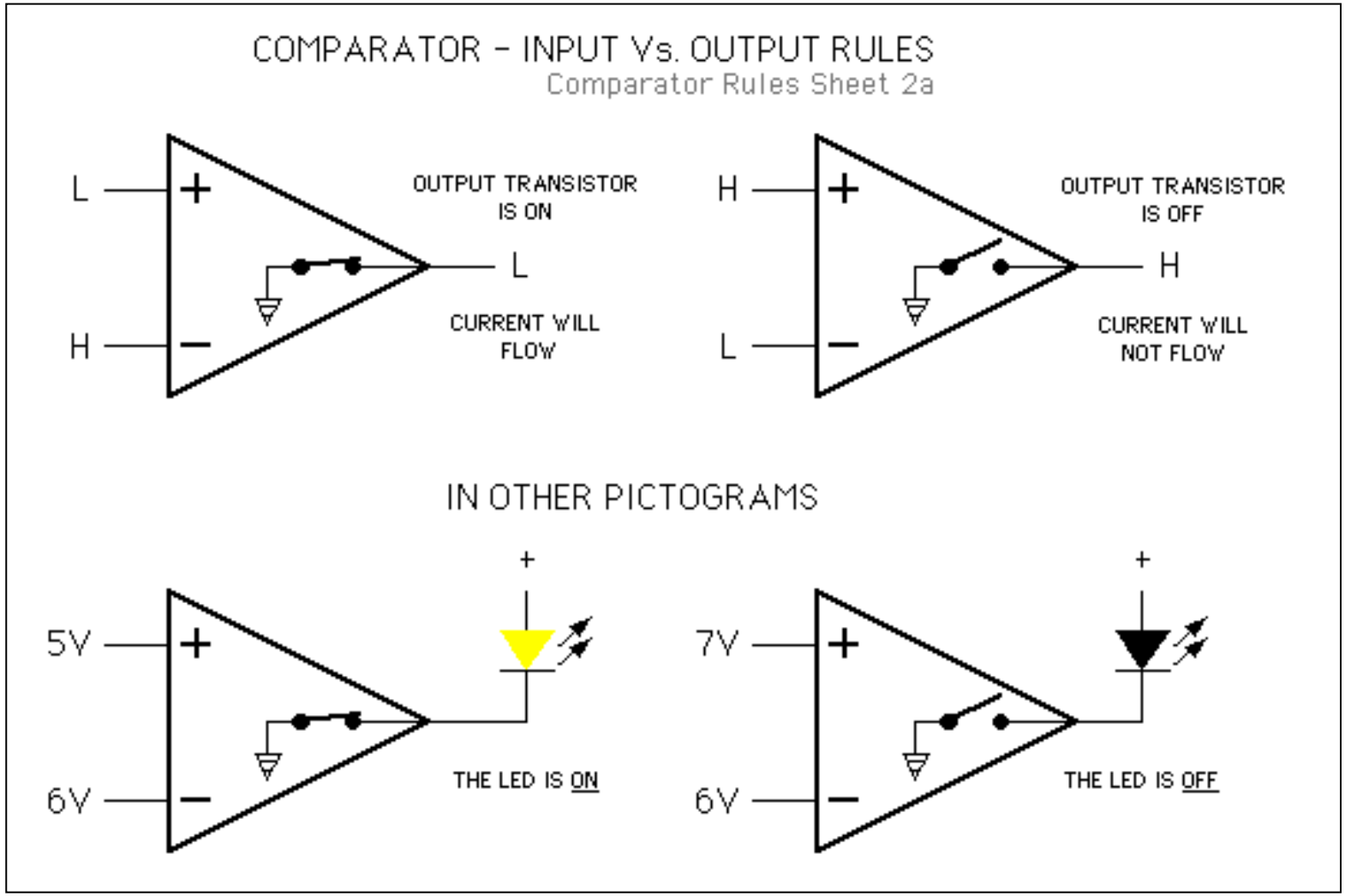


The circuit that is actually inside the "chip" is fairly complex. Here we see the actual complexity of the 555 timer circuit. Hans actually duplicated the circuit with discrete parts before he began the actual chip design and went through about 30 "iterations" or basic design changes before he was happy with the performance of the device.



We like to say that there are "linear" integrated circuits and "digital" integrated circuits, but the 555 is really neither. It is analog in that it uses the charge-discharge of a capacitor to make itself work, but it is digital in that it outputs a pulse waveform that is either high or low.

Comparator: The 555 timer relies on several of the transistors inside the chip acting as a "comparator". A comparator is nothing more than a high gain amplifier whose output is digital and input is analog.



As with the "op amp" there are two inputs and one output. We have arranged the transistors inside to have a (+) noninverting and a (-) inverting input and a single ended digital high or digital low output.

The principle of the comparator is to "compare" two voltages. If the voltage at the (+) input is greater (more positive) than the (-) input, the output is high. Conversely, if the voltage at the (-) input is greater, the output is low.

In a pinch, a plain old op-amp makes a pretty good comparator if you don't have a "real" comparator on hand.