NATIONAL WOMEN'S HISTORY MUSEUM

Lesson Plan: **Hedy Lamarr, An Inventive Mind**

6th-8th Grade

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Description

Hedy Lamarr, long known only for her beauty and numerous Hollywood roles, was a brilliant inventor. She would shoot a scene and return to her trailer to tinker with new ideas and inventions. One of her most brilliant inventions was that of a secret communication system that could guide military weaponry using "frequency-hopping" technology. This same technology is used today as the basis for WiFi, GPS, and Bluetooth. Students will learn about Hedy's double life as an actress and an inventor, what her inventions consisted of, the basic ideas behind her most significant invention, and how female inventors—both past and present—faced a multitude of challenges.

Short Description

Time: 1 class period

Relevancy

It was seen in 2010 that only 18.8% (1 in 5) patents were held by women. While the number has jumped since 1977, when only 3.4% of patents were held by women, this rate of progress indicates that the "patent gap" won't be closed until 2092.

Objectives

Students will gain knowledge on the history of a famous female inventor, learn the difficulties surrounding female inventors and scientists in a world that didn't want to accept them.

Students will learn about women's roles and limitations in World War II.

Students will learn about the process of attaining and maintaining a patent; they will subsequently learn about the lack of representation of women inventors and women in STEM.

*Optional science component:

Students will learn that inventors must endure periods of trial and error before succeeding.

Students will grasp an understanding of how radio waves are created, transmitted, and sometimes blocked.

Prerequisites

Students should understand why World War II was fought and who was involved.

Students should understand that women played a role in World War II.

Students should understand that very few women were represented in STEM fields in the past and the lack of representation still continues to today.

*Optional science component:

Students should understand that there are a range of electromagnetic waves that carry signals.

Materials

- Worksheet (hyperlink the worksheet here)

*Optional science component:
- Radio-controlled car and its corresponding remote control (both with working batteries)
- Cotton (such as a piece of clothing made from cotton)
- Aluminum foil
- Plastic wrap
- Wax paper
- Rubber glove
- A smooth, wide open space to test drive your radio-controlled car

Procedures

1. Begin lesson by handing out worksheets.
2. Directly after, have students complete a 5-minute "Quick Write" answering the first page of the worksheet:
    - Name 5 female inventors and their inventions.
    - Was it difficult to name these female inventors? If so, why?
3. Share out responses and see how many women and inventions are mentioned. Discuss why it might be that female inventors have been undervalued or overshadowed in history.
4. Introduce students to Hedy Lamarr by playing short Google Doodle clip from YouTube: https://www.youtube.com/watch?v=VuKZqsQfroQ. If you have time, watch the Bombshell documentary in class.
    - Ask students if they had ever heard of Hedy.
    - Describe her beginnings in Austria
        - named Hedwig Eva Kiesler
        - of Jewish decent
        - married an Austrian arms dealer
        - escaped to Hollywood to star in various roles
5. Discuss Hedy's foray into inventions—
    - refer to worksheet for her list of inventions; focus specifically on her "frequency-hopping technology": Hedy and her inventing partner, George Antheil, developed a secret communication system that could guide military technology—like a torpedo—using "frequency-hopping" technology so that signal could not be intercepted and read by the enemy. Guided by radio waves, the torpedo's transmitter and receiver would jump to different radio frequencies so that its signal could not be intercepted. This same technology is used today as the basis for WiFi, GPS, and Bluetooth.
6. Divide students into groups of 3-5. Have them answer questions #1-4 and discuss within groups; allow approximately 25 minutes. Share answers amongst the class.
7. Proceed to the primary source investigation on the worksheet. Discuss the differences between a primary source and a secondary source and follow by examining the drawings on the 1942 patent. Have students take 5 minutes to write a description of what they see in the images (Question #7 on worksheet). Share responses.
8. Discuss the technology that fueled Hedy and George's wartime invention.
9. Divide into groups again and have students answer questions #8-12 and discuss within groups; allow approximately 25 minutes. Share answers amongst class.

Optional science component:

Background

Hedy Lamarr used radio waves to invent her "frequency hopping" technology. A transmitting antenna generates and sends out radio waves due to an electrical current. This is made possible through wires inside the device that allow negatively charged particles, called electrons, to flow through them, creating an electrical current. When this current flows within the wire, it generates an electromagnetic field around the wire. This electromagnetic field is emitted out of the antenna in all directions as invisible radio waves.

When the electromagnetic radio waves hit a receiving antenna, such as in a radio, it generates a current inside of a wire in the receiver. The receiver then processes the current back into the transmitted information, which, for a radio, allows you to hear music or other broadcasts. In Hedy's invention this allowed torpedoes to be guided in the proper direction and meet their final destination. Some materials can block the radio waves that the transmitter generates, which can be tested by seeing whether a receiver can process and respond to information sent by a transmitter. This is something Hedy accounted for when she worried about wartime enemies intercepting the torpedo's signal, disabling its effectiveness. As a result Hedy and George Antheil decided that the transmitted signal must jump frequencies to avoid detection by the enemy.

Preparation

- Check the radio-controlled car and its remote control to ensure that they both have effective batteries. Check that the car runs well on the open space that you will be using.
- Make sure you have enough of each material you want to test (the cotton, aluminum foil, plastic wrap, wax paper, and rubber glove) to completely cover the car remote control. Every covering should be loose enough so you can still operate the remote control buttons through it.

Procedure

- Wrap the remote control in cotton. Make sure that the remote control is completely and securely covered so that there are not any openings or holes in the covering, and that it is covered loose enough so that you can still operate the controls.
- Try to operate the radio-controlled car using the cotton-covered remote control. *Does it work? Does the car move at all?*
- Remove the tested material from the remote control. Test to make sure that the car still works when it is not covered with any material.
- Repeat this process using each different material separately. *For which materials does the car still operate, and for which materials does the car not operate? Why do you think this is?*

Observations and results

After results are recorded, discuss findings and present the following explanation:

When you operate the car using its remote control, the remote control transmits radio waves at specific frequencies that can be received by the car. The remote control acts as a transmitter and the car as a receiver. Then, when the car receives the radio waves, which are electromagnetic

waves, the waves generate a current in a wire in the car, and this tells the car which direction to move in.

Depending on a material's thickness and composition, it might block—or interfere with—radio waves. Thin amounts of plastic wrap, wax paper, cotton and rubber are not likely to interfere with radio waves. However, aluminum foil, and other electrically conductive metals such as copper, can reflect and absorb the radio waves and consequently interferes with their transmission. Placing the transmitter or receiver in a fully enclosed container made of highly conductive metal, such as was done in this activity, is the most efficient way to interfere with radio waves.

For tagging purposes

• Grade Level: 6th – 8th Grade

• Topics (choose from list below, as many as you want) we can add more topics

o Arts and Culture

o Film and Theatre

o STEM

o World War II

Standard

CCSS.ELA-LITERACY.RH.6-8.1
Cite specific textual evidence to support analysis of primary and secondary sources.

CCSS.ELA-LITERACY.RH.6-8.2
Determine the central ideas or information of a primary or secondary source; provide an accurate summary of the source distinct from prior knowledge or opinions.

CCSS.ELA-LITERACY.RH.6-8.7
Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.

*Optional science component:

CCSS.ELA-LITERACY.RST.6-8.3
Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Hedy Lamarr, An Inventive Mind

Name: _____

Date: _____

Quick Write!

Name 5 female inventors and their inventions:

1. _____

   _____

2. _____

   _____

3. _____

   _____

4. _____

   _____

5. _____

   _____

Was it difficult to name these female inventors? If so, why?

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"The biggest people with the biggest ideas can be shot down by the smallest people with the smallest minds. Think big anyway." -Hedy Lamarr

Hedy's inventions:

- new design for plane wings (to increase speed) based on analysis of the fastest bird and fastest fish
  "[I] showed it to Howard Hughes (pilot and businessman) *and he said, 'You're a genius.'"*
- "secret communication system" for radio-guided torpedoes using "frequency-hopping" technology
- "bouillon" cubes to transform water into a Coke
- "skin-tautening technique based on the principles of the accordion"
- better Kleenex box
- new traffic signal

1. What obstacles do you think have prevented female inventors and scientists from receiving recognition in the past? What about inventors and scientists that were also women of color?

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2. Do you see any of these obstacles still in place today? If so, how can we confront these obstacles?

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3. What kind of roles did women fill in WWII? Did the war give women new responsibilities?

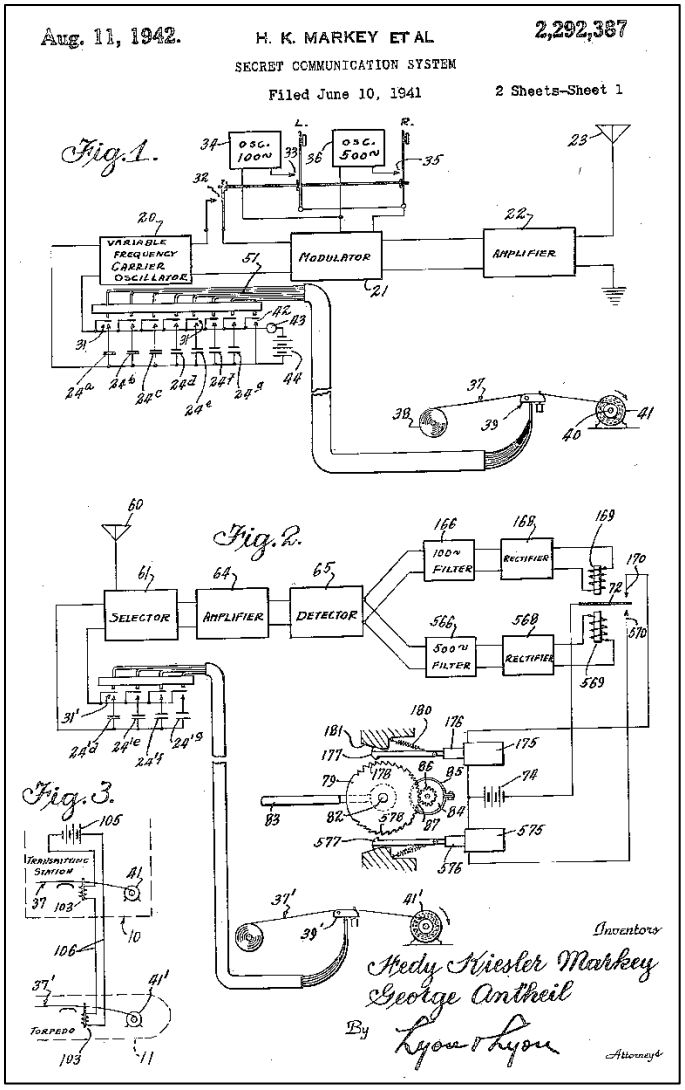
4. Why were Hedy Lamarr and George Antheil inspired to invent in a time of war?

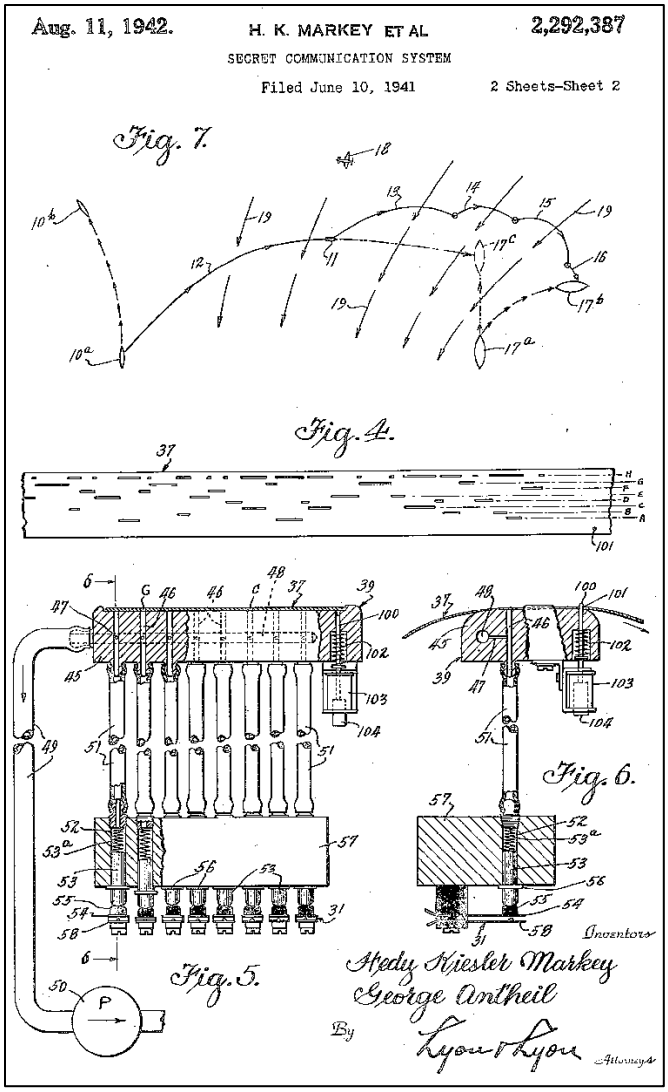
Primary Source Investigation

5. Define primary source.

6. Define secondary source.

Attached are two images of Hedy Lamarr's and George Antheil's 1942 patent.


Aug. 11, 1942.
H. K. MARKEY ET AL
2,292,387
SECRET COMMUNICATION SYSTEM
Filed June 10, 1941
2 Sheets-Sheet 1
Fig. 1.
OSC. 100N
OSC. 500N
VARIABLE FREQUENCY CARRIER OSCILLATOR
MODULATOR
AMPLIFIER
Fig. 2.
SELECTOR
AMPLIFIER
DETECTOR
100N FILTER
500N FILTER
RECTIFIER
RECTIFIER
Fig. 3.
TRANSMITTING STATION
TORPEDO
Inventors
Hedy Kiesler Markey
George Antheil
By Lyon & Lyon
Attorneys



7. Describe what you see in the images.

HEDY LAMARR INVENTOR

Actress Devises 'Red-Hot' Apparatus for Use in Defense

Special to THE NEW YORK TIMES.

HOLLYWOOD, Calif., Sept. 30—Hedy Lamarr, screen actress, was revealed today in a new role, that of an inventor. So vital is her discovery to national defense that government officials will not allow publication of its details.

Colonel L. B. Lent, chief engineer of the National Inventors Council, classed Miss Lamarr's invention as in the "red hot" category. The only inkling of what it might be was the announcement that it was related to remote control of apparatus employed in warfare.

8. Describe Hedy and George's invention. What was its purpose? What kind of technology did it utilize to ensure that signals wouldn't get intercepted?

Source: *New York Times (1923-Current file);* Oct 1, 1941;
ProQuest Historical Newspapers: The New York Times

9. In 2010, 18.8% of patent-holders were women, compared to 3.4% in 1977. What does it mean to have a patented invention? Why do you think there are less women than men that hold patents?

10. While being boxed in by the title of "Most Beautiful Woman in the World," what other challenges did Hedy face in the process of patenting and implementing her invention?

11. Do you think the patent would've been approved without George Antheil's name next to Hedy's?

12. Do you have any ideas for inventions? If so, what are they?

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"The brains of people are more interesting than the looks I think" -Hedy Lamarr

Remote Control Car Experiment

Write your observations as each material is wrapped about the remote control.
Why do you think the material does/ does not block the radio waves?

Cotton:

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Aluminum foil:

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Plastic wrap:

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Wax paper:

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Rubber glove:

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How did Hedy Lamarr prevent interference to the radio wave system she was working with? What was her technology called?

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Vocabulary

- Patent: a writing securing for a term of years the right to exclude others from making, using, or selling an invention
- Communications system: a system for transmitting or exchanging information

- Electromagnetic spectrum: the entire range of electromagnetic radiation (from gamma rays to the longest radio waves to visible light); measured in frequency and wavelength
- Transmitter: generates and sends out the signal
- Receiver: detects and receives the signal
- Radio waves: a type of electromagnetic wave; electromagnetic waves are made when a magnetic field and an electric field come together to make a wave – it isn't a wave that can be seen but provides us with sound, energy, colors, x-rays, etc.
- Frequency: the number of times per second that the wave cycles; measured in Hertz or cycles per second
- Wavelength: the distance the wave travels from one peak to the next peak; from one peak to the next peak is a cycle
- Frequency-hopping: sending a signal over a random series of radio frequencies, switching from frequency to frequency at split-second intervals
- Intercept: to stop, seize, or interrupt in progress or course or before arrival
- WiFi: a wireless method of sending information using radio waves