

CONTENTS

	<u>PAGE</u>
The Beginning _____	1
The Early Years _____	13
The Installation of Wiring _____	42
Ground - Grounded - Grounding _____	63
Multiwire Branch Circuit _____	83
Load Balancing _____	89
Summary _____	114

Introduction

I'm writing this book on the beginning of house wiring as today most electricians never heard of a 2-wire 110 volt service. It's history now a very few today understand the beginning wasn't easy as the comforts of electricity we enjoy today, like a hot shower!



My birth place in 1938 in Bellefontaine, Ohio the electrical service as I first remember it was 110 volt 2-wire 30 amp service with I think with two 15 amp fused circuits.

One must remember when it was wired maybe 1900-1920 there were no appliances just ceiling lights with knob and tube wiring in the plastered walls and ceilings. When I was a kid we had no water heater. Mom put a bucket of water on the furnace register to heat water for the bathtub. We had an ice box-no refrigerator. No appliances what so ever. I can't remember the year mom got her washing machine that had a MOTOR, it blew the fuse.



Of course that brings to mind a neighbor, up the street who used to put a copper penny behind the fuse and warm up the wire with all the stuff he plugged in. Eventually it got hot enough to start a fire and burn the back porch off the house.

I can remember the first part of the World War II, mom worked at Grimes Mfg. in Urbana, Ohio riveting landing lights for B17 bombers. Mom was a "Rosie the Riveter" to help the industry as the men were at war.



The original system was intended only for lighting. In fact houses didn't even have wall outlets at first, just ceiling lights. The wire sizes required at 110 volts were perfectly reasonable. There was no incentive to go to a higher voltage.

On September 4, 1882, Edison switched on his first power grid supplying 110 volts DC to 59 customers in lower Manhattan.

Not long ago electricity was a stranger it was merely a plaything. It could be made to do a few tricks, give shocks and produce sparks, but that was all. Gentlemen in powdered wigs and silken breeches rubbed glass rods and drew forth sparks to awe and amuse the ladies. No one knew how to make electricity do anything useful. There was not a single penny in all the world invested in any form of electrical enterprise. There were no dynamos, no electric lights, no radios, no telephones, no x-rays, no motors.

Men had known something about electricity for many centuries. Why did they not find some useful purpose for it sooner?

Because, until little more than a century ago, electricity was a stranger. No one was really acquainted with it. There was little knowledge of those rules or laws which electricity obeys.

It is our acquaintance with electricity, our knowledge of how and why it behaves as it does, that has made it man's most valuable servant.

This knowledge came from experiments. An experiment is an exploring trip, an adventure in the land of science. Thousands of men made countless experiments - went exploring in unknown electrical territory looking for new knowledge. They brought back with them telegraph instruments, telephones, x-ray tubes, electric eyes, and a host of other wonders.

Some of these scientific adventurers won fame, some fortunes; others only the pleasure of discovery. Many obscure men, whose names we have never heard, discovered and are still finding scientific nuggets by experimenting in electricity's gold-fields. Others, and from a long list we might mention Volta, Franklin, Faraday, Ampere, Morse, Bell, Edison, Kelvin, and Tesla, were electrical adventurers whose experiments made them world famous.

What is electricity?

A most amazing fact is that not one of these men, not even Faraday or Edison, ever saw or felt or heard the wonderful force which helped them master. *Not one of them ever knew what it was.*

Neither can we hope to see or feel or hear electricity itself. It is invisible. It is somewhat like the wind. It is a force - a form of energy. We can only see the effects of the wind - those things the wind does. We can hear leaves rustle, feel pressure against our faces, see trees sway, smoke swirl and waves and ripples sweep over the water, yet we will be only hearing, feeling and seeing the effects of the wind and not hearing, feeling, or seeing the wind itself.

In our own electrical experiments - adventures in which we become acquainted with electricity and make it do as we ask - we will never see or feel or hear electricity itself. We will be aware only of its effects, of the things that electricity does.

No one knows the answer to the question, *what is electricity?* We know where and how to get it and what to do with it - that is all.



When we speak of generating or producing electricity, we do not mean *creating* it. It is like the rabbit the magician pulls out of his hat. The magician does not create the rabbit. It was hidden in the hat. It is merely *revealed or released* by the magician at the proper time.

Electricity is not created. Electricity itself is a creator. All matter, all substances, are composed of electricity. It is built up as part of every little bit of matter, solid, liquid, or gas, in the universe. Electricity is, in the end, responsible for all varied kinds of light we know, the light of a flame as much as that of an electric light. At least that is what scientists have good reason to believe. It is the only way in which they can logically explain the behavior of electricity.

Such an explanation is a *theory*. A theory is sort of a mental tool or implement useful to scientists. It is a plan or scheme which subsists in the mind only, but is based on observation and experiment.

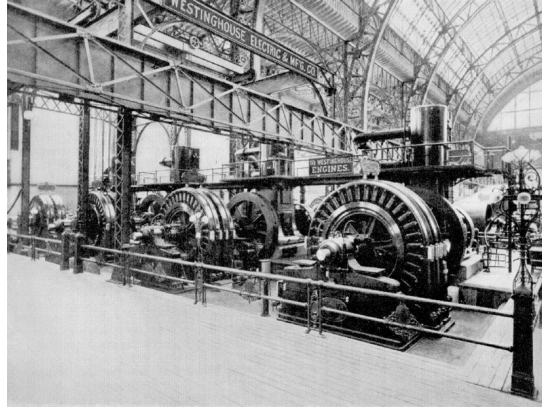
Did Edison invent the light bulb, Marconi the radio, Bell the telephone, Morse the telegraph? The answers are no. They didn't invent the wheel. They were instrumental in making it better and in some cases obtaining the patent.

Electrical history goes back before Christ and brings us to the computer age. Along this journey you will discover it took several people along the way to make the light bulb glow.

The world works and lives at the end of a wire. And we will pay tribute to the many people that made it possible.

The journey won't end with this book, as we are constantly discovering new inventions that will someday even take us to the stars.

A handwritten signature in black ink, appearing to read "Tom Hany".



Tesla AC generator in the Electricity Building at Chicago's World Fair in 1893.

Nikola Tesla, a Serbian mathematician and engineer, was a valuable partner with the genius to make AC work, while Westinghouse had the business acumen to sell it. Tesla sold him several patents concerning his polyphase motor for a large lump sum, shares and royalties.

The success of lighting up “the white city” was so impressive that Westinghouse was awarded the Niagara Falls contract. Tesla’s patented polyphase alternating current system would power the generators and bring electric lights and power to Buffalo 26 miles away. As somewhat of a consolation prize, Thomas Edison’s General Electric Company was hired to construct the long-distance transmission lines. Edison likely found this demeaning, not to mention ironic, given that his preferred direct current system could not be transmitted long distances and was the reason he lost the coveted Niagara contract in the first place. Edison would largely abandon direct current power plants after Niagara, following along on *Tesla’s alternating current success*.

The war of currents came to an end and this merger of the Edison company, along with its lighting patents, and the Thomson-Houston, with its AC patents, created a company that controlled three quarters of the US electrical business.

Tesla's development of alternating current was just the start of a long string of inventions. His partnership with Westinghouse gave him the opportunity to design what may have been Tesla's greatest achievement: the world's first hydroelectric generating plant.



The concept behind gaining energy from the Niagara Falls is relatively simple. Potential energy is stored at the top of the Falls and as it drops the energy becomes kinetic. To tap it, some of the water that would go over the Falls is displaced through a long tunnel to turn a series of turbines, which converts the energy into mechanical energy, and that generates electricity.

The Beginning

Completed in 1895, Tesla's polyphase generator could produce 15,000 horsepower, an unprecedented amount of power at that time. The Westinghouse Company would add seven more generating units to raise that level to 50,000 horsepower. On November 15, 1896, Westinghouse Electric, powered by nine key patents comprising Tesla's polyphase system, began providing alternating current electricity to the city of Buffalo, twenty miles from the Falls. This achievement, was the first alternating current electrical generating plant built on a large scale in the world. Its success encouraged the international creation of hydroelectric stations, now the most widely used form of renewable energy.

The key to Westinghouse's win was none other than **Nikola Tesla**. In *My Inventions*, Tesla recalls that he first heard of Niagara Falls when still a boy in his backwoods school. Some mechanical models used by his instructors interested him in the idea of water turbines. After hearing a description of the great Niagara Falls, Tesla "pictured in my imagination a big wheel run by the Falls." He proclaimed to his uncle that one day he would "go to America and carry out this scheme."



Nikola Tesla's success changed the world, and soon many other power stations would be built at and elsewhere in the United States. Within ten years hydroelectric plants would provide 15 percent of all the electricity in the U.S.; by 1920 that had reached 25 percent. *It was his transformers that solved one of the most difficult problems in electrical science.*



Nikola Tesla

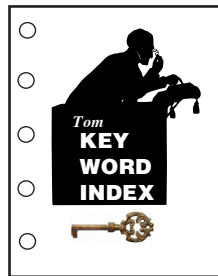
I don't care if they stole my idea...
I care that they don't have any of their own.

REPEAT THIS 3 TIMES!

A neutral conductor in the Edison 3-wire system is always a grounded conductor, *but a grounded conductor is not always a neutral.*

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GROUNDING

Grounded conductor	Article	200
Grounded conductor, appliances		200.10(E)
Grounded conductor auto transfer		210.6(C3)
Grounded conductor, black color		210.5(2)(b)(1)
Grounded conductor flexible cord		400.22(B)
Grounded conductor service sizing	T. 250.102(C)(1)	
Grounded conductor, 3 white stripes		200.6(A)(3)
Grounded conductor, #6 or smaller		200.6(A)
Grounded conductor, #4 or larger		200.6(B)
Grounded conductor, 50v or less		200.7(B)
Grounded conductor, 50v or more		200.7(C)
Grounded conductor, clearly evident		200.10(A)
Grounded conductor, continuity		200.2(B)
Grounded conductor, definition		100
Grounded conductor, device terminals		200.10(A)
Grounded conductor, different system		200.6
Grounded cond. disc. simult.		404.2(B) ex.1
Grounded conductor, connection		200.3
Grounded conductor, identification		200.6
Grounded conductor, identification		210.5(A)
Grounded conductor, insulated		200.2
Grounded conductor, multiwire		210.4 IN #2
Grounded conductor, multiwire group.		210.4(D)
Grounded conductor, neutral point		250.36(B)
Grounded conductor, polarity connect.		200.11
Grounded conductor, white or gray		200.7(A)
Grounded equipment rack		770.114
Grounded conductor, screw shells		200.10(C)
Grounded metal barrier		680.23(A)(2)
Grounded conductor, scope		200.1
Grounded shield, transformer		426.31
Grounded, clothes dryer		250.140
Grounded, conductive path		DEF 100
Grounded, continuously		250.52(A)(1)
Grounded, metal faceplates		406.6(B)
Grounded, ranges		250.140
Grounded, service cond. min. size		250.24(C)

NEUTRAL

Neutral can be reduced		551.72(D)
Neutral common		225.7(B)
Neutral common, feeders		215.4(A)
Neutral conductor		310.15(E)
Neutral conductor solid state		520.27(B)
Neutral conductor, branch circuit		200.4(A)
Neutral conductor, definition		100
Neutral point, transformer		250.36(D)
Neutral conductor routing		250.36(D)
Neutral conductor, cords		400.5(A)
Neutral fully insulated		250.36(B)
Neutral grounding impedance		250.36(C)
Neutral point		100
Neutral, ampacity solar		705.28(C)
Neutral, ampacity		225.7(B)
Neutral, autotrn. phase current		450.5 IN
Neutral, bare service		230.22 ex.
Neutral, boiler over 600v		490.72(E)(2)
Neutral, bonding to service		250.92(B)
Neutral, busway		368.258
Neutral, carry the unbalance		310.15(E)(1)
Neutral, clothes dryer feeder 70%		220.61(B)(1)
Neutral, cook. equip. B.C.		210.19(A3) ex 2
Neutral, cook. equip. feeder 70%		220.61(B)(1)
Neutral, feeder load		220.61
Neutral, feeders		215.4(A)
Neutral, insul., mobile homes		550.11(B)
Neutral, min. insulation level		250.184(A)(1)
Neutral, minimum service size		250.24(C)(1)
Neutral, multiple circuits		200.4(B)
Neutral, outside wiring		225.7(B)
Neutral, switchboard parallel		520.27(A)(2)
Neutral, portable switchboard		520.52(B)
Neutral, reduction feeder		220.61(B)
Neutral, solid-state dimmers		520.25(D)
Neutral, solidly interconnected		250.20(D) IN # 1
Neutral, solidly grounded		250.184