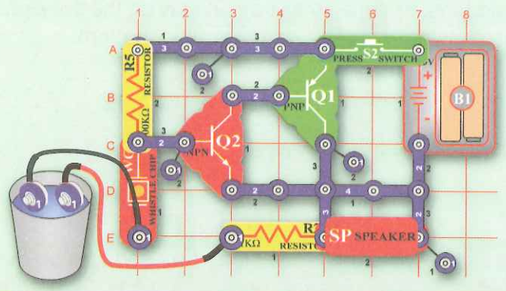
6-4 Oscillator Circuits

Experiments

Consider this circuit (which is project 197):



If the two loose jumpers are placed into a cup of water, an alarm sounds. You could put this circuit in your basement and use it to alarm you if the basement floods during a storm. If you slowly add salt to the water, you will hear the pitch slowly increase.

Oscillators are used in nearly all forms of radio communications, and are among the most important circuits in electronics. They can also be the most difficult circuits to design, due to the feedback involved. Selection of component values is very important for oscillation to occur. For example, the above circuit would not work if the 0.02μF capacitor were replaced with the 100μF. Also, many snap circuit oscillator circuits do not work at all settings of the adjustable resistor.

Capacitors are important in a oscillator and filtering circuit because of their ability to store electric charge. This allows their values to be selected so they **pass some frequencies while blocking other frequencies**. For example, **a capacitor has lower resistance at higher frequencies, but higher resistance at lower frequencies**.

The resistance of a capacitor may be calculated from the frequency and capacitor value:

$$R_{capacitor} = \frac{1}{6.28 \times Frequency \times Capacitance}$$

For example, a 10μF capacitor will have a resistance of 1592Ω at 10Hz, but only a resistance of 15.92Ω at 1000Hz.

Experiments

Modify the circuit by replacing the press switch with the slide switch. You need one more part, and you are going to draw it. Take a pencil (No. 2 lead is best), SHARPEN IT, and fill in a shape like this:

Place a hard, flat surface beneath the paper you draw on. Press HARD and fill in the shape several times to get a thick, even layer of pencil lead. Turn on the switch and press the loose ends of the jumpers to the drawing, move them around over it. The tone of the sound will have a higher pitch if the ends are farther apart in the shape. If you don't hear any sound, add another layer of lead or put a drop of water on the jumper ends to get better contact.

You can draw your own shapes and see what kinds of sounds you can make. Wash your hands when finished.

Actually, pencils aren't made out of lead anymore (although they are still called "lead pencils"). The "lead" in pencils is really a form of carbon, the same material that resistors are made of. So the drawings you just made should act just like the resistors in snap circuits.

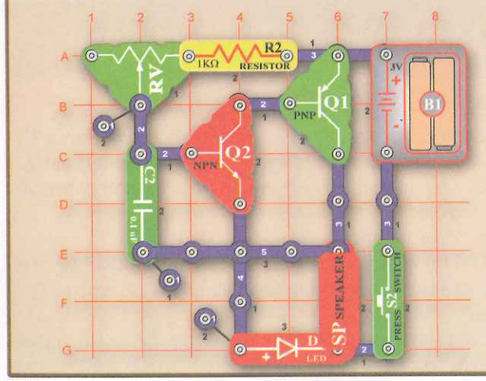
Morse Code: The forerunner of today's telephone system was the telegraph, which was widely used in the latter half of the 19th century. It only had two states - on or off (that is, transmitting or not transmitting), and could not send the range of frequencies contained in human voices or music. A code was developed to send information over long distances using this system and a sequence of dots and dashes (short or long transmit bursts). It was named Morse Code after its inventor. It was also used extensively in the early days of radio communications, though it isn't in wide use today. It is sometimes referred to in Hollywood movies, especially Westerns.

MORSE CODE

A	._	N	_.	Period	._._._
B	_...	O	___	Comma	__..__
C	_._.	P	.__.	Question	..__..
D	_..	Q	__._	1	.____
E	.	R	._.	2	..___
F	.._.	S	...	3	...__
G	__.	T	_	4	...._
H	....	U	.._	5	.....
I	..	V	..._	6	_....
J	.___	W	.__	7	__...
K	_._	X	_.._	8	___..
L	._..	Y	_.__	9	____.
M	__	Z	__..	0	_____

Experiments

Consider this oscillator circuit (which is project 228):

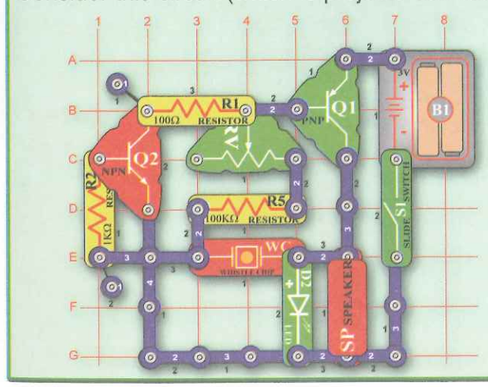


Press the switch in long and short bursts to make a sound pattern representing the dots and dashes shown in the table above. You can use Morse Code and this circuit to send secret messages to friends in hearing distance without others knowing what you're saying.

Replace the speaker with the 100Ω resistor to send Morse Code messages using flashes of light instead. During World War II Navy ships sometimes communicated by flashing Morse Code messages between ships using searchlights (because radio transmissions might reveal their presence or position to the enemy).

Experiments

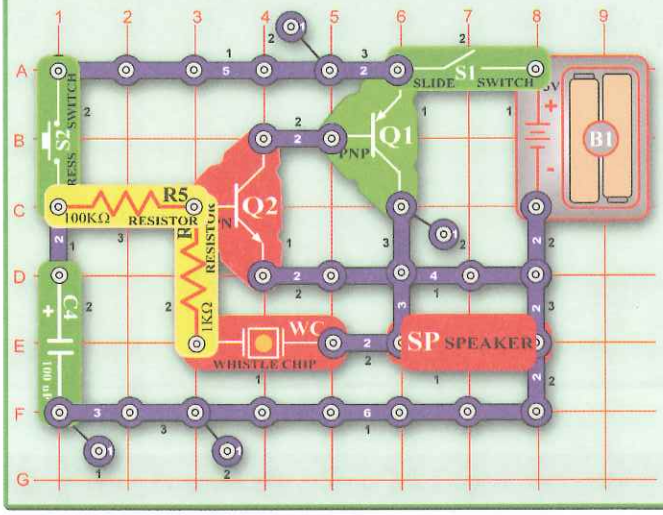
Consider this circuit (which is projects 185-189):



This is another adjustable oscillator circuit, which also includes an LED. Although the LED appears to be on, it is flashing at a very fast rate. The 0.02μF or 0.1μF capacitors can be placed on top of the whistle chip to lower the frequency. The 10μF may also be placed there, but then the frequency is so low that the LED is flashing and the series of clicks is heard. The speaker may be replaced by the 2.5V lamp.

Experiments

Consider this circuit (which is project 294):



This circuit is an oscillator controlled by a discharging capacitor. Turn on the slide switch and press the press switch. The sound is loud but slowly goes away.

Other snap circuits projects related to transistor oscillators: 110, 111, 112, 123, 134, 135, 136, 137, 138, 180, 181, 182, 183, 184, 190, 191, 192, 206, 207, 208, 209, 210, 211, 212, 230, 231, 232, 265, 266, 267, 284, and 285.

Summary

Summary of Chapter 6:

1. A speaker uses a changing electrical signal to make variations in air pressure.
2. All sounds are variations in air pressure that your ears feel.
3. Oscillators use feedback to set and control the frequency.
4. Frequency measures how fast something occurs, and is expressed in Hertz.
5. Audio refers to the range of frequencies that can be heard by human ears.
6. The whistle chip acts like a capacitor but can also make sound like a speaker does.
7. Capacitors have higher resistance at lower frequencies but lower resistance at higher frequencies.

Quiz

Chapter 6 Practice Problems

1. Which of the following has the highest frequency?
   A. A stoplight repeating its green-yellow-red cycle.
   B. The minutes hand on a clock passing twelve o'clock.
   C. Your birthday.
   D. The wipers sweeping across the windshield of a car while driving in the rain.

2. If you wanted to pass some frequencies of a signal while blocking other frequencies, which part would you need to use?
   A. Capacitor
   B. Resistor
   C. Lamp
   D. Switch

3. To lower the frequency in an oscillator circuit, you could . . .
   A. increase the circuit resistance.
   B. decrease the circuit capacitance.
   C. add more batteries.
   D. Both A and B.

4. Which of these parts has the lowest resistance at low frequencies?
   A. Whistle Chip
   B. Speaker
   C. 1KΩ Resistor
   D. 10μF Capacitor

Answers: 1. D, 2. A, 3. A, 4. B