

Build Your Own Telephone

Eric Hayes

Hixson Middle School

Runnrz26@aol.com

Dan Ihms

Marion Count R-II

Rrm009@mail.connect.more.net

Kelly Moore Williams

Holman Middle School

williams.dane@webster.k12.mo.us

Final Project for
Summer Physics Institute
Electricity and Magnetism
Instructor: Dr. Meera Chandrasekhar
University of Missouri-Columbia

June 28, 2000

History

The telephone has been around for most of the 20th century. The electrical speech machine, now known as the telephone was created by Alexander Graham Bell in 1876. He quickly advanced his phone and set up a telephone system in New Haven, Connecticut in 1878, and had long distance systems set up by 1884 that connected Boston to New York.

How it Works

Advancements in telephone technology have been dramatic over the past one hundred years. What began as a manual connection, hand-cranked machine has evolved into a computer-driven electronic device that is connected all over the world by fiber optics and satellites. The telephone consists of four key components: the dialer, the ringer, the transmitter, and the receiver.

This particular phone has the option of **tone** or **pulse dialing**. When the phone is in pulse mode, there are a certain number of pulses that are sent to the local loop to identify the desired phone number. Each number on the keypad represents a different number of pulses that can be identified by the central office. When in the tone mode, the signal is sent out using different frequency tones created by the keypad. Once the number has been dialed, it is sent out to the phone you are calling.

The **ringer** is the signal that a call is coming into the phone. The ringer consists of a buzzer that has an alternating current passing through it to set up the sound. There is a capacitor that blocks the normal 48 VDC (volts direct current) that is always present when the phone is on the hook. When the signal comes in, there is an additional 90 VAC sent into the receiving phone. During the positive cycle, a transistor conducts current into the buzzer, and then blocks the current during the negative part of the cycle. The buzzing sound is created during the positive cycle.

The **transmitter** is the part of the phone that the person speaks into. It is a microphone that works by compressing carbon granules. The change in pressure due to the speaker's voice increases and decreases the electrical resistance, which in turn translates sound waves into electrical impulses. The impulses are then sent to the central office to be amplified and passed back to the sending telephone.

The **receiver** is the earpiece through which sounds are heard. As electrical impulses enter the receiver, they pass through an electromagnet. The electromagnet is inside a permanent magnet, which is near a diaphragm. Electric currents affect the diaphragm by pulling it toward and pushing it away from the permanent magnet. The movement of the diaphragm creates airwaves, which are translated into sound in the listener's ear.

Classroom Applications

- There are many ways that this phone model could be used in the classroom.
- Most simply, it could be used as a model to demonstrate electrical circuitry. Every person in the class can relate to telephones because of their wide use.
 - This kit could be put together as an after-school club and discussed.
 - The teacher could set up sample circuits and have the students relate it to the phone circuit board.
 - The students could be asked to solve for different variables in different circuits (voltage, current, resistance).
 - The students could be asked to interpret the markings on a resistor or capacitor.
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Vocabulary

- Resistor: device that is used to impede electrical flow
- Diode: device which controls an electric current so that it can flow in only one direction
- Capacitor: device which collects and stores electrical charge
- Transistor: device containing a semi-conductor used in electronics to control or increase an electric current.
- Resonator: device used to produce sound by causing vibrations
- Receiver: part of the telephone a person holds to their ear
- Transmitter: part of the telephone that a person talks into
- Local Loop: the pair of wires between the telephone set and the telephone company central office
- Hook Switch: a switch inside a telephone which closes when the telephone receiver is lifted
- Tone Dialing: dialing system in which a combination of two frequencies on the local loop represent the number dialed
- Pulse Dialing: dialing system in which the number of pulses on the local loop represent the number dialed
- Alternating Current (AC): a current that will flow in two different directions
- Direct Current (DC): a current that will flow in only one direction

Price List

AmeriKit AK-700 (telephone): \$19.95

Solder Iron/Solder/Solder Stand: \$10.25

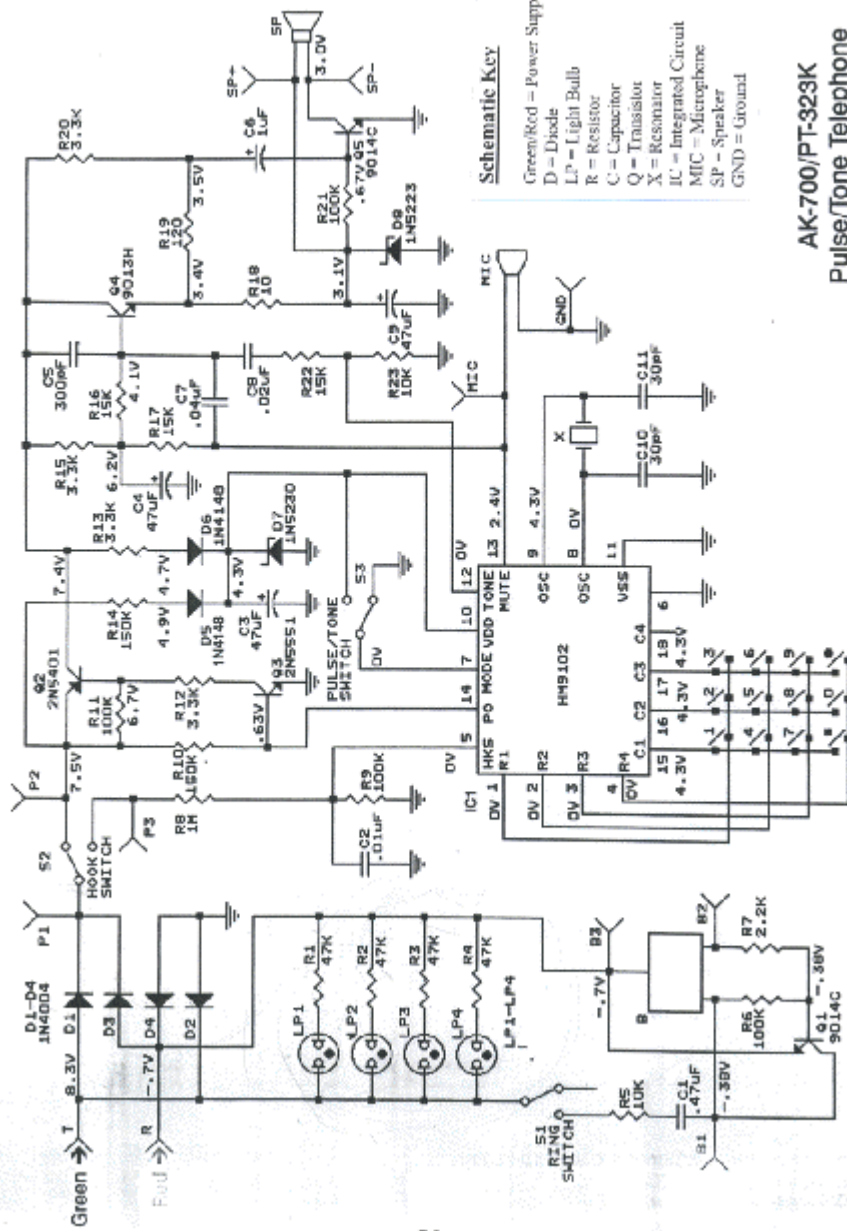
9-Volt Battery: \$1.00

Wire Clippers: \$4.99

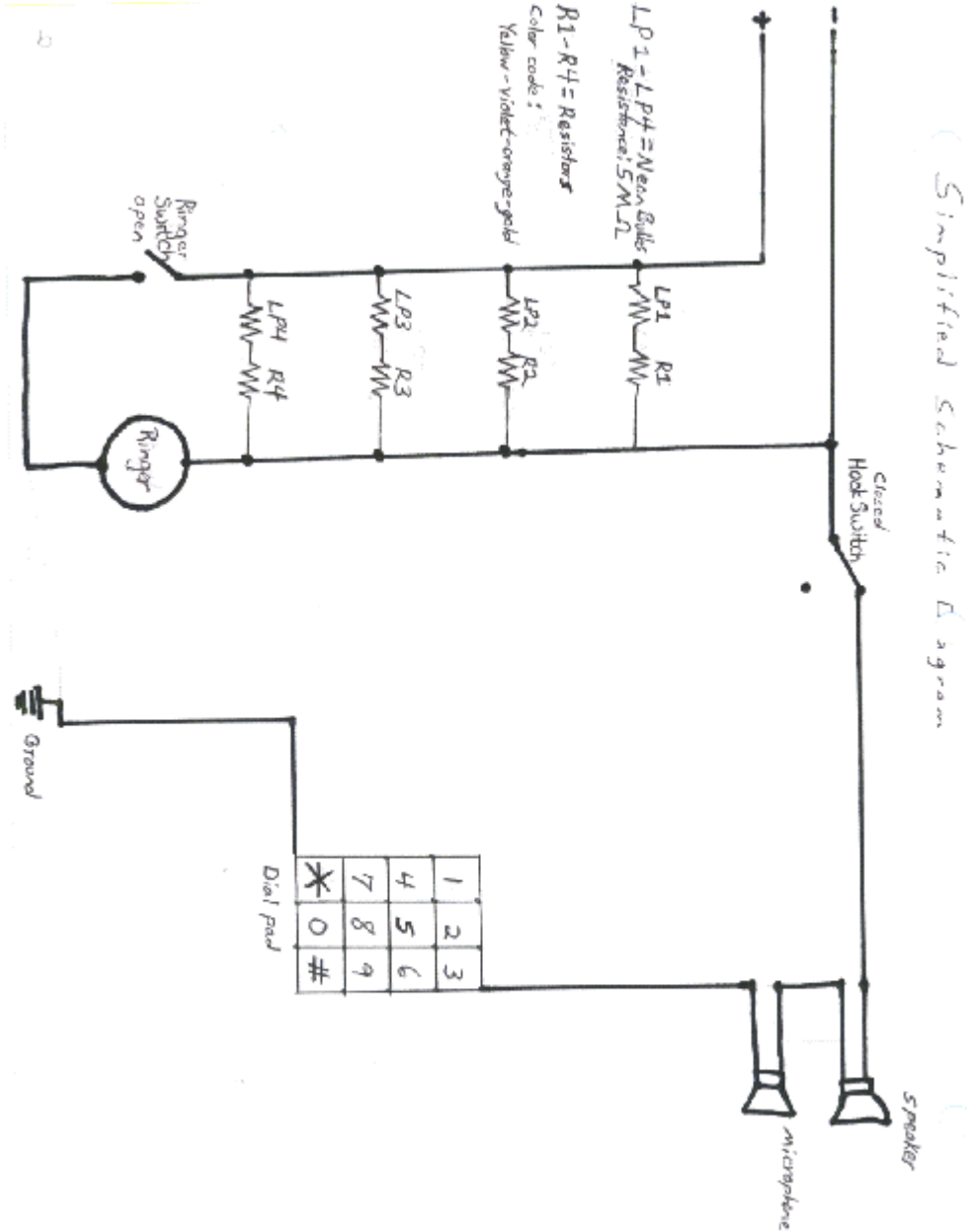
On Hook	On Hook Ringing	Off Hook	
48 Volts DC	138 Volts DC	3.7 Volts DC	<u>Capacitor</u>
53.7 Volts DC	138 Volts AC	11.3 Volts DC	<u>Lights</u>
53.7 Volts DC	138 Volts AC	11.3 Volts DC	<u>Power Supply</u>
1.9 Volts DC	1.9 Volts DC	11.3 Volts DC	<u>IC</u>

Changes in Voltage for Various Components in the Circuit Throughout the Telephone Cycle

SCHEMATIC DIAGRAM



AK-700/PT-323K
Pulse/Tone Telephone



Telephone Application Questions

_____ is an electrical engineer?

Directions: Answer the following questions in complete sentences. Show all work on math questions.

1. If light bulb LP1 goes out, what would happen to the rest of the ringer section of the circuit? Why?
2. Using the resistor value key provided, calculate the total resistance of the ringer circuit. (Assume zero resistance for the ringer.)
3. Using your answer from number 2, calculate the current in this section of the circuit if the voltage is 138 V.
4. If the hook switch is open, what is the phone capable of doing?
5. If the hook switch is closed, what is the phone capable of doing?
6. Using the resistance value key, draw and color any three resistors. Give the resistance of each, and explain the significance of each color band.

Telephone Application Questions Key

Ima Key

1. If light bulb LP1 goes out, the rest of the lights will still work and the phone will still be able to ring because the four lights and the ringer is wired in parallel.
2. Neon Bulbs LP1-4=5MΩeach

Resistors R1-R4=47kΩ

First Calculate for each series: $5\text{M}\Omega + 47\text{k}\Omega = 5.05 * 10^6 \Omega$

Then calculate the series in parallel: $\frac{1}{R_p} = 4 \frac{1}{5.05 * 10^6 \Omega}$

$$R_p = 1.26 * 10^6$$

3.

$$V = IR \quad \frac{138V}{1.26 * 10^6 \Omega} = I$$
$$\frac{V}{R} = I \quad 1.10 * 10^{-4} = I$$

4. When the hook switch is open, the only operations the phone is capable of is ringing, lighting up, and storing information in the integrated circuit.
5. When the hook switch is closed, the phone is capable of dialing, transmitting sound, and receiving sound.
6. The first colored band represents the first digit in the value of the resistor. The second colored band represents the second digit in the value of the resistor. The third colored band represents the power of ten that the first two digits should be multiplied by in order to get the final value of the resistor. These three bands are evenly spaced. The last colored band on the resistor is farther away from the other bands and represents the resistance tolerance. The tolerance simply shows how close the actual measured resistance will be to the given value.