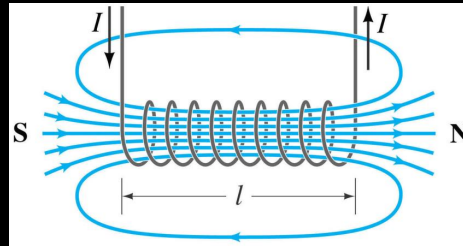


Alexander Graham Bell, Joseph Henry, and the “empty helix” experiment



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Alexander Graham Bell visits Joseph Henry

March 1-2, 1875



Joseph Henry (1797 – 1878)

– First Secretary of Smithsonian (1846 – 1878); Previously a Professor at Princeton College; Early contributor to science of electromagnetism. Contemporary of Ohm, Faraday, and Ampere – electrical units are named after these individuals.



Alexander Bell (1847 – 1922)

– Teacher of the deaf; Professor of Vocal Physiology at Boston University. In 1875, he is figuring out how to send many telegraph messages on a single wire. His work follows the 1872 invention of the duplex telegraph of Stearns.

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Dear Mama and Papa, (letter of March 18, 1875) ...

when I related a experiment that at first sight seems unimportant — I was startled at the sudden interest manifested. I told him that on passing an intermittent current of electricity — through an empty helix of insulated copper wires a noise could be heard proceeding from the coil — similar to that heard from the telephone. He started up — said "Is that so?" Will you allow me Mr. Bell to repeat your experiments

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The “telephone” mentioned is a telegraphic device using tuned reeds

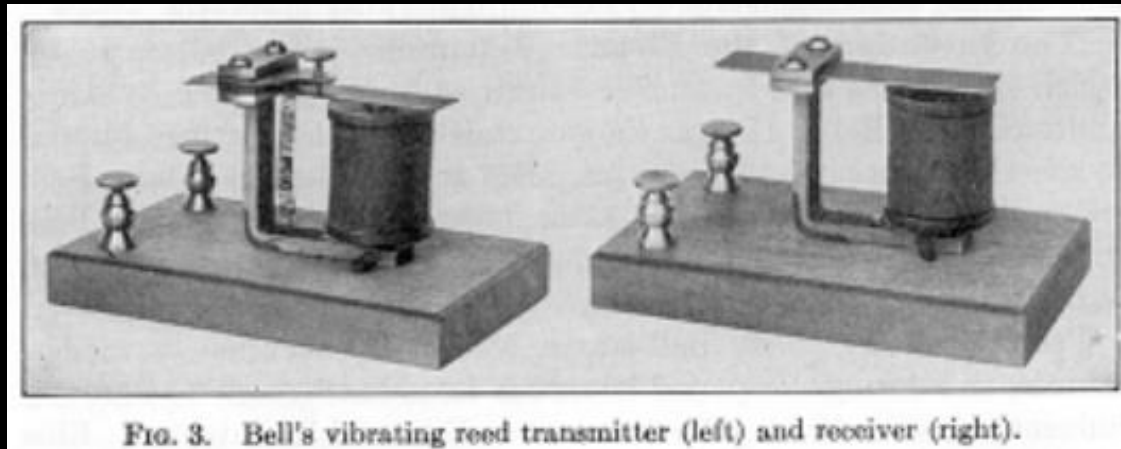


FIG. 3. Bell's vibrating reed transmitter (left) and receiver (right).



Make and Break transmitter (at the vibration frequency of the iron reed)
And matched receiver with a second iron reed resonantly excited by pulses

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I sat at the instrument working and he sat at a table for a long time with the empty coil of wire against his ear listening to the sound.

I felt so much encouraged by his interest - that I determined to ask his advice about the apparatus I have designed for the transmission of the human voice by telegraph. I explained the idea and said "What ^{would} you advise me to do - ~~publish~~ publish it and let others work it out - or attempt to solve the problem myself."

~~He said~~ He said he thought it was "the germ of a great invention" - and advised me to work at it myself instead of publishing.

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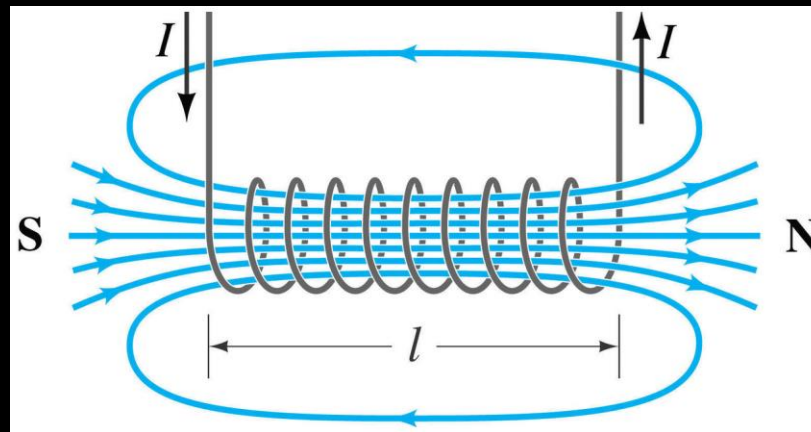
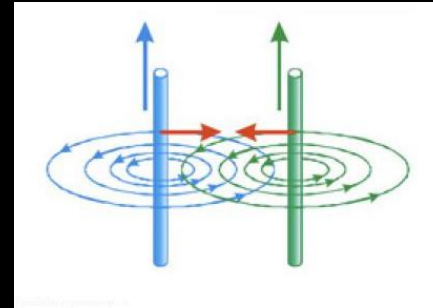
I said that I recognized the fact that there were mechanical difficulties in the way that rendered the plan impracticable at the present time. I added that I felt that I had not the electrical knowledge necessary ~~to overcome~~ to overcome the difficulties. His laconic answer was "Get it".

A.G.B.

* I cannot tell ^{you} how much these two words have encouraged me.

Why does this work?

Ampere's observation that parallel wires with current in same direction attract



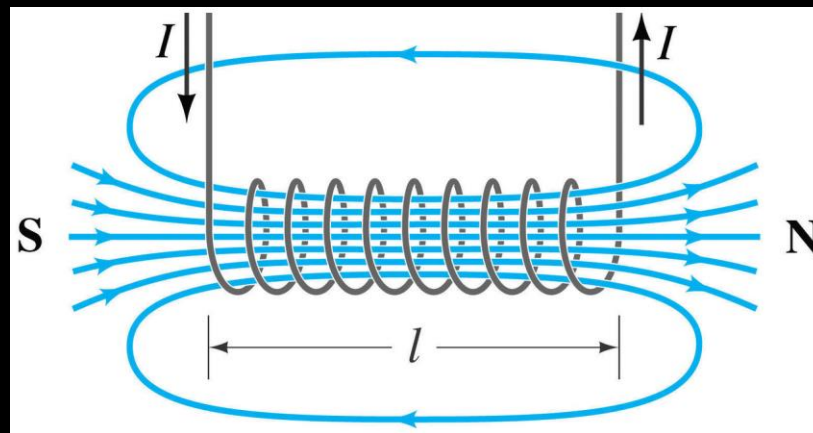
Therefore when current is flowing in an empty helix, it contracts axially



When current is pulsing, the empty helix pulses axially producing sound

What do we know about actual helix?

In an earlier letter (Thanksgiving 1874) Bell describes the first observation of this effect – the coil consisted of No. 23 (AWG) insulated wire having a resistance of 12 ohms. It was excited with a pulse frequency of 100 pulses per second



Therefore when current is flowing in an empty helix, it contracts axially

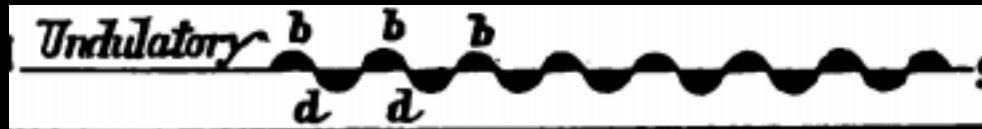


When current is pulsing, the empty helix pulses axially producing sound

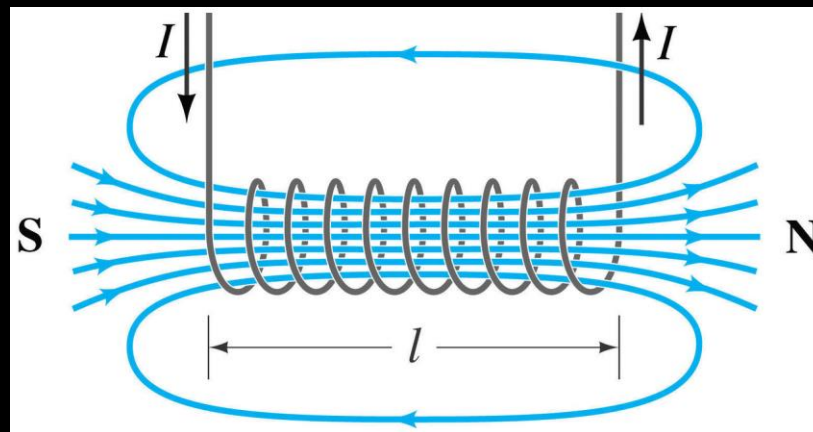
We repeated the experiment and it works well



= sound at pulsing frequency



= sound at twice the frequency



It works even better using a flat helix of 100 turns of heavier gauge wire (20 AWG) at higher frequencies (1000 Hz).

Summary

Bell and Henry meet in March 1875 – Bell is Telegraph Experimenter and Henry is Scientist and Smithsonian Director

Bell demonstrates empty coil experiments to Henry
empty coil produces sound when excited by pulsed current

We replicated Bell's experiment – it works as described

Using modern equipment experiment it is easily confirmed, but note ...
– Alternating Current (AC) in coil produces sound at twice the frequency
– pulsed Direct Current (DC) produces sound at the pulse frequency

Within 1 year, Bell has advanced his telephone well enough to patent it –
Harmonic Telegraph Patent – Feb 14, 1876

By March 10, 1876 Bell has working model using coils wrapped around iron
cores that interact with iron diaphragms

The beginnings of the microphone and loudspeaker