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## Introduction to electromagnetic induction

### Lesson Title

Circuits without batteries and the decline of the banjo in American Jazz

A special type of circuit that makes use of the interplay between electricity and magnetism.

### Demonstrations of curious phenomena:

Pen solenoid

Hand generator

Lenz's Law Magnet Tube

### The Bottom Line:

Magnets can create electric currents

Electric currents can create magnetic effects

### So What?

Electric Guitars use a magnetic "pickup." The vibrations of the steel strings change the magnetic field around the pickups and create an electrical current in a coil of wire wrapped around the magnet. This current runs through an amplifier and causes a changing magnetic field that vibrates a coil of wire suspended over a magnet. This coil is attached to a diaphragm in the front of the speaker (normally paper) and causes the vibrations.

Most microphones are "dynamic" microphones that operate like a speaker in reverse. In fact, if you are ever in a pinch, you can use a pair of headphones for a crude microphone.

### **As promised:**

The banjo was a standard rhythm instrument in many early jazz bands, and can be heard in many famous songs (Black and Tan Fantasy, Creole Love Call (1927)). However, by the end of the 1930s, the "big band" movement had taken hold with jazz orchestras ranging in size from 15-20 players, using as many as 5 saxophones simultaneously. With so many instrumentalists, band leaders needed a way to keep the rhythm section (bass, drums, banjo, piano) from being drowned out. The arbitrarily loud electric guitar was a natural choice. Soon, guitar pioneer Charlie Christian, playing with the Benny Goodman Orchestra had developed a jazz guitar idiom that would help to cement the future of the guitar and signal the end of the banjo's days as a jazz instrument.

### **Even if you are not a big music fan:**

Circuits that use the give and take between electricity and magnetism are the basis for everyday staples of our lives, such as power locks on car and building doors, electric motors to power cars, kitchen appliances, and computers, brake systems in new cars, and traffic signal actuators. These same circuits also have more exotic applications, such as propulsion systems for magnetic levitation trains, and particle accelerators.

### **A secret relationship exposed:**

Einstein was able to use the theory of Special Relativity to show that electricity and magnetism are the two faces of a single, electromagnetic force. For more information about this relationship, the following url has some interesting (albeit a bit technical) information: <http://physics.weber.edu/schroeder/mrr/MRRtalk.html>