

Wireless!

The forces and strategies that shaped a revolution



Lecture 2- Wires and waves The Age of Fast Communications

Lecture 2- Classwork

1. Please summarize in 3-4 sentences the Pre-Lecture reading for Lecture 2 including some important takeaways from your reading.
2. Why was a telegraph network able to cover the country quickly?
3. Can you provide an example from this lecture that illustrates how Technology can advance even without fully understanding the Science behind it?
4. Why was the telephone a more difficult problem?
5. Why were radio channels for many popular and important services so limited before 1950?

The focus of our lectures

- ❑ Throughout this course we will look for the “big picture”
 - The technological advances that make a new capability possible (but that’s just the beginning)
 - The human needs that make that possibility important
 - How much will it cost to create? To use?
 - How the structure will be financed and operated
 - Who will benefit and who will be hurt?
- ❑ From those inputs we start to ask what is going to matter and what could happen

Topics for discussion in this lecture

- ❑ The dramatic effects of “fast communication and its origins in 19th century science and invention
- ❑ The creation of the Telegraph
- ❑ The creation of the Telephone
- ❑ The beginning of Radio and the variety of uses it allowed

“Fast” communications in history

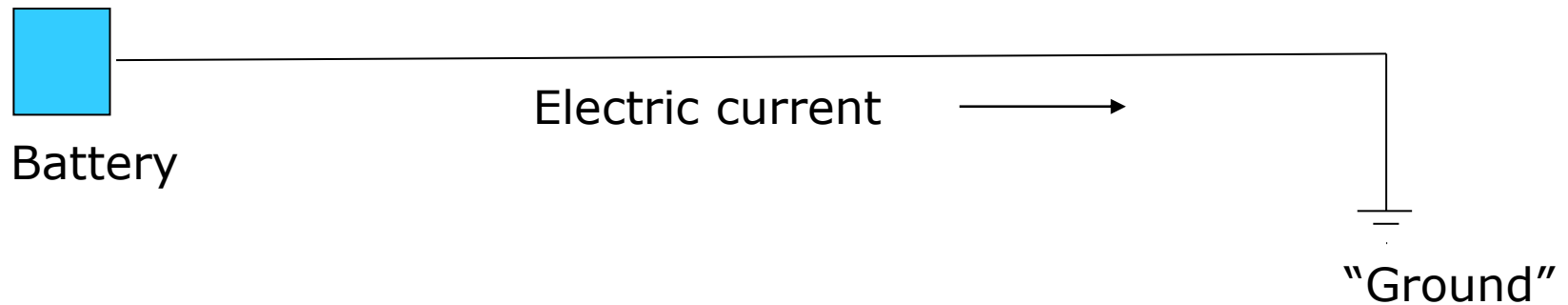
- ❑ Fire, drums and carrier pigeons
 - From Marathon (490 BC) to Trojan War (800 BC) to the Erie Canal (1825)
- ❑ Smoke and mirrors
- ❑ Semaphore
- ❑ All are specialized or short range
- ❑ Once the wires were in place, the telegraph (~1837) could carry any written message, any distance, almost instantly
 - From days, weeks or months to minutes or hours (the endpoints were still slow)
 - At rail stations (dispatch; then commercial communications)
 - Western Union (1851)
 - Cable across the Atlantic (1865)
- ❑ Personal messages and news (the other “communications”)

From science to invention

- ❑ In 1800 the sciences were exploding
- ❑ New phenomena were noticed
- ❑ Some, like electricity and magnetism, were used by inventors before they were understood by scientists.
- ❑ Some led to popular fiction

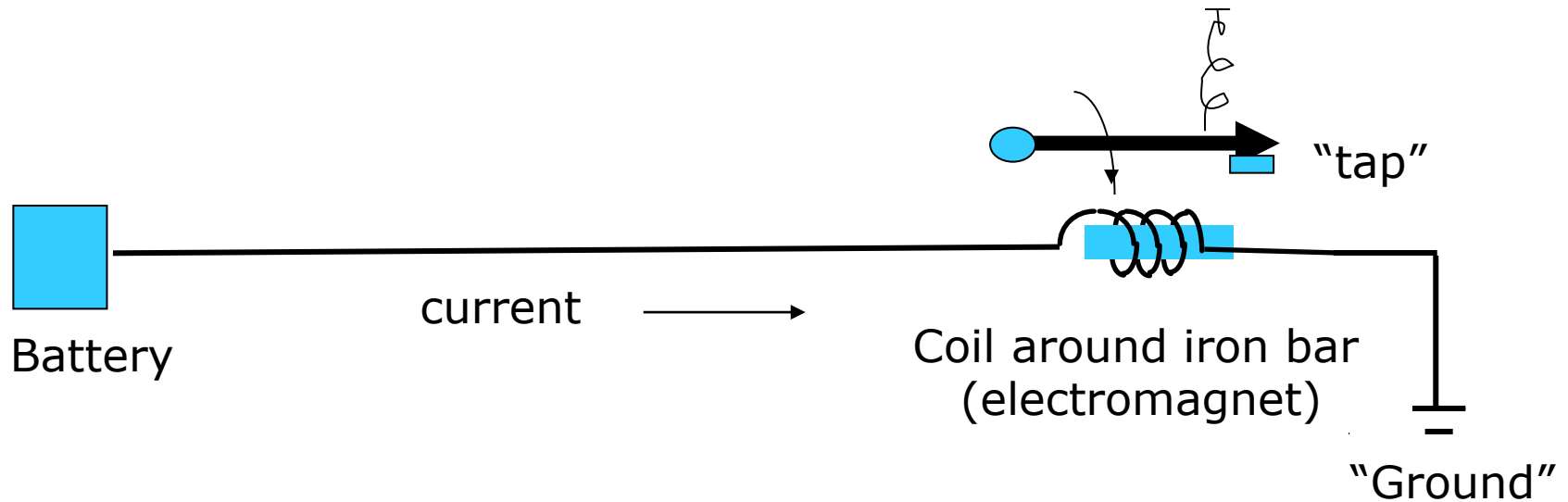
What scientific experiments led to Mary Shelley's famous novel "*Frankenstein*"?

Communications goes from the speed of a person to the speed of electricity

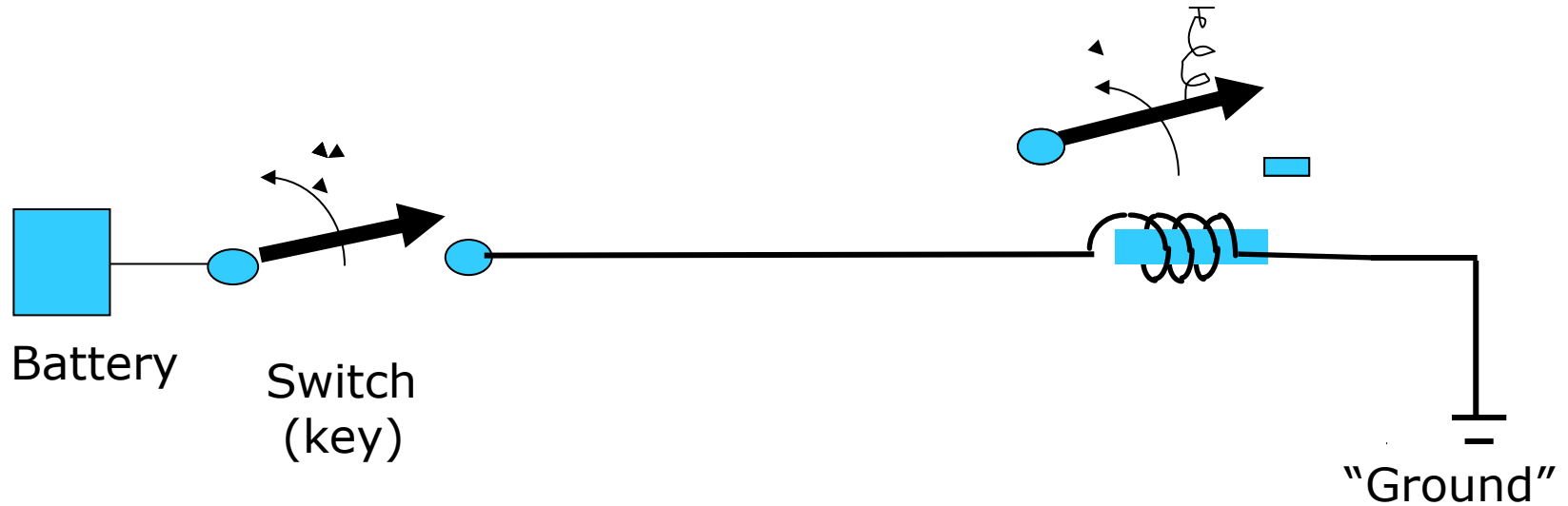


How do we use the current flowing through a wire to create a system?

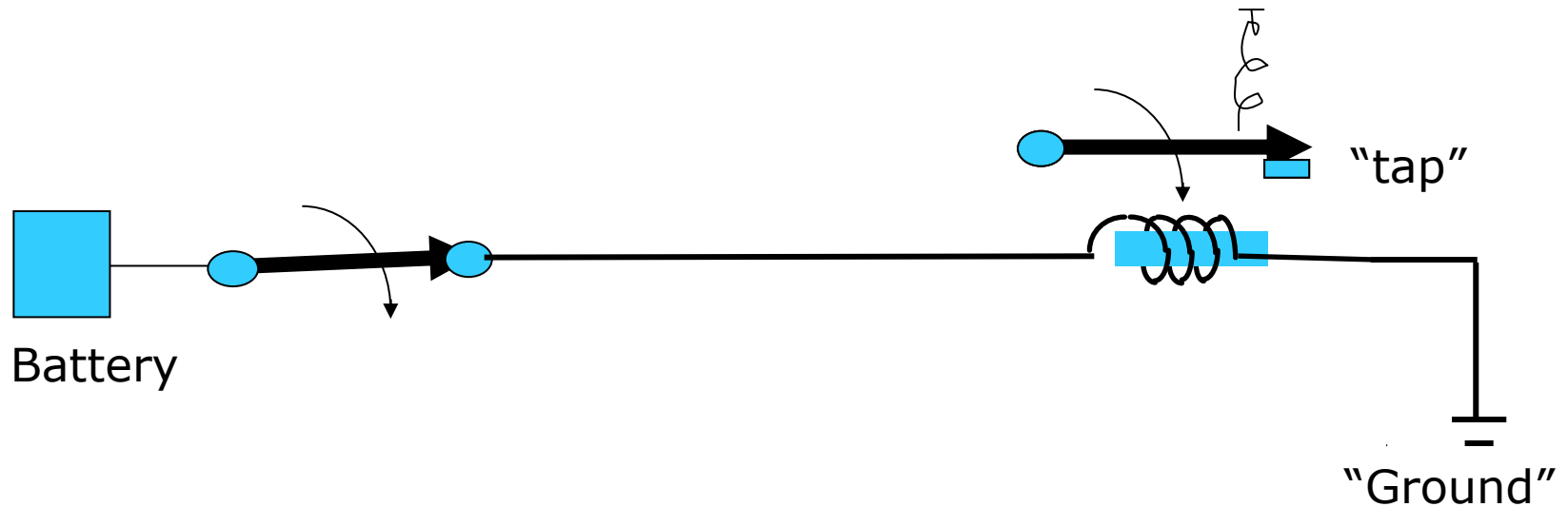
Communications goes from the speed of a person to the speed of electricity



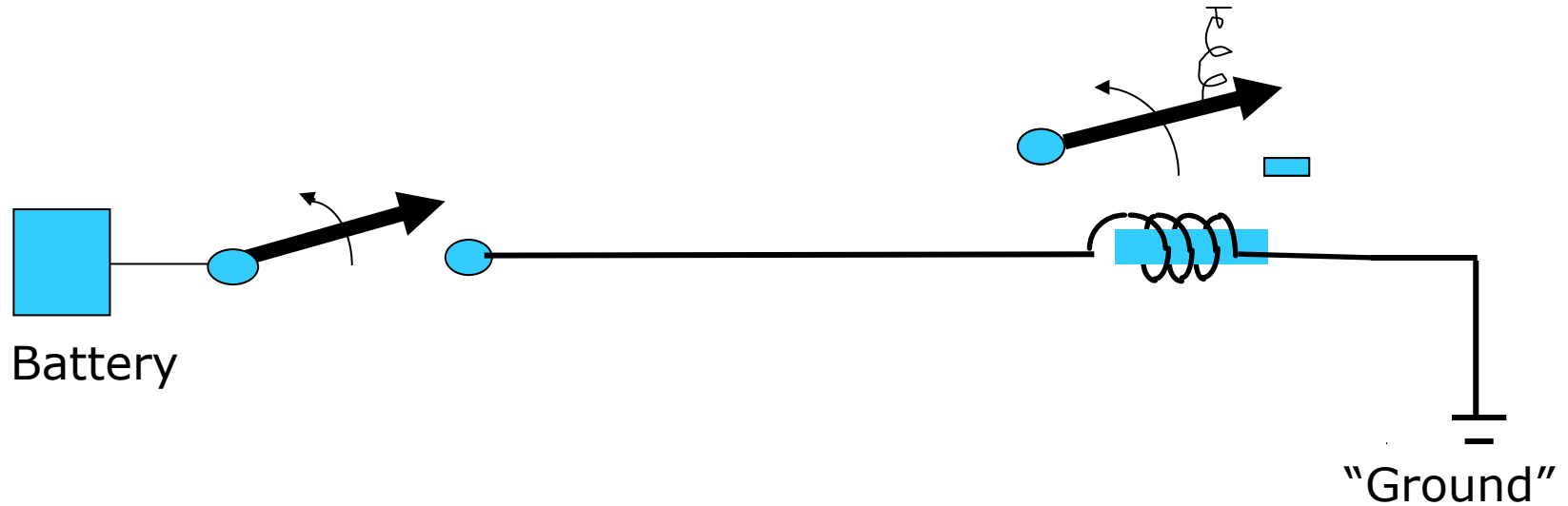
Communications goes from the speed of a person to the speed of electricity



Communications goes from the speed of a person to the speed of electricity



Communications goes from the speed of a person to the speed of electricity



“Mass” communications

- The traveling merchant (storytelling)
- The printing press
 - “hard” information
- The newspaper
- The telegraph
 - Rapid
 - (sort of) accurate
 - Around the world
 - “mass” communication is born

The telegraph

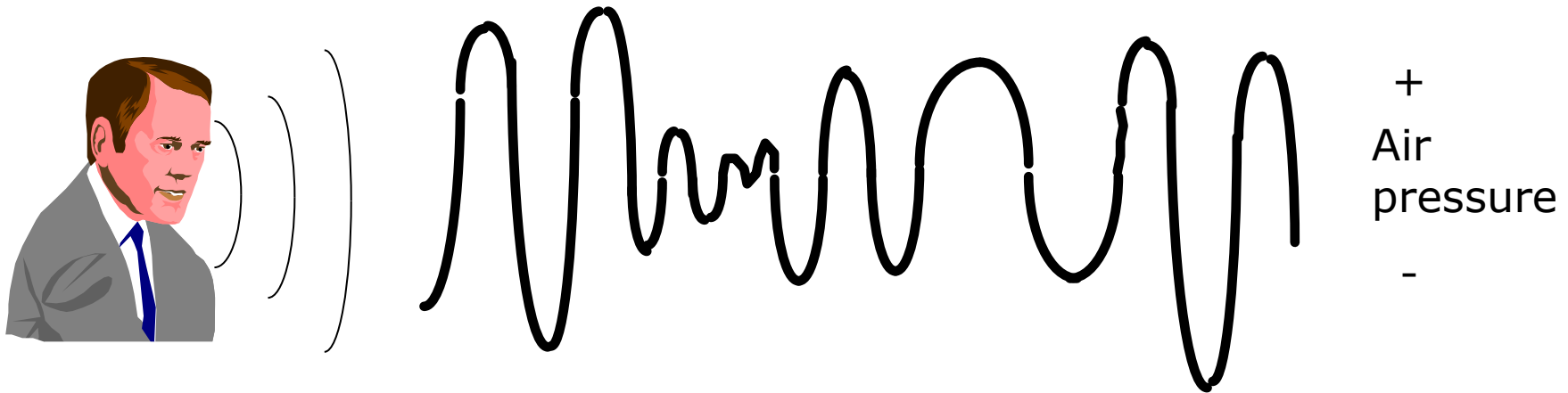
- ❑ **What related “inventions” were needed to create a useful telegraph system?**
- ❑ **What allowed telegraph systems to spread quickly nationwide?**
- ❑ **Why was telegraph service both “instantaneous” and “kind of slow?”**
- ❑ **Q2**

An Interesting Timeline

- Faraday's experiments (and Laws) – 1831
- Morse Code and Telegraph – 1837 **Q3**
- Telegraph Lines and Commercial Systems – 1840s onwards
- Actual mathematical explanation of Faraday's Laws by Maxwell (Electromagnetic Theory) -1861
 - Also discovered electromagnetic waves that travel on wires and in air

The telephone as an invention-

Putting voice on the wire



A complicated pressure wave

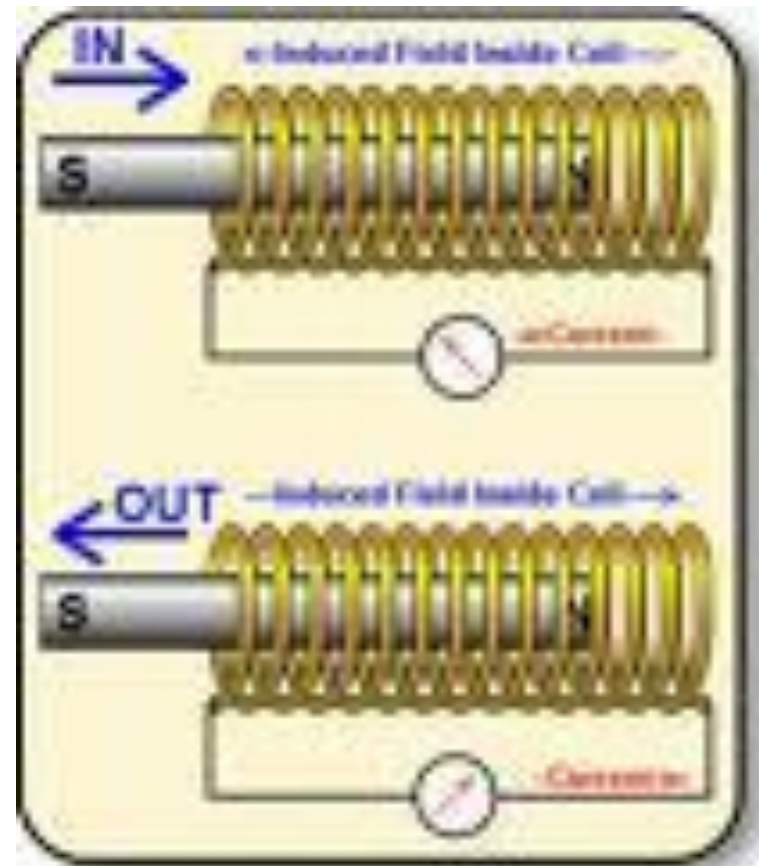
Q4

The telephone as an invention-2

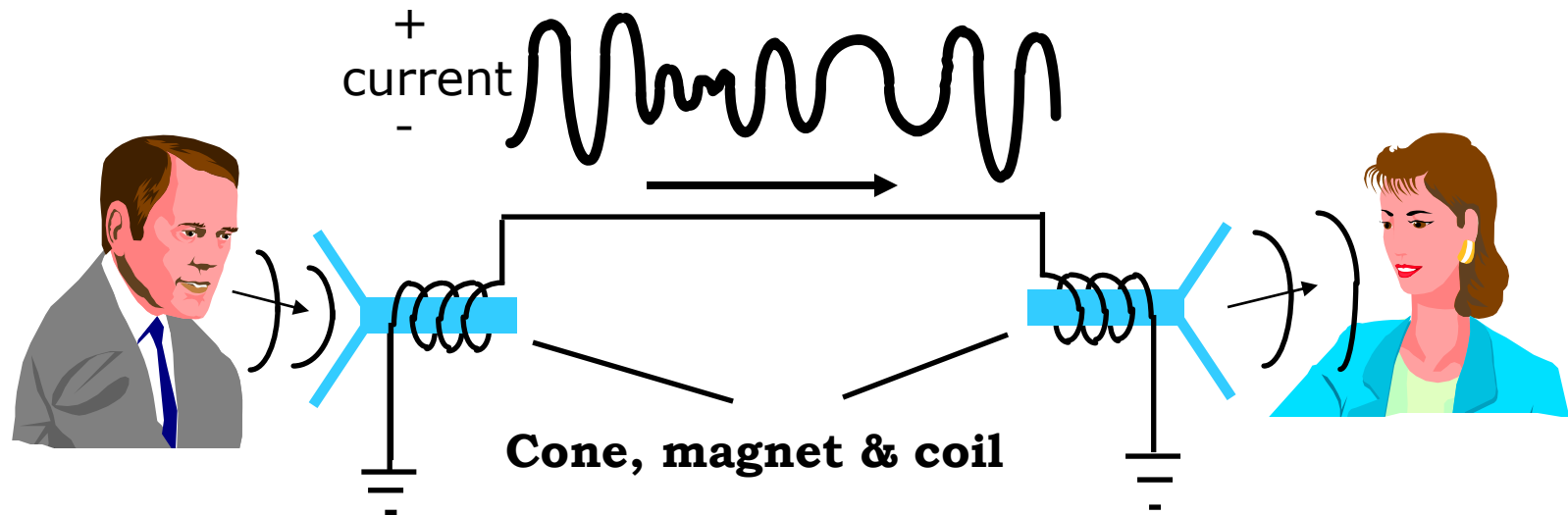
- **What newly understood scientific principle allowed Bell to turn a pressure wave in air (voice) into an “analog” electrical signal on a wire and then bring it back to voice?**
 - **Relationship between Electricity and Magnetism**
- **What other invention was needed to create a strong electrical signal that could travel for practical distances?**
 - **“Amplifiers”**

The magnet and coil

- A moving magnet
 - Produces current in the coil
 - Faster motion = more current
- Current in the coil
 - Makes a magnet move
 - More current = faster motion

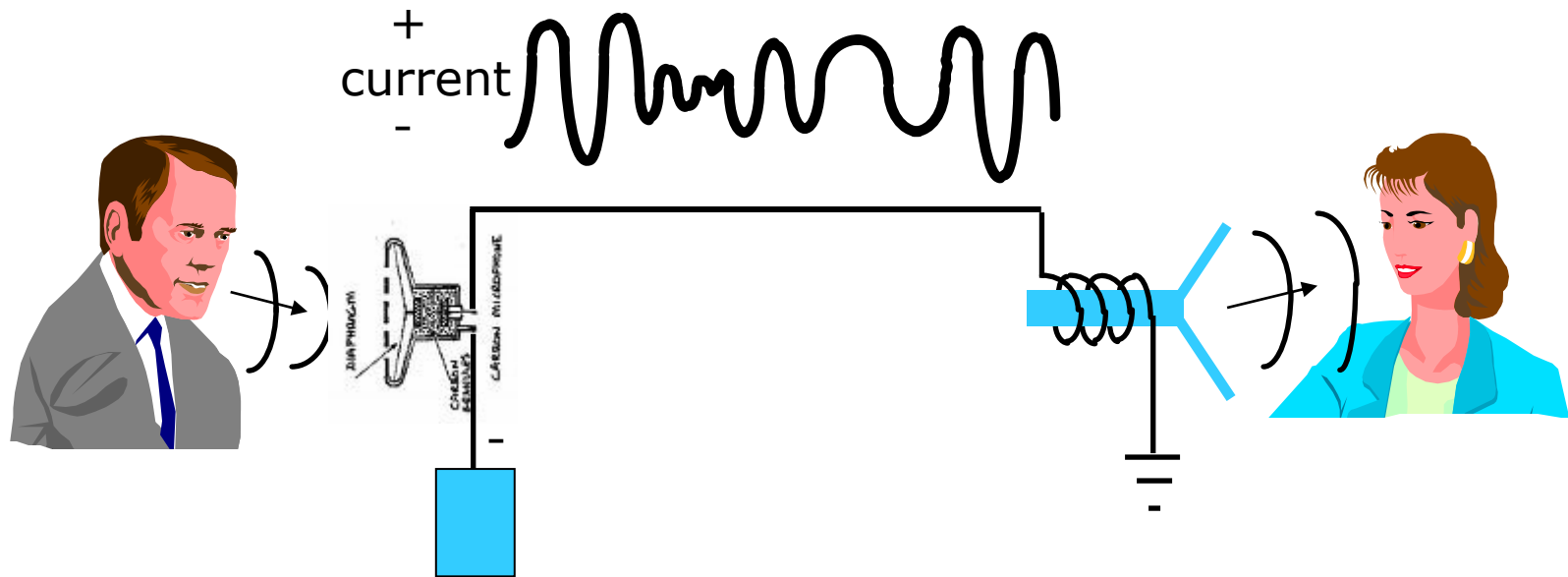


Bell's invention

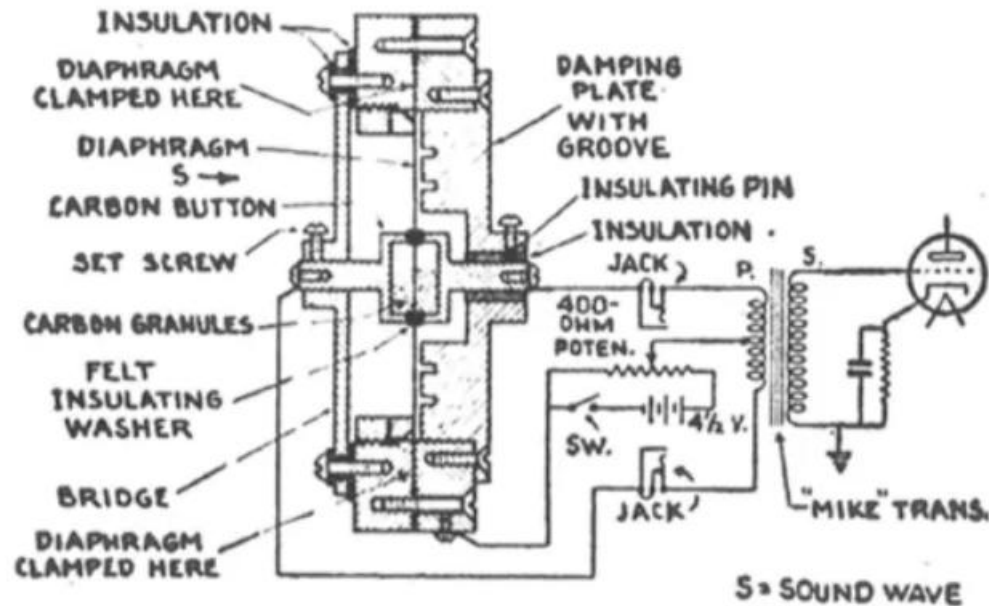


Turning pressure waves into electrical waves—
and back again

Making the signal stronger- the carbon microphone

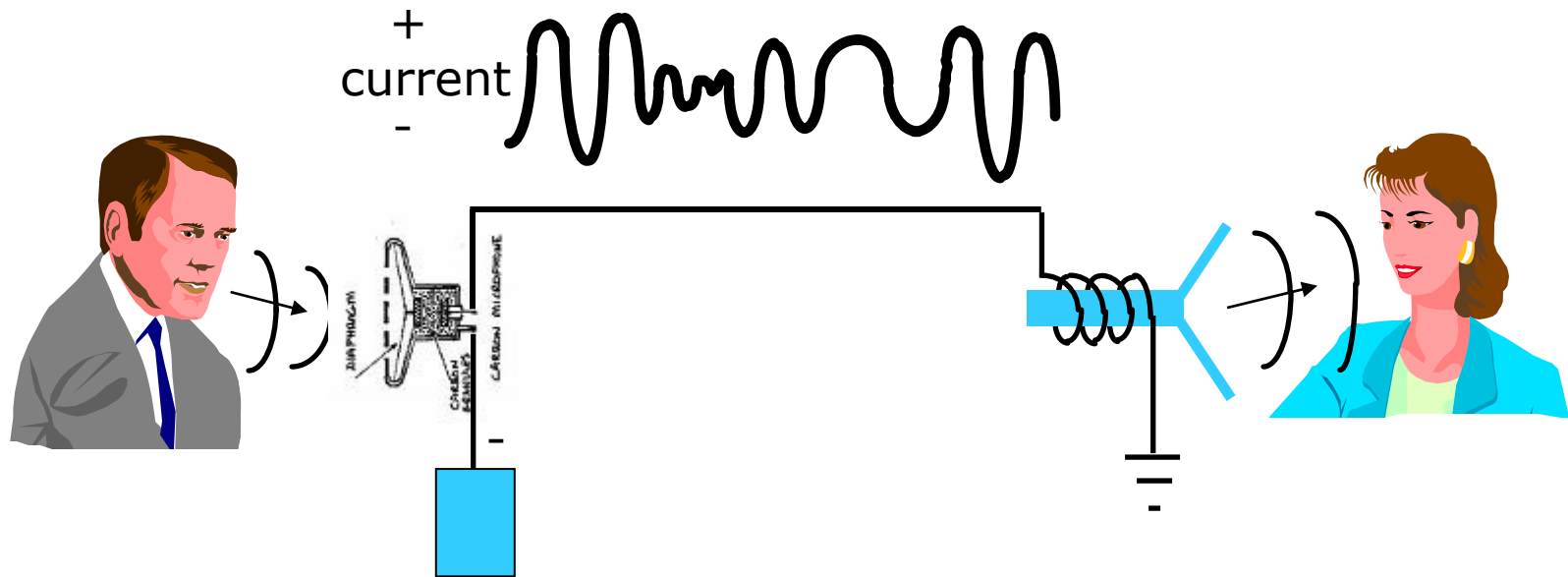


The carbon microphone (Emile Berliner patent)



The anthracite coal (carbon) granules are contained within a small half-sphere covered with a thin metal diaphragm. External power is applied to generate a current flow through the microphone. Sound waves strike the microphone diaphragm causing it to vibrate, exerting varying pressure onto the carbon granules. These varying pressure levels translate into varying levels of resistance, which in turn vary the electrical current passing through the microphone. It's a simple concept resulting in a rugged and reliable, if somewhat noisy, microphone.

Making the signal stronger- the carbon microphone



Person to person- directly
No training in codes
Truly instantaneous

Western Union's strategic blunder

Turning down the telephone patent (1876)

"Messers Hubbard and Bell want to install one of their 'telephone devices' in every city. The idea is idiotic on the face of it. Furthermore, why would any person want to use this ungainly and impractical device when he can send a messenger to the telegraph office and have a clear written message sent to any large city in the United States?"

In view of these facts, we feel that Mr. G.G. Hubbard's request for \$100,000 for the sale of this patent is utterly unreasonable, since this device is inherently of no use to us. We do not recommend its purchase."

(Bell bought Western Electric six years later, in 1882)

And finally– RADIO!

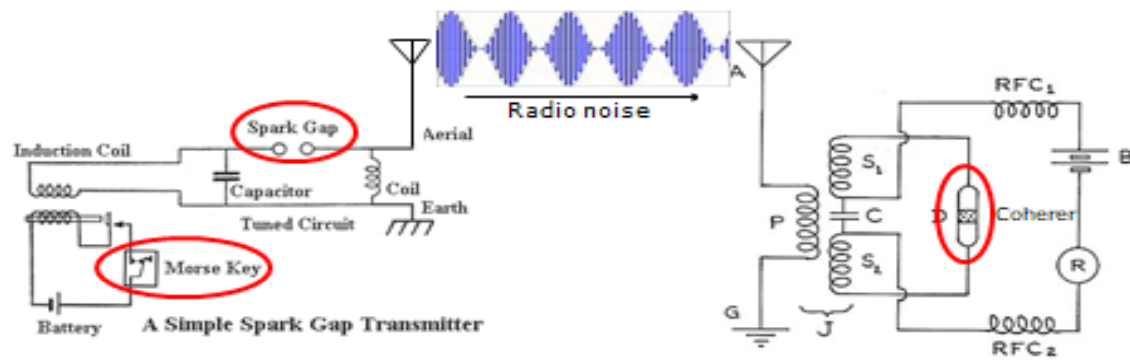
From Maxwell to Marconi in three decades

- ❑ James Clerk Maxwell (1860s) A prediction of radio based on theory (an electromagnetic wave that would move at a predictable speed (same as light))
- ❑ Heinrich Hertz (1870s) Demonstrates a radio wave (***"It's of no use whatsoever-- this is just an experiment that proves Maestro Maxwell was right - we just have these mysterious electromagnetic waves that we cannot see with the naked eye. But they are there."***)
- ❑ Guglielmo Marconi (1899) sends a "wireless" telegraph message from Atlantic Highlands to a ship in NY harbor– radio communication is born!

Marconi's radio

- ❑ How did Marconi first transmit "information" through the air?

Marconi's first radio telegraph A strange but historic device



Communicating with radio noise
(but soon with different radio frequencies)

Marconi's radio

- ❑ **What was the big limitation of Marconi's first radio system?**
- ❑ **What advances/inventions allowed the transmission of an analog voice signal on a radio channel?**

Let's compare wire and radio

- ❑ **What were the advantage of radio compared to wire for communications?**
- ❑ **What was the resulting disadvantage?**

Wireless vs. Wired: The “Negroponte switch”

New technology shifts usage

- ❑ **TV shifted from radio to wire (cable technology)**
 - **And cable finally created competition for the local telephone monopoly**
- ❑ **Telephone shifted from wire to radio (cellular technology)**
- ❑ **Might high-capacity digital cellular send TV from cable back to Radio?**
 - **“Home Internet”**

A look ahead

▣ Q5

- ▣ This lecture, and the 7 that follow, focus on creation and evolution of cellular.
- ▣ Lecture 3 will focus radio communications before cellular and the early decisions of the Federal Communications Commission (FCC) that led to the creation of cellular