Gakken

Gakken **EX-150**

150-In-One Block Type Electronic Experiment

OWNER'S MANUAL

Please read before using this equipment

* * * Please be sure to read the following before beginning the experiment. * * *

Note 1 The electronic parts such as transistors and diodes are fragile. Use caution when handling these. Over-current will cause breakages. The following precautions should be taken to avoid over-current.

1. Be sure to place the blocks as the circuit diagrams shows. Be sure to turn off the switch before taking out a block or changing blocks. (Also, be sure to turn off the switch when moving on the next experiment.)
2. Do not pull out or put in resistor blocks more than is necessary.

<When experiments don't go well, check first that transistors and diodes are broken or not. "No.138:Diode Tester" and "No.139:Transistor Tester" are useful for the check.>

Note 2 Please note that there may be some difference between the wiring diagrams on the blocks and the circuit diagrams at the upper right of each page because the electronic parts such as resistors and condensers may be used as lead blocks.

Note 3 Be sure to check the wiring diagrams on the blocks when arranging them. If a wrong block is used or a block is placed wrongly, the circuit doesn't work. Check them well.

Note 4 Be careful of bad contacts of the blocks. If the blocks don't fit in completely, the electrical contact becomes bad. Also, there may be the case when something like white powder is on the metallic parts of the blocks. In such a case, wipe it off with cloth because it may cause bad contacts.

Note 5 Loud sound may be produced in some experiments. Turn the switch on and check the volume before putting the earphone to the ear.

Note 6 Adjust the length of the earphone cord by untwisting the end. Split the microphone cord to adjust the length.

Note 7 In some experiments, tuning the radio is necessary. And there may be the case that the radio is already tuned when the switch is turned on without doing any process written in the instructions.

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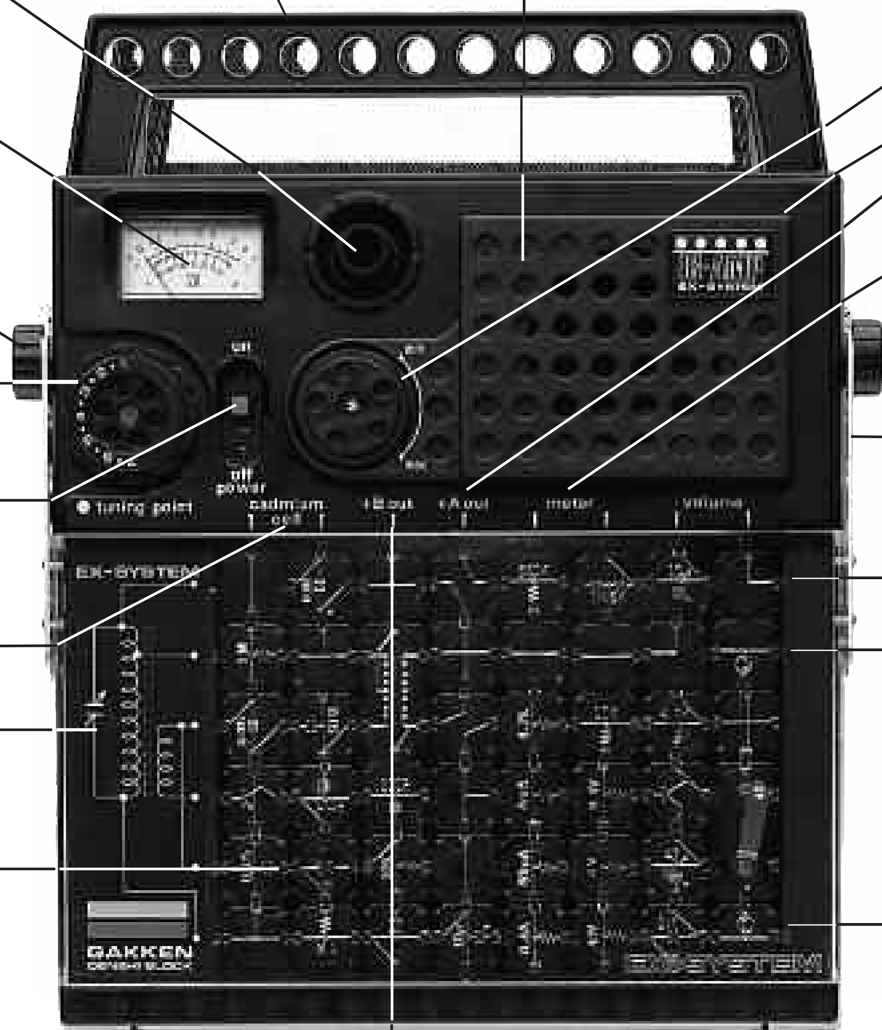
Parts Identification



IC Amplifier
12-transistor and 6-diode IC amplifier

Handle

CdS Cell
A component that responds to change in the intensity of light.

Meter

Side Knob

Dial
A tuning dial knob to be used when a radio or wireless microphone is set up.

POWER ON/OFF Switch
An intermediate switch between batteries and blocks. Be sure to turn it off when you have finished experimenting.

Cadmium Cell Connection Point

Antenna Circuit
An antenna circuit as illustrated is built in each set.

Block Spaces

Volume Control Knob
Used for IC amplifier and also as a variable resistor.

Casing

+A OUT
Connection to + terminal of 6V batteries.

Meter Connection Point

Side Knob

Side Arm

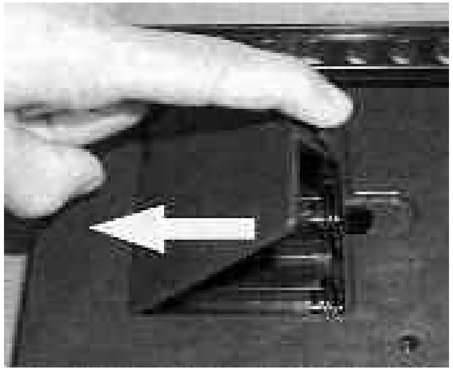
IN PUT
Connection to volume control

+A OUT
Connection to + terminal of 6V batteries.

- OUT
Connection to-terminal of 6V batteries.

+ B OUT

How to Install and use the Batteries



1.Remove the cover from the battery compartment on the back, slide it in the arrow direction.

2.Install the batteries in place following the polarity indications. 4 size AA (R6) batteries are required.
3.Replace the battery compartment cover.

WARNING:
Be sure to load the battery with correct polarity.Wrong polarity installation may cause damage to the IC amplifier.

If you do not use this laboratory kit for an extended time, be sure to remove the batteries.

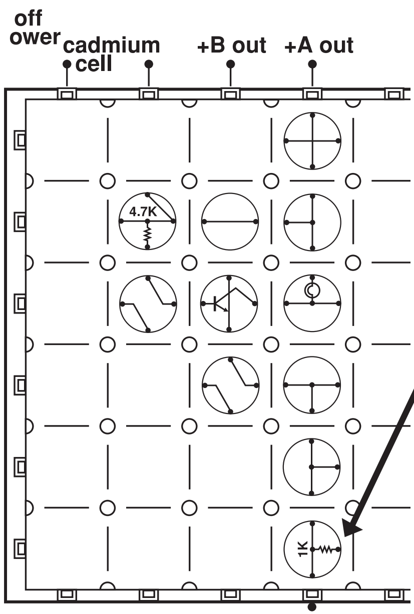
Never try to use the power from the AC outlet to this kit.This is extremely dangerous and will cause electric shock.

Do not plug the test lead paddles into the power outlet.

Electronic Symbols and Functions

Various wiring and electronic parts marks are hot-stamped on the electronic blocks wiring. In order to minimize the number of blocks required for each experiment, a block may be used only as a lead in some cases. (That is, the connecting lead of the block is used, but not the electronic part in it.)

(Example) No. 4 Transistors and Vacuum Tubes



A block will also work here, but a block having a resistor is used as a lead for the above-mentioned reason. Look at both the block and the circuit diagram to see why the substitution is possible.

⋆ WARNING

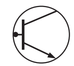
Never connect this kit to the AC outlets. Use four 1.5 Volt batteries only.

Before conducting the circuit for continuity tests, ensure that electrical devices are completely disconnected from the AC outlets.

It is legally necessaly to obtain a Licence to transmit radio signals in most Countries.

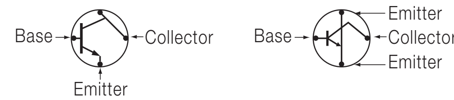
●Transistor

Electronic Symbol



Silicon transitor

Symbol used for "Electronic Blocks"



This series uses silicone transistors as shown above.

Amplification

When a signal is fed to the base, a lager signal can be taken out from the collector.

Biasing Resistor

Biasing resistor provides an operaring point when the transistor is used to amplify. The biasing resistor is connected between the base of the transistor and the power supply.

Load Resistance

When a resistor or transformer is connected to the base of the transistor,the signal current flowing through the collector can be taken out as a signal voltage to operate an earphone or loudspeaker, also works to send out a signal to be magnified by the next transistor.

●Resister

Electronic Symbol

Symbol used for "Electronic Blocks"

The resistor determines the quantity of the direct current delivered from the batteries.

The battery voltage has the follwing relationship with resistance current :

$$\text{Current (mA)} = \frac{\text{Voltage (V)}}{\text{Resistance (K}\Omega\text{)}}$$

$$\text{When battery voltage is 6V } \frac{6V}{10K\Omega} = 0.6mA \text{ at } 10K\Omega$$

$$\frac{6V}{4.7K\Omega} = \text{Approx. } 1.3mA \text{ at } 4.7K\Omega$$

●Capacitor

Electronic Symbol

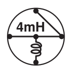
Symbol used for "Electronic Blocks"

The capacitor performs many functions. It passes a signal (alternating) current only, while shutting off a direct current. It sends as signal current in or out with out disturbing the direct current following to the base and collector resistors.
The capacitor also works to deliver a suitable magnitude of signal to the transistor and to separate the flow of low-frequency signal from that of high - frequency signal.
Examples of the numbers given on the electronic blocks are 100PF(picofarad), 0.05μ F (microfarad) ,and 10μ F. Farad is the unit of the Capacitance of a capacitor.
100PF (picofarad) = 0.0001 microfarads

●coil

Electronic Symbol

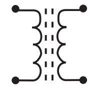
Symbol used for "Electronic Blocks"



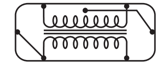
The coil allows a direct current to flow freely through it, but not a signal (alternating) current. The coil has propeties opposite to those of the capacitor in this respect. In the case of the same coil, the higher the frequency of a signal current, the more difficult it is for the signal to be passed through. In the case of a signal current of the same frequency, the higher the quality factor of the coil, the more difficult it is for the signal to pass through the coil.
Henry (H) is the unit of the quality of coils. 1/1000 of H is millihenry (mH)
The coils used in this Electronic Blocks are about 4mH.

●Transformer

Electronic Symbol



Symbol used for "Electronic Blocks"

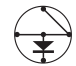


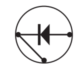
A transformer is made up of a pair of coils coupled to each other. There are the primaly and secondary coils. The transformer has the property of passing a signal (alternating) current from the primaly to the secondary coil, changing the voltage in proportion to the ratio of the secondary to the primaly turns. This being so, it is possible to change the voltage to a desired value by changing the turns in the primary and secondary windings of the transformer. This outstanding characteristic of the transformer is not found in the resistor, capacitor and coil.

●Doiode

Electronic Symbol

Symbol used for "Electronic Blocks"





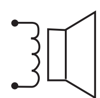
The diode is used for rectification and deteclion. It allows a current to flow only in the direction of the arrow, as shown above.

●Battery

Electronic Symbol

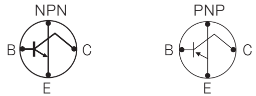
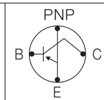
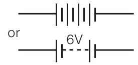
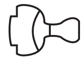
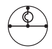
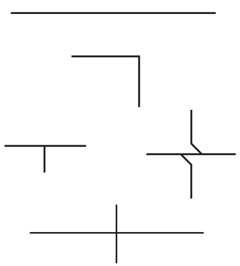
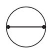
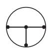
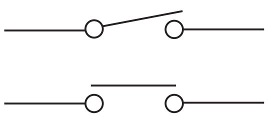
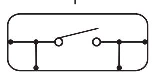
Transistors, transformers, and other electronic components will not work if they are not fed electricity. The battery is the source of energy that is needed to put all the electronic components into action.

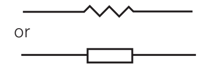
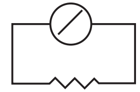
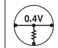
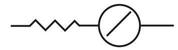
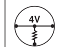
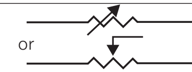
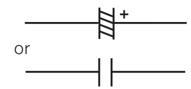
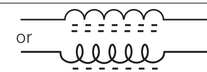
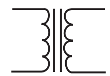
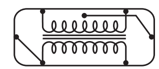
●Loudspeaker



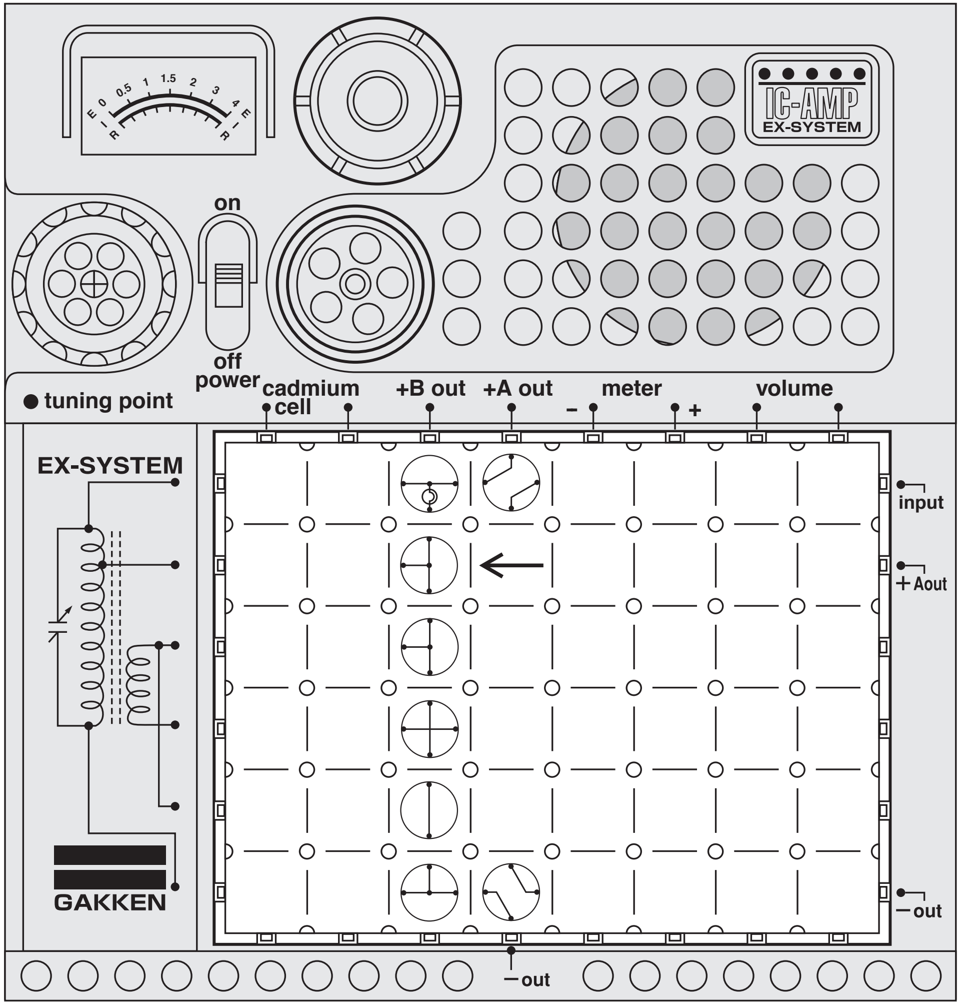
Electronic Symbol

The loudspeaker is constructed so that a sound will come out of it when an eleclric current flows in its coil.

Name	Symbols and Functions	
Transistor		 There are no PNP types in the kit
Battery		+A OUT & -OUT
Loudspeaker		Built in with the IC amplifier.
Earphone		
Bulb	Indicating Illuminating 	
Meter		Meter
Connecting wires and joins		 Staight wire  Bent Wire   Two wires joined  Two wires cross but do not join
Switches	 Both symbols stand for switch. The upper one is used in this kit.	On/off power 

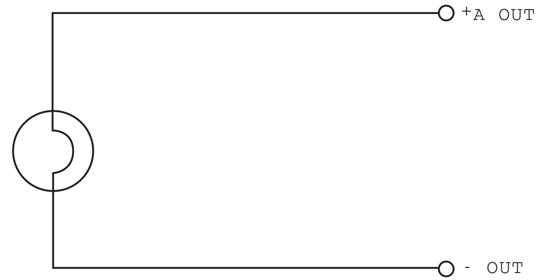
Name	Symbols and Functions	
Resistor		
Shunt		 A resistor which is placed in parallel with the meter so that it can be used to measure voltage.
Multiplier		 A resistor which is placed in series with the meter so that it can be used to measure voltage.
Variable resistor		Volume control
Light dependant resistor (LDR)		Cadmium cell
capacitor		
Electrolytic capacitor		
Variable capacitor		Tuning point
Coil (choke)		
Transformer		
Antenna		The kit contains an internal antenna. You can use the yellow wire as the external antenna.
Diode		

No.1 Electronic Circuit and Current



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

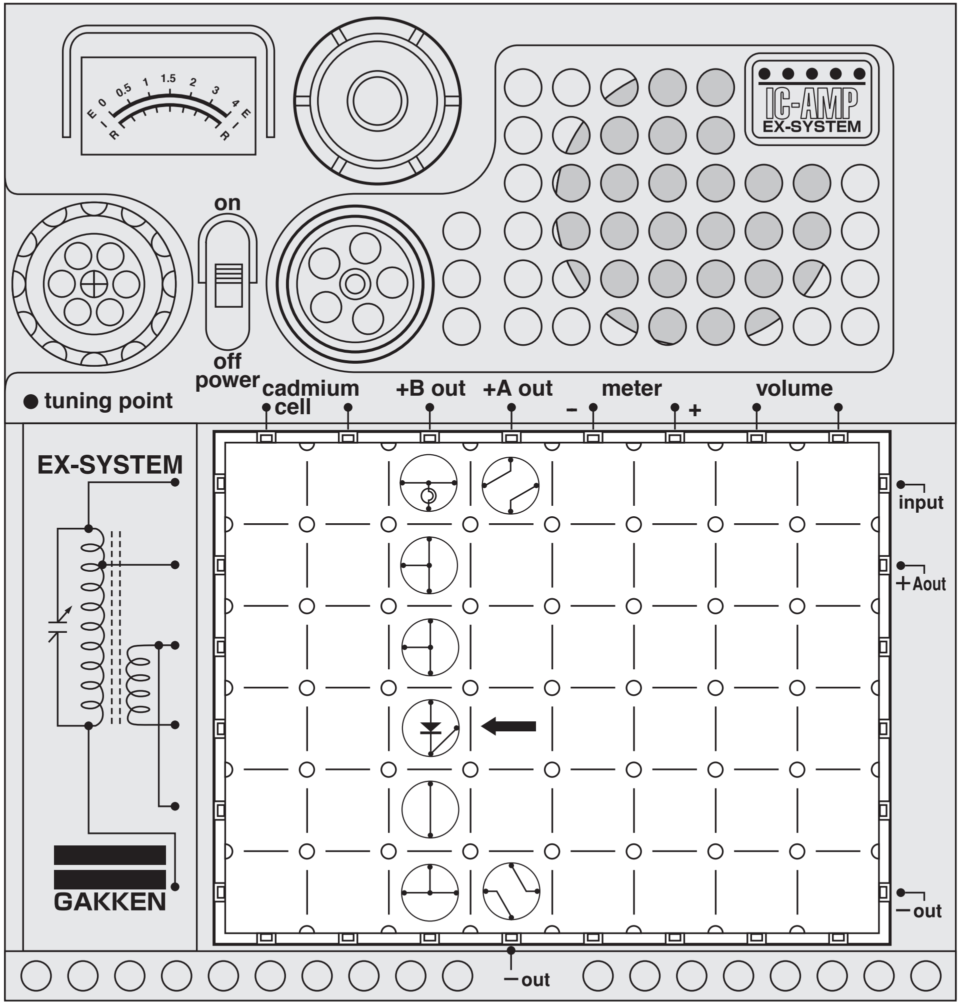
Circuit diagram for this experiment:



Arrange the blocks as illustrated at left,turn on the main switch, and the lamp will glow.
Now, remove the highest block ⊕ and the light will go off. From this experiment, you have learned that there was something flowing to the lamp to light it when block ⊕ was in place, and when it was pulled out, the flow stopped and the light went off. The "something" is an electrical current, and the path of the current is called the "electrical circuit". A battery has positive ⊕ and negative ⊖ terminals, and there is a voltage across them. This voltage causes an electrical current to flow through the circuit.

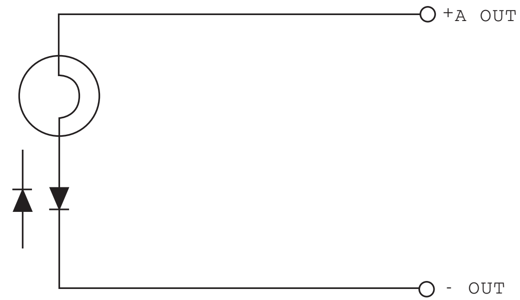
```
Note: Be sure to turn off the switch before
 out a block or changing blocks.
If the switch is on, over-current flows and
it breaks electronic parts (such as transis
 diodes).   (Be sure to turn off the switch
 when moving on the next experiment.)
```

No.2 Direction of Current and Rectification (1)



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

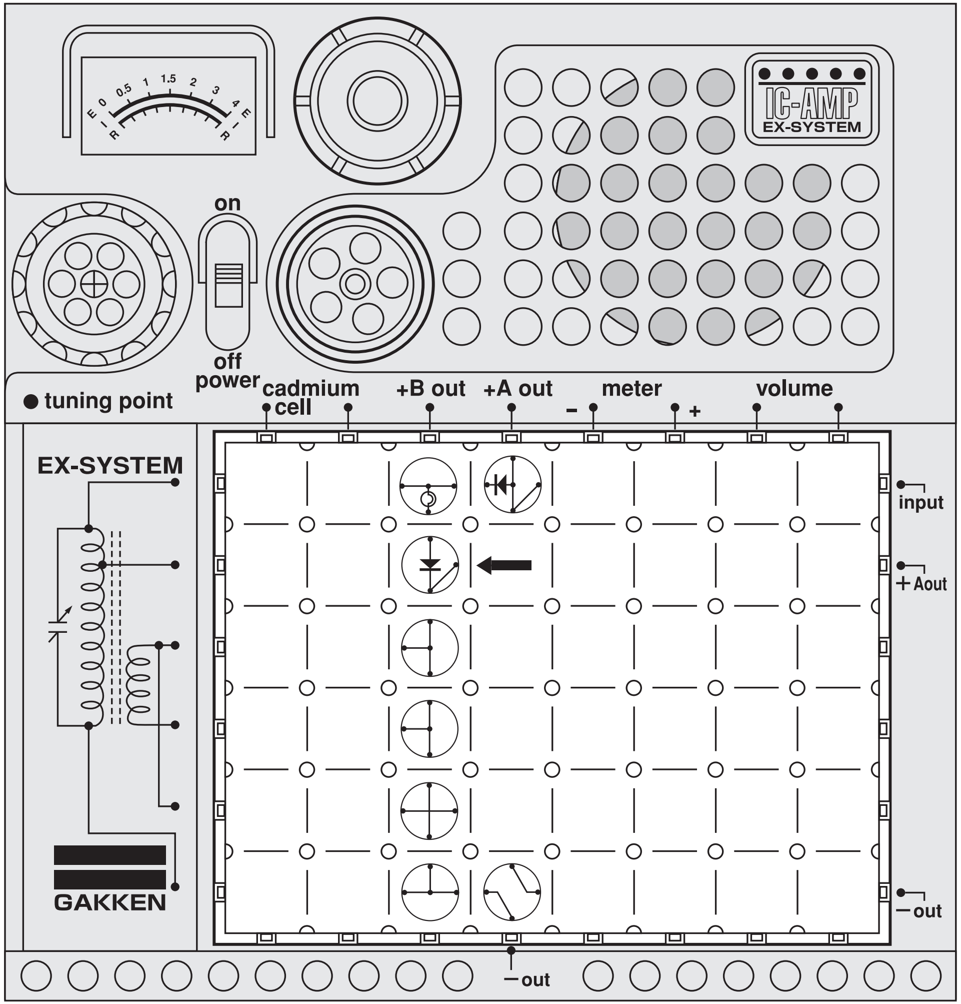


Arrange the blocks as illustrated at left, trun on the main switch, and the lamp will glow. Turn the block to . See if the light goes on. This time, it does not. Block contains a diode, which allows the passage of an electrical current in only one direction. Let's go over what we have just learned.

The diode allows the current to flow from the ⊕terminal of the battery to the ⊖through, but it does not allow it to flow from the ⊕terminal to the ⊖terminal through. This is an important principle for the following experiments. Repeat this experiment and study the circuit diagram drawn for you above until you fully understand the function of the diode. Go on to the next experiment. Or, Turn off the power switch and remove the batteries from the kit before storing.

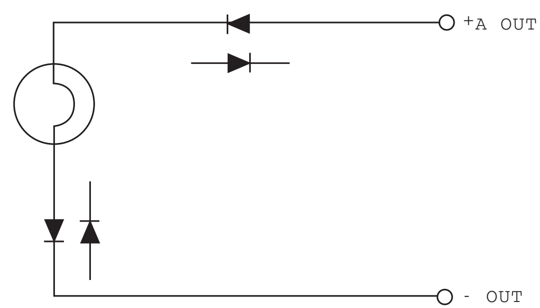
Note: Transistors and diodes are easily broken by over-current. Look at the circuit diagrams well to check if the placement is correct before turning on the switch.

No. 3 Direction of Current and Rectification (2)



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

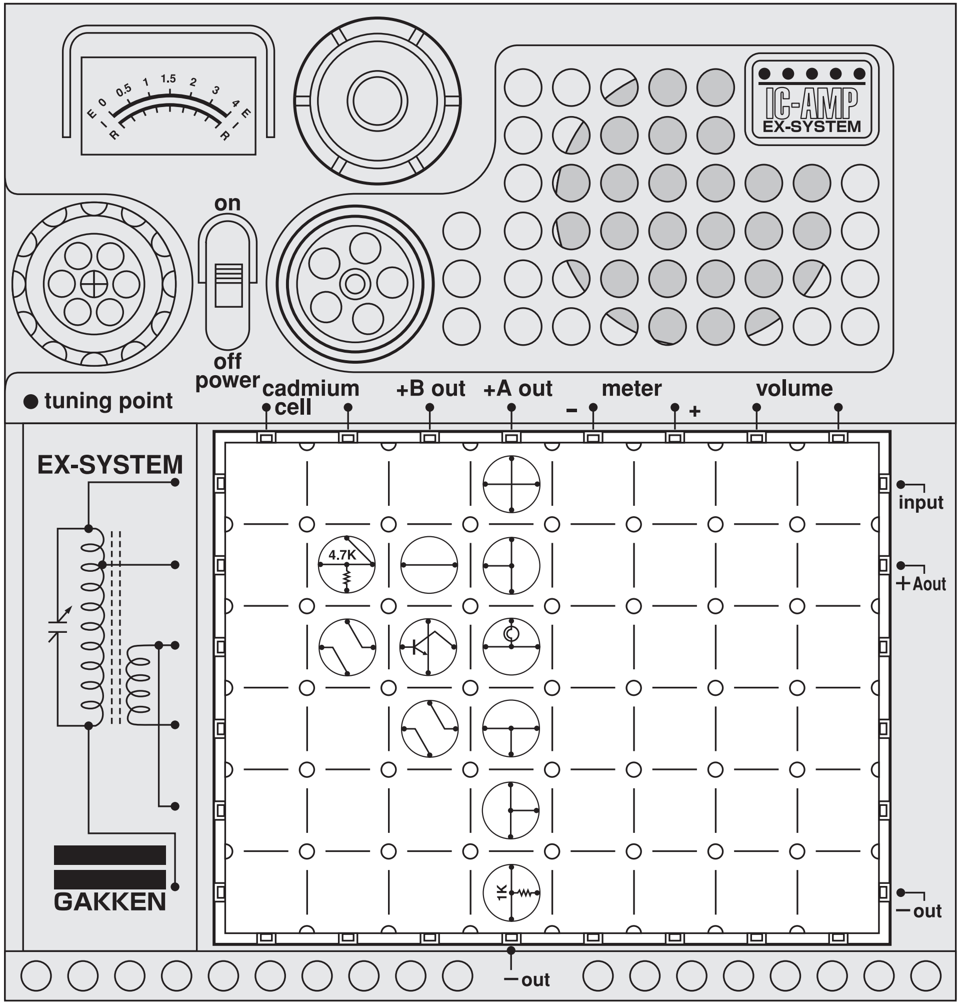
Circuit diagram for this experiment:



Now let's do another interesting experiment. First, arrange the blocks as illustrated at left. Turn on the main switch, and the miniature lamp will glow dimly. Interchange the block with . This time the bulb will not glow. Next, trun to The lamp still fails to light with this arrangement of blocks. Now you should understand the propeties of diodes even better. If the circuit has any block whose arrow is not in the direction of the current flow, the lamp will not go on ; that is, no current is flowing through the circuit.

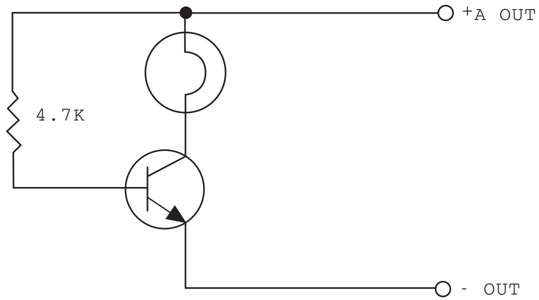
```
Note: Be sure to turn off the switch before
 out a block or changing blocks.
If the switch is on, over-current flows and
it breaks electronic parts (such as transis
 diodes).   (Be sure to turn off the switch
 when moving on the next experiment.)
```

No. 4 Transistors and Vacuum Tubes



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:



Now let's learn about transistors. Invented at the Bell Telephone Laboratories of the United States in 1948, transistors almost completely replaced vacuum tubes in all electronic equipment in just a little over a decade because transistors have a far better performance than vacuum tubes.

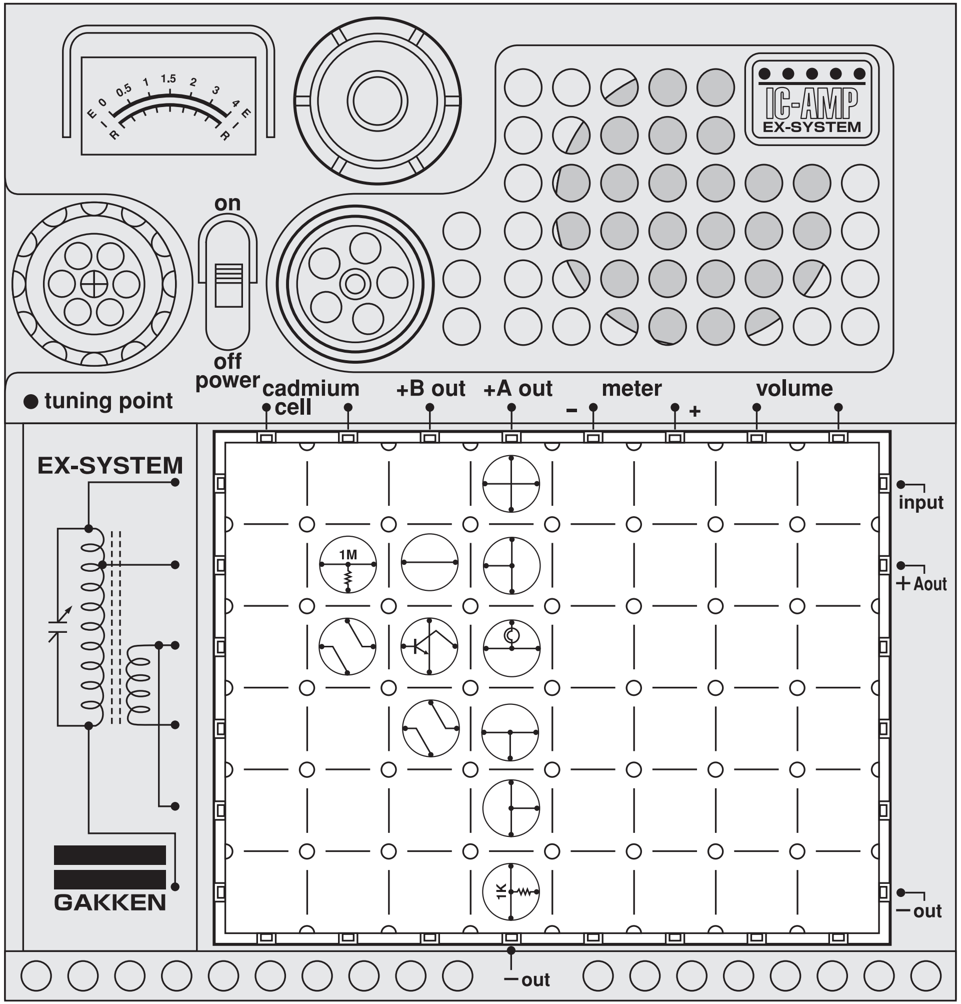
Arrange the blocks as illustrated at left and turn On the power switch. Referring to the circuit diagram above, you can see that a current

$\frac{6(V)}{4.7(K\Omega)}$ = approx. 1.3mA flows to the base and

a current of approx. 40 mA flows from the battery's ⊕ terminal through the miniature bulb, collector., and emitter to the battery's ⊖ terminal, so that the lamp may glow.

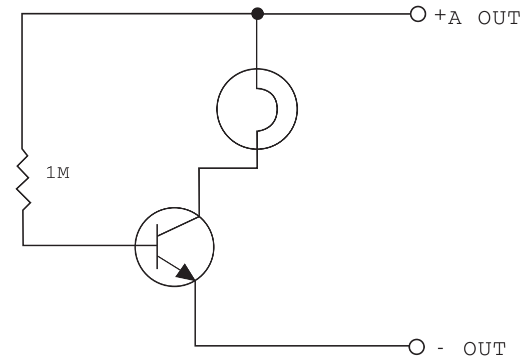
Note: Be sure to turn off the switch befor
out a block or changing blocks.
If the switch is on, over-current flows an
it breaks electronic parts (such as transi
diodes). (Be sure to turn off the switc
when moving on the next experiment.)

No. 5 Characteristics of Transistors

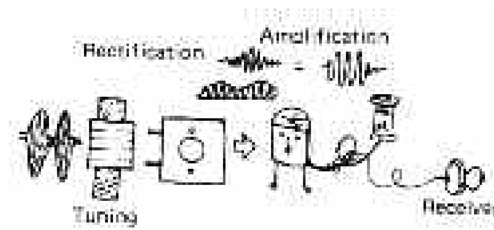


Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:



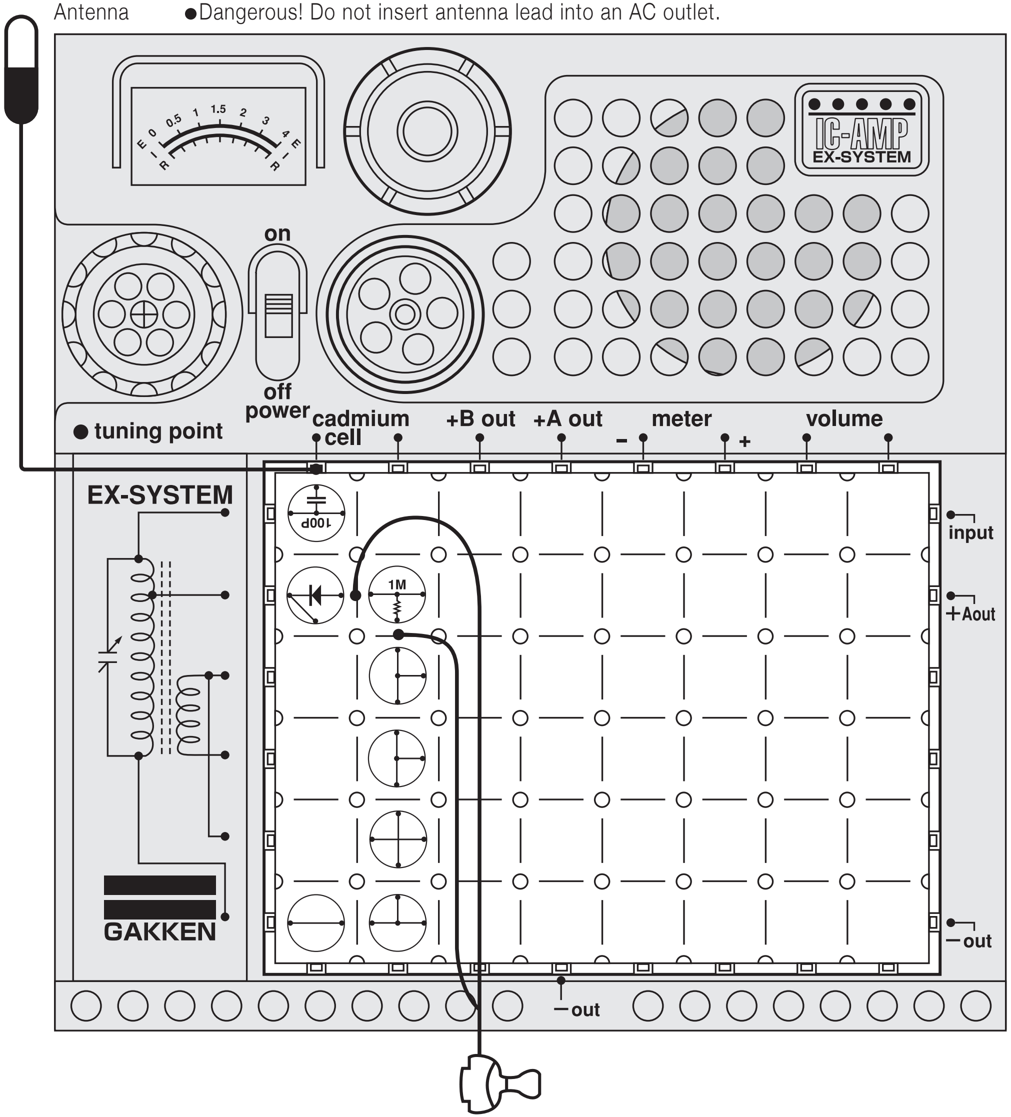
Arrange the blocks as illustrated at left. Comparing the circuit diagram above with the one for Experiment No. 4, you will find that the 4.7KΩ resistor has been changed to a 1MΩ resistor. Turn on the main switch. The lamp will not glow. This is because the change of resistance from 4.7KΩ to 1MΩ has substantially reduced the amount of electrical current flowing to the lamp. The amount of current flowing between the collector and emitter can be changed by changing the base resistance.



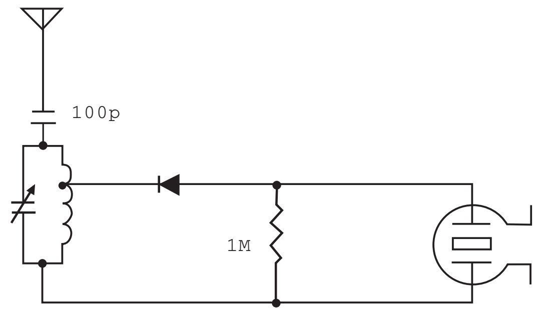
Note: Be sure to turn off the switch before out a block or changing blocks.
If the switch is on, over-current flows and it breaks electronic parts (such as transist diodes). (Be sure to turn off the switch when moving on the next experiment.)

NO.6 Diode Detector Radio

Antenna ●Dangerous! Do not insert antenna lead into an AC outlet.



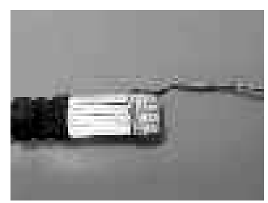
Circuit diagram for this experiment:



The germanium rectifier radio is the simplest radio receiver. The crystal set that was used widely in the early days of radio employed crystal detectors (crystalline mineral substances such as gelena and iron pyrites) . Now we use the germanium doide.

Arrange the blocks as illustrated at left and attach the earphone. It is also necessary to set up large antenna because a battery and transistor are not used. A5-meter vinyl-coated yellow cord is provided for the antenna. This length of antenna may not be enough to have good reception in a place where the incoming radio waves are weak. Attach an enameled cord end of the antenna cord in this case after shaving off enamel from end of enameled one.(See the picture below.)

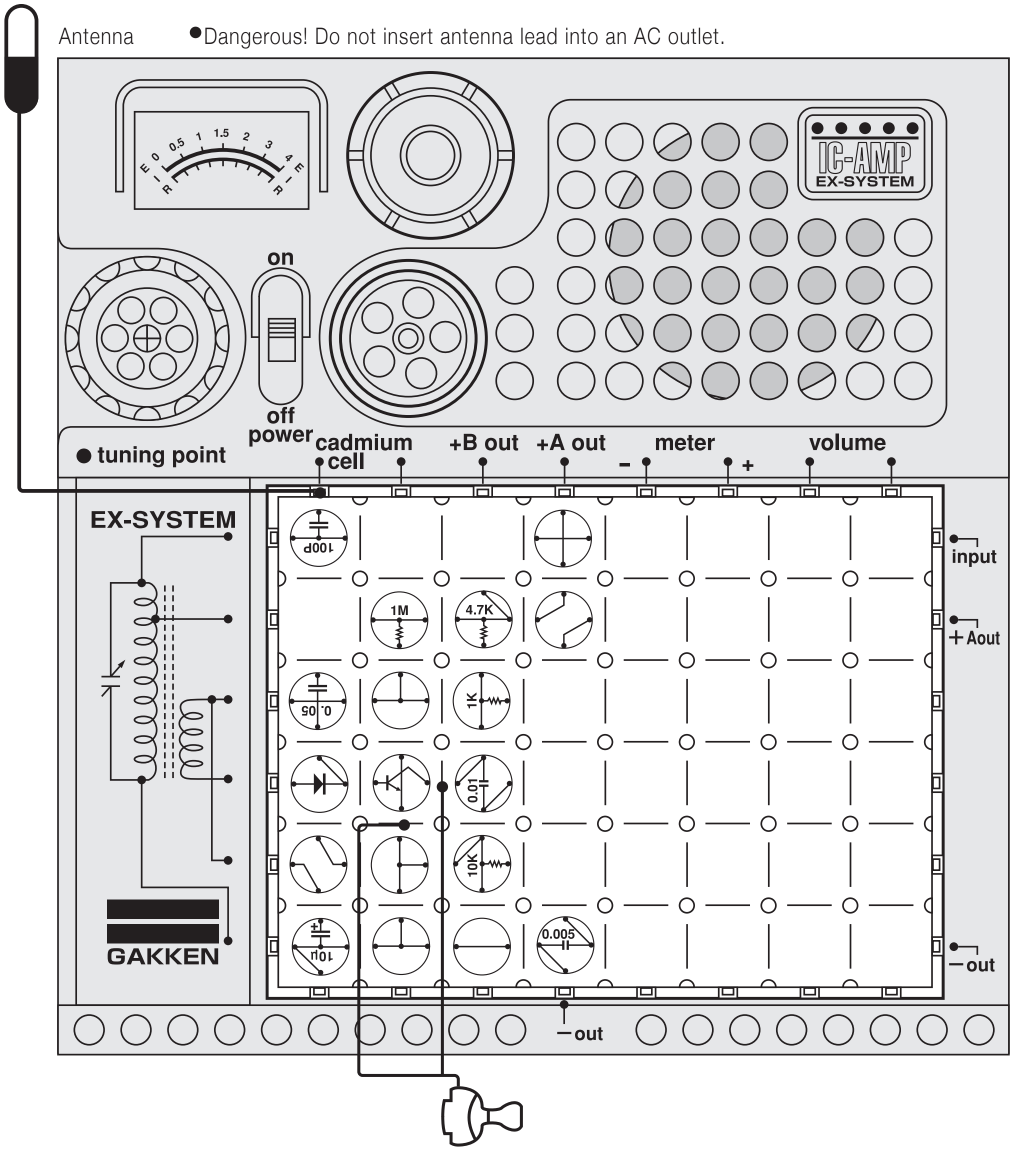
Place the earphone in your ear, turn on the power switch, and the radio will play.



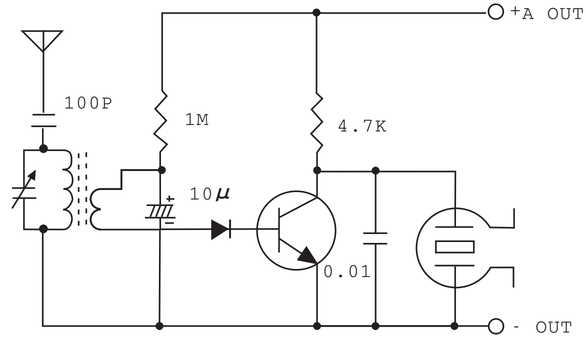
This picture shows
how the antenna cord and
the enamel cord are connected.

No. 7 Diode Detector 1-Transistor Radio

Antenna ●Dangerous! Do not insert antenna lead into an AC outlet.



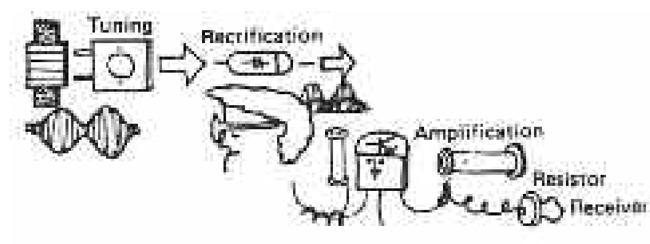
Circuit diagram for this experiment:



By connecting Various forms of amplifier (low-frequency amplifier circuit) to the germanium diode detector radio. you will gradually increase your knowledge of the construction of the germanium diode detector 1-transistor radio, which is made up of various combinations of such tuning and detector circuits and amplifier. The transistor diodes are of the germanium type and silicon type. The former type of diode is used in the Electronic Block.

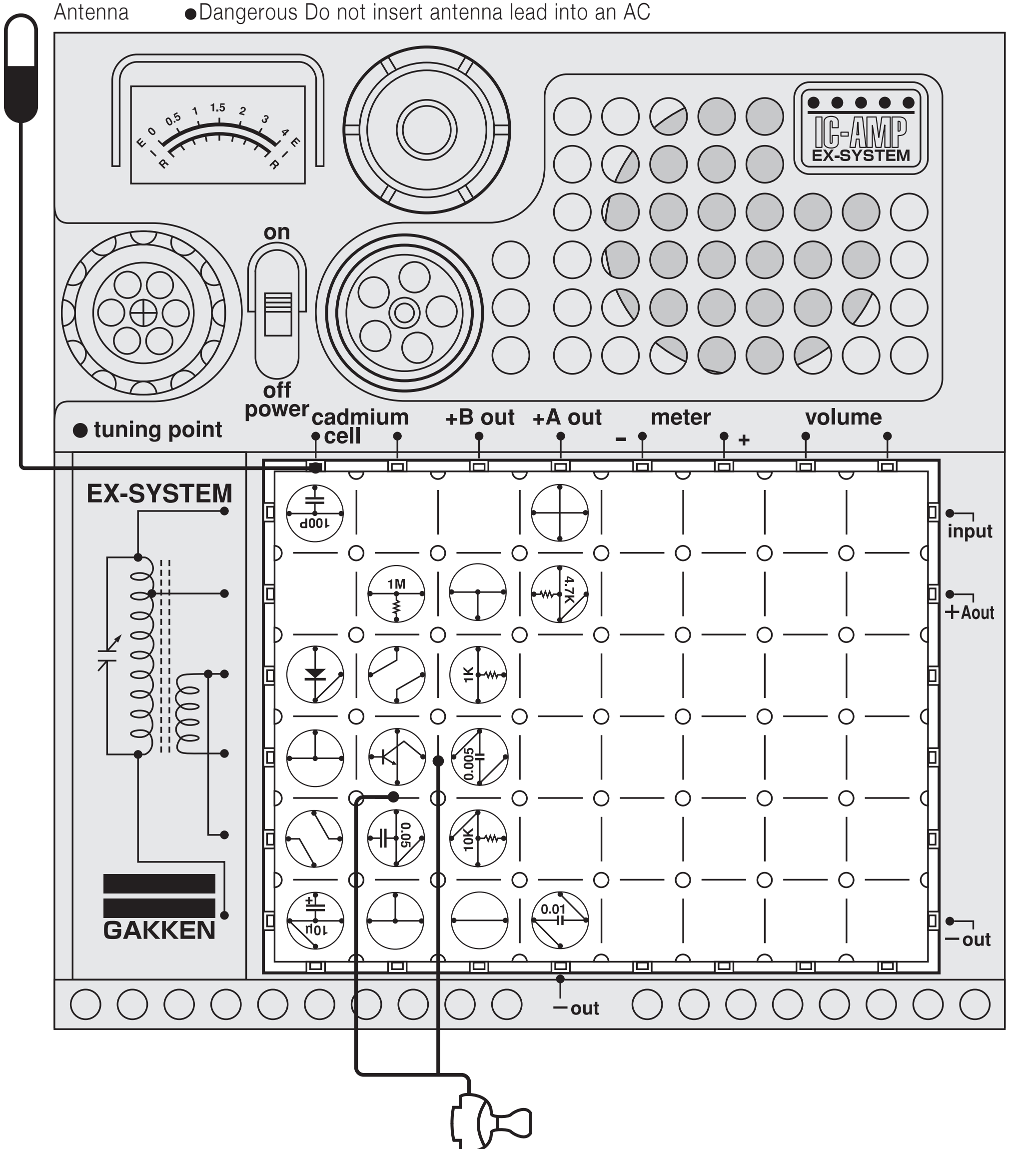
Now let's connect a fixed bias transistor amplifier (Resistive load) to the germanium diode detector radio. Arrange the blocks as illustrated at left, attaching the earphone and antenna.

Place the earphone in your ear, turn on the main switch, and the radio will play.

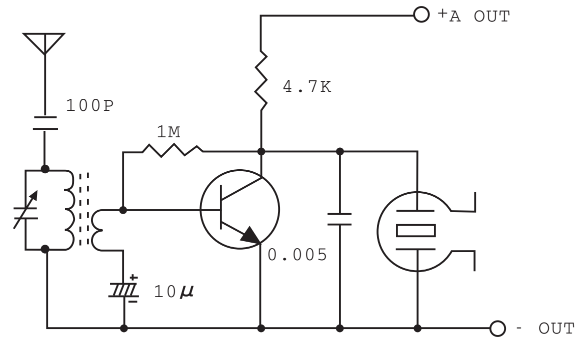


No.8 1-Transistor Detector Radio

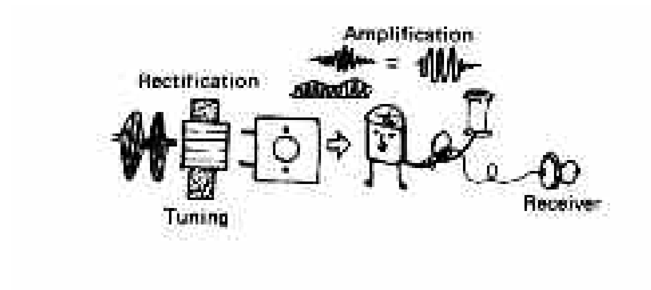
Antenna ●Dangerous Do not insert antenna lead into an AC



Circuit diagram for this experiment:

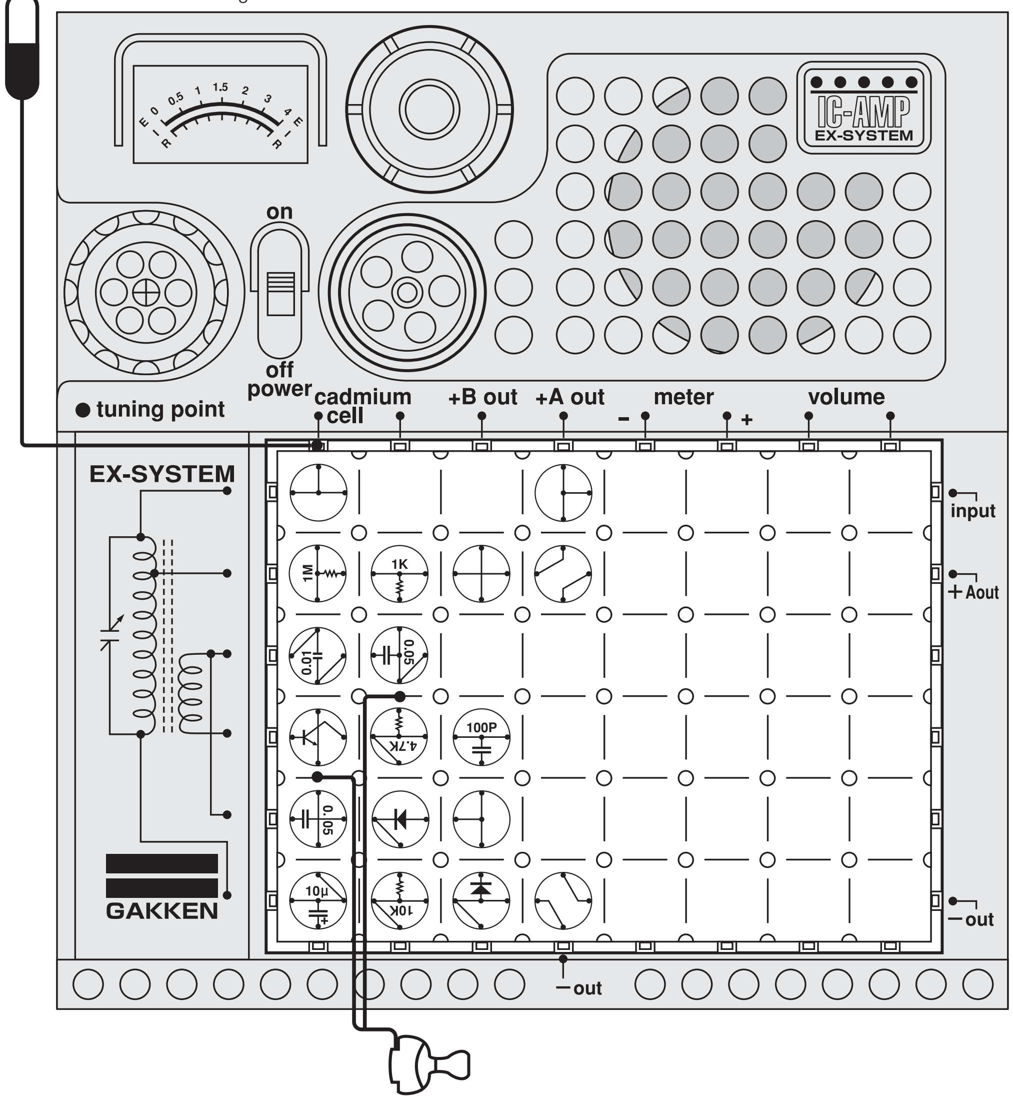


Since the transistor performs the function of detection in addition to amplification, the rtansistor radio circuit you will build in Experiment No. 8 requires no diode. A large antenna is needed when experimenting with this type of radio, however, because it uses only a small number of transistors. Arrange the blocks as illustrated at left, attaching the earphone and antenna. Place the earphone in your ear, turn on the power switch, and the radio will play.

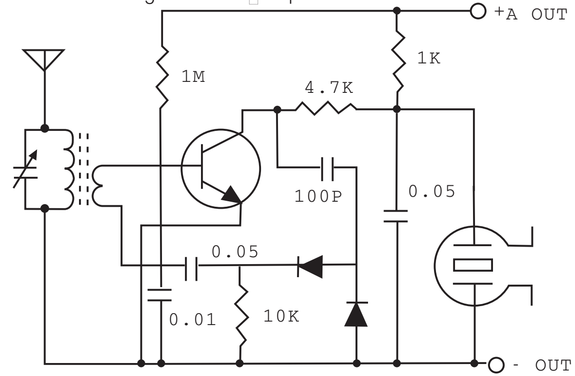


No. 9 1-Transistor RefIex Radio

Antenna ●Dangerous! Do not insert antenna lead into an AC outlet.



Circuit diagram for this experiment:



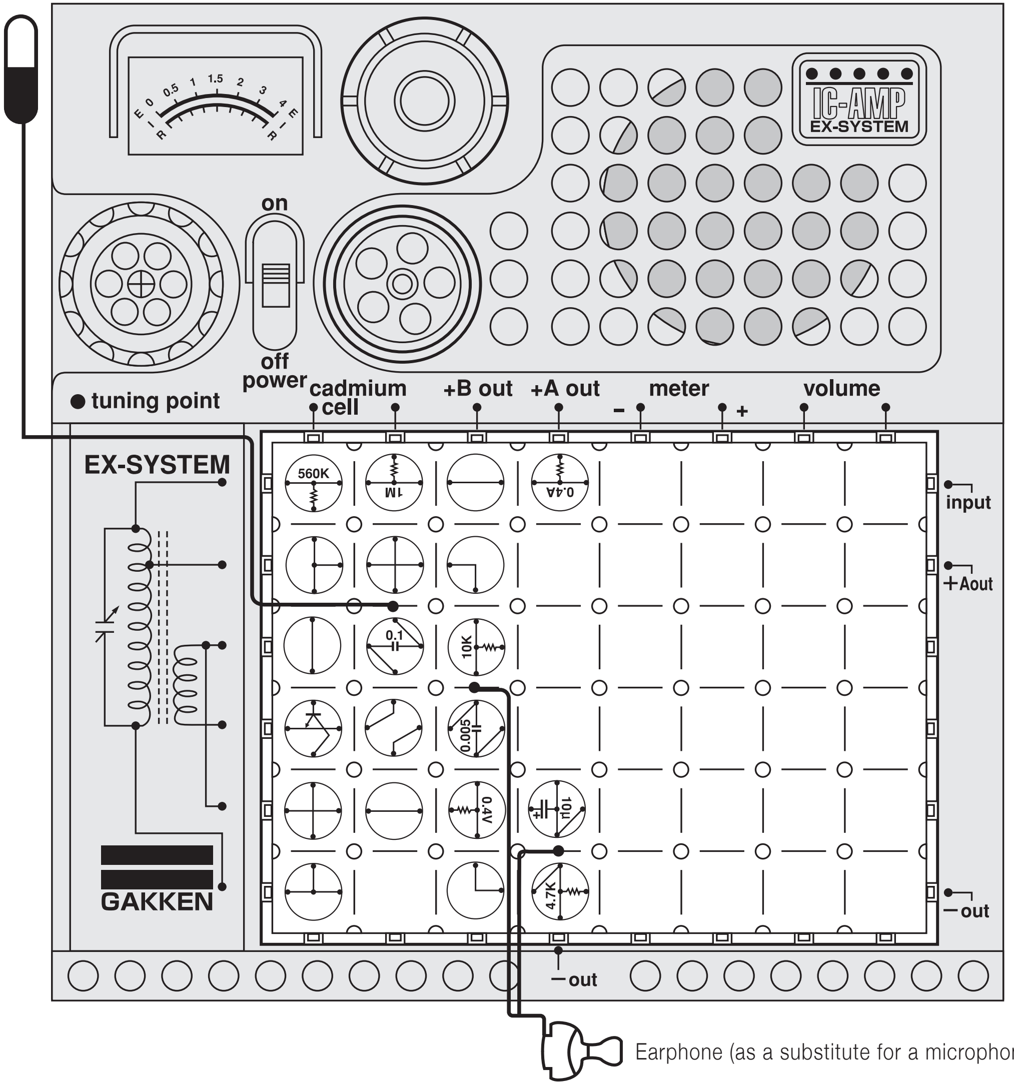
A circuit with one transistor performing two functions, high-frequency amplification and low-frequency amplification is called the "reflex circuit". This type of circuit is a little more complex than the ones you have already built, but it has a greatly increased sensitivity. Unlike the circuit in the superheterodyne radio, the reflex circuit does not need adjust and is therefore very suited for studying the elementary principle of radio and the construction of simple radio receivers.

This circuit may produce oscillations when used in a place where the incoming radio waves are very strong. In such a case, disconnect the antenna.

Arrange the blocks as illustrated at left, attaching the earphone and antenna. Place the earphone in your ear, turn on the power switch, and the radio will play.

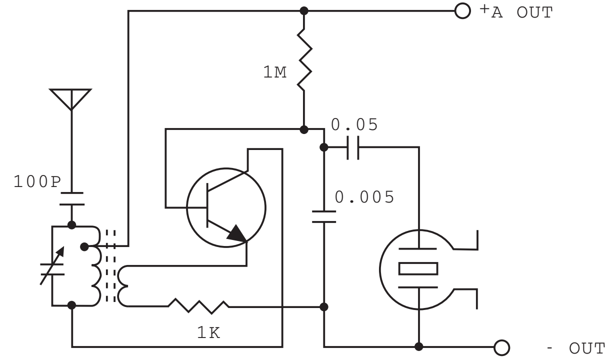
No.10 1-Transistor Wireless Microphone

Antenna ●Dangerous! Do not insert antenna lead into an AC outlet.

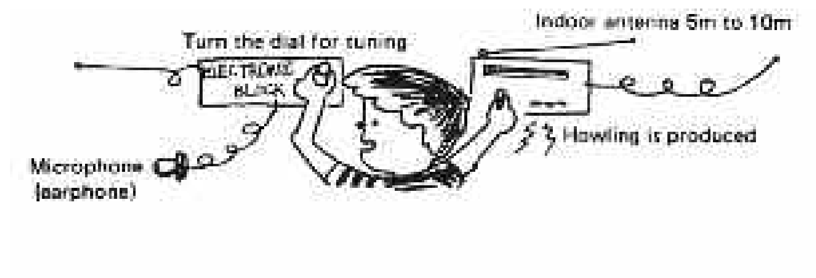


Earphone (as a substitute for a microphone.)

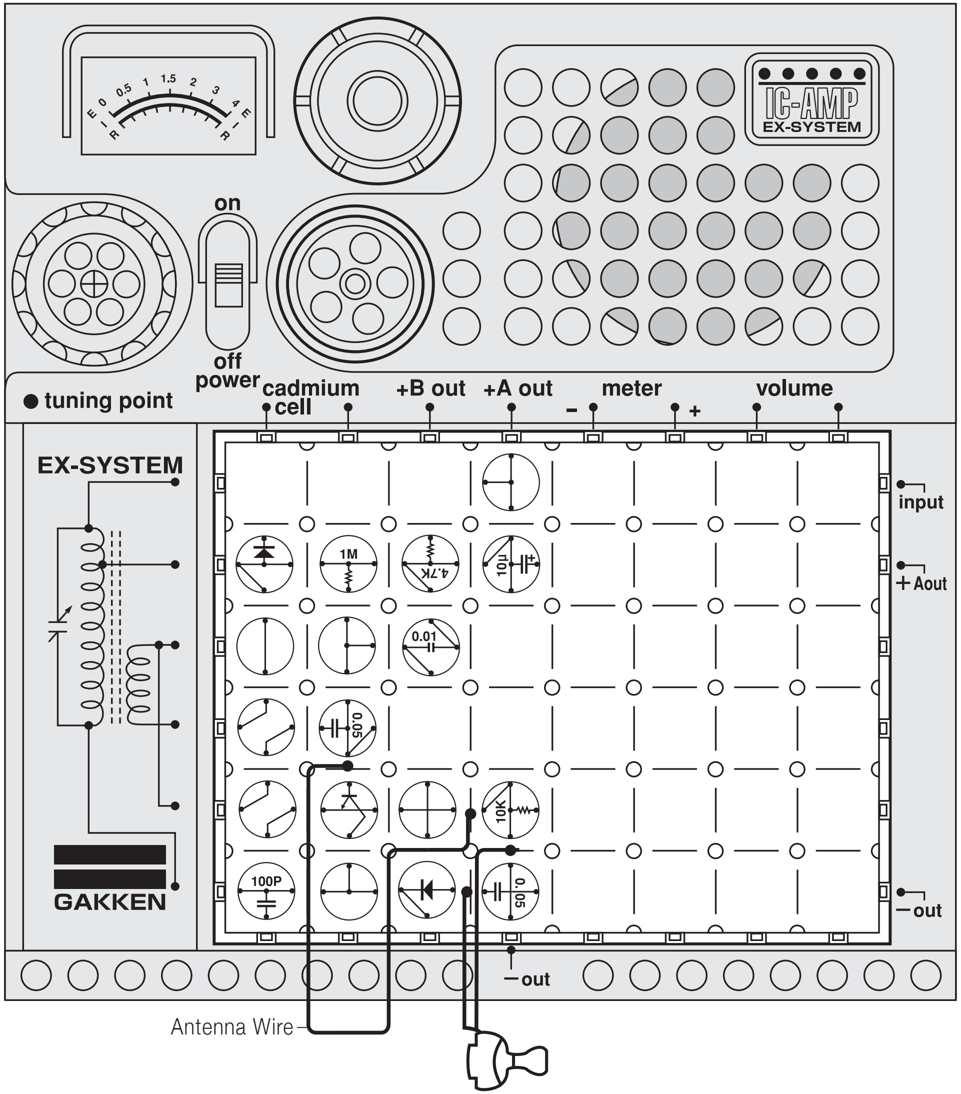
Circuit diagram for this experiment:



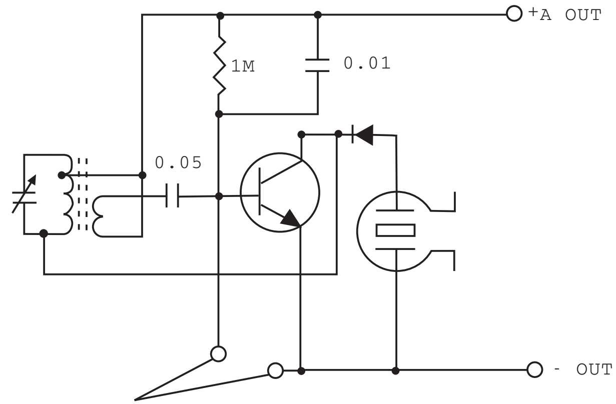
Arrange the blocks as illustrated at left, attaching the earphone and antenna. Turn on another AM radio receiver and turn its dial so that it is not tuned to any station. Next, turn on the power switch on the board of electronic blocks and slowly rotate its dial, with its antenna located close to the other radio. Turn the dial until a high-pitched whistling sound comes out of the radio speaker. You have just built a wireless microphone that is now tuned to the radio receiver. Speak into the earphone and your voice will come out of the radio.



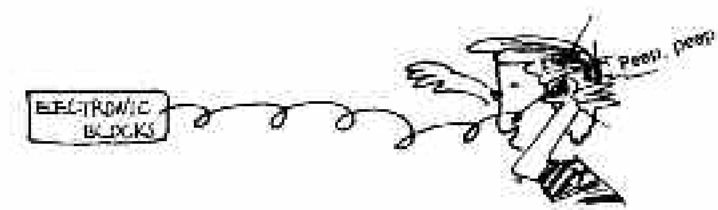
No. 11 Circuit Disconnection Warning Device (Earphone



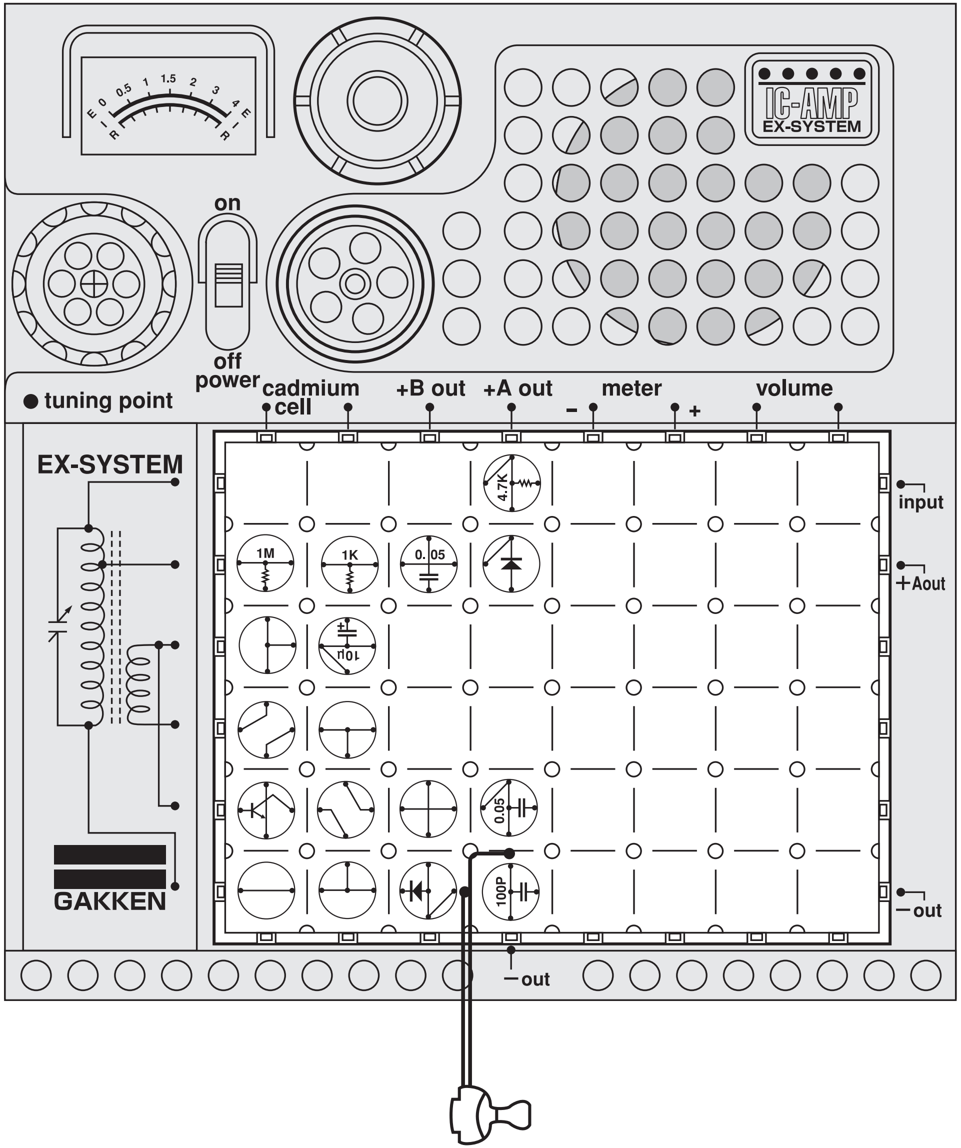
Circuit diagram for this experiment:



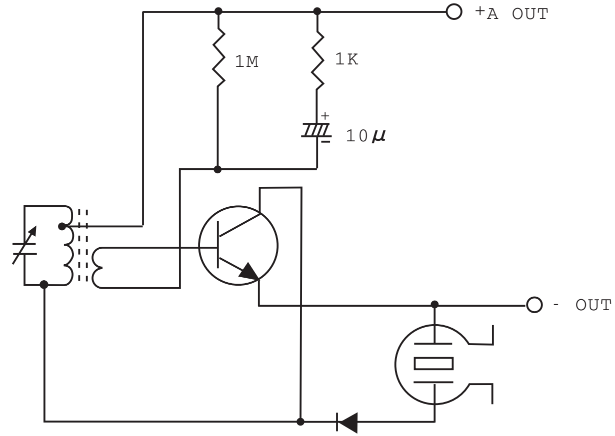
Let's do an experiment with an oscillatory circuit by using an antenna coil. Arrange the blocks and connect the earphone and antenna wire as illustrated. Place the earphone in your ear and turn on the power switch. You will hear high-pitched note whenever you disconnect the antenna wire from the block.



No. 12 Electronic Sleeping Aid (Earphone Type)

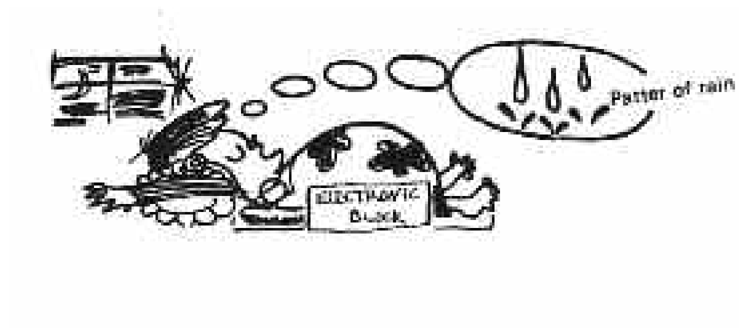


Circuit diagram for this experiment:

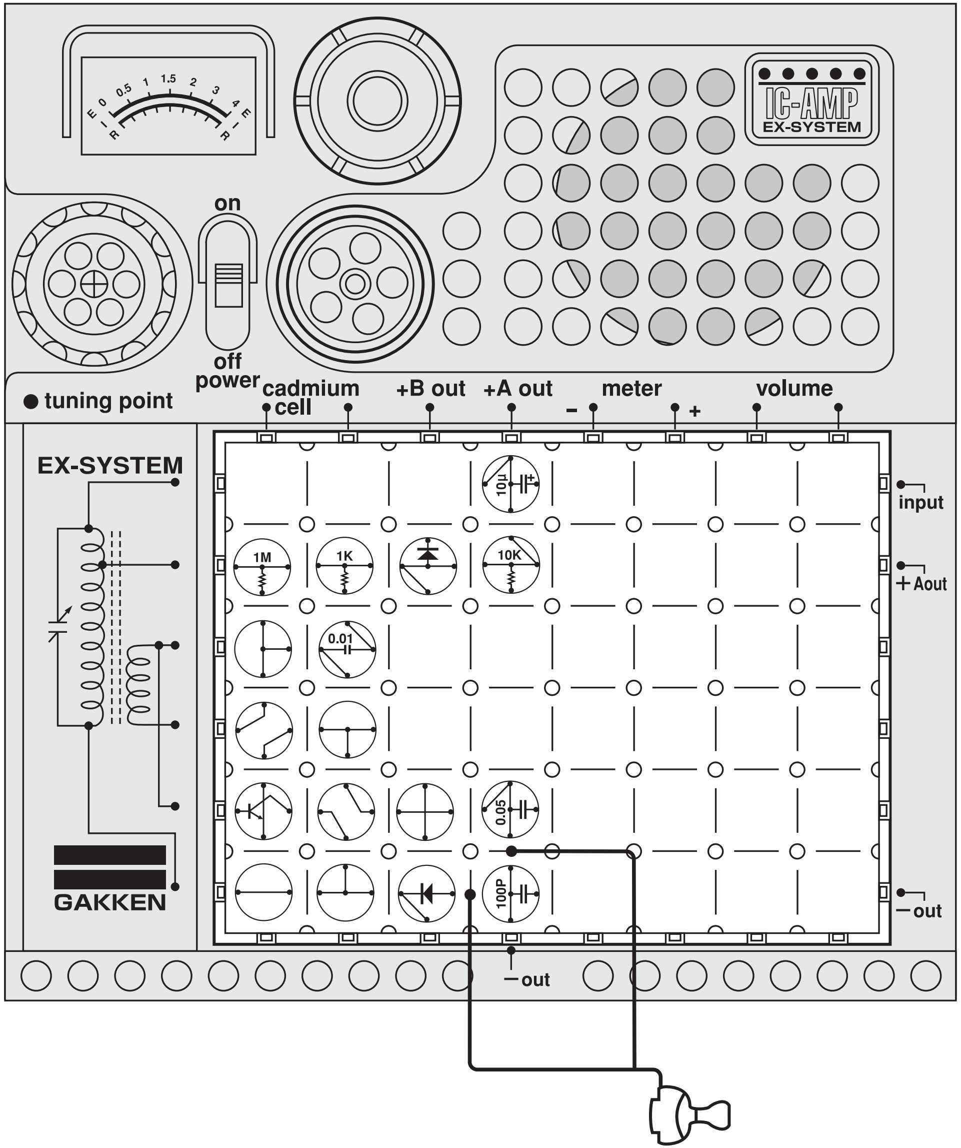


Do you feel sleepy when you listen to the continuous patter of rain ? Let's experiment with an electronic circuit that makes such a sound.

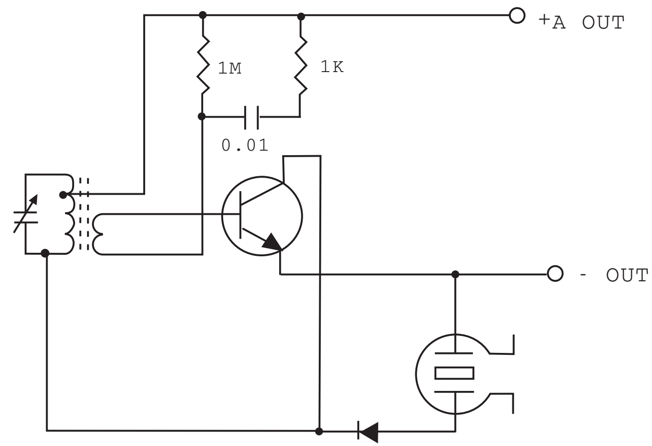
Arrange the blocks as illstrated at left, connect the earphone, and turn on the main switch. Place the earphone in your ear and listen to the soothing sound.



No.13 Audio Generator

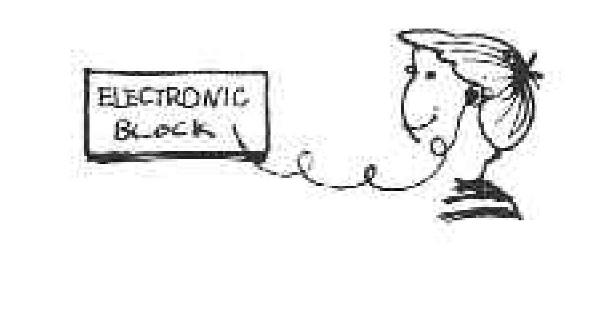


Circuit diagram for this experiment:

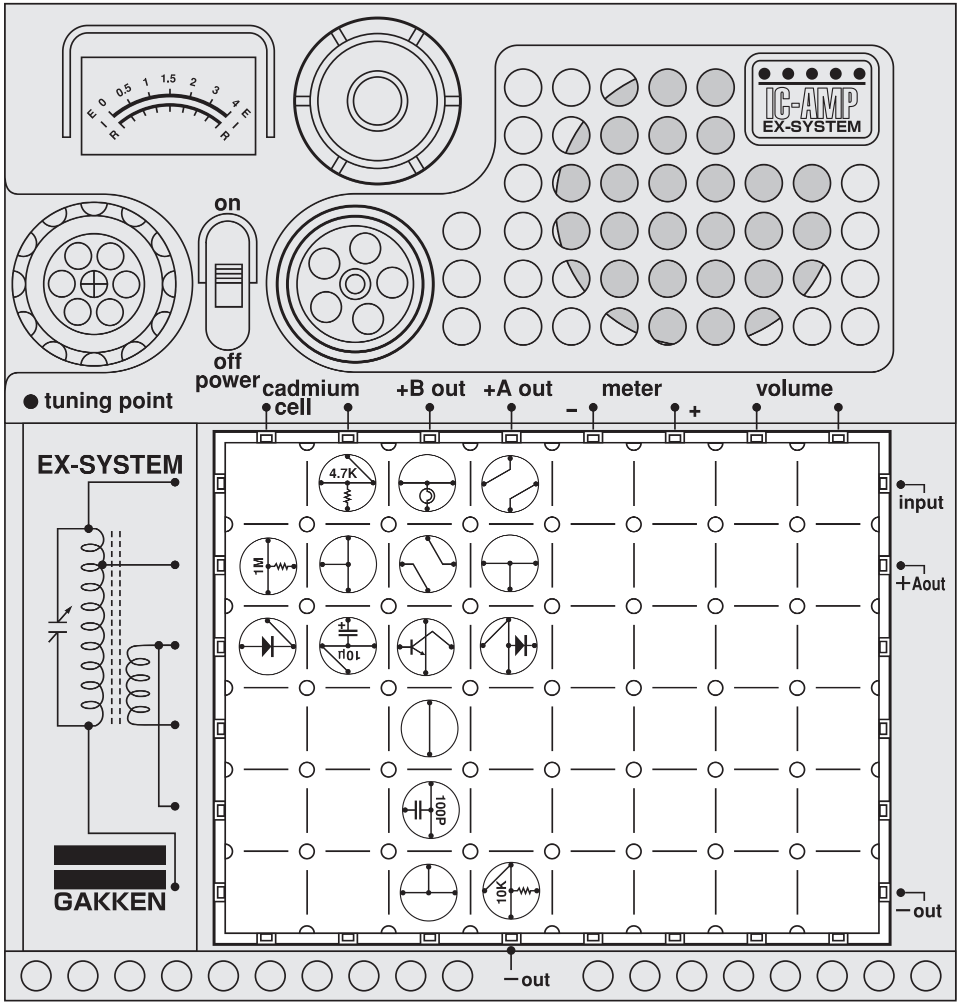


Let's use the antenna coil in place of a low-frequency transformer. This experiment will show that the antenna coil is a kind of transformer. Since a variable capacitor is connected to the antenna coil in this oscillator, the oscillalion frequency can be changed by turning the variable capacitor (dial).

Arrange the blocks as illustrated at left, attaching the earphone. Place the earphone in your ear and listen to the various tones produced by operating the dial.

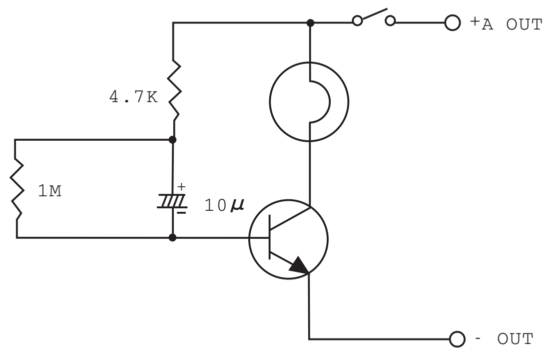


No.14 Flash Lamp



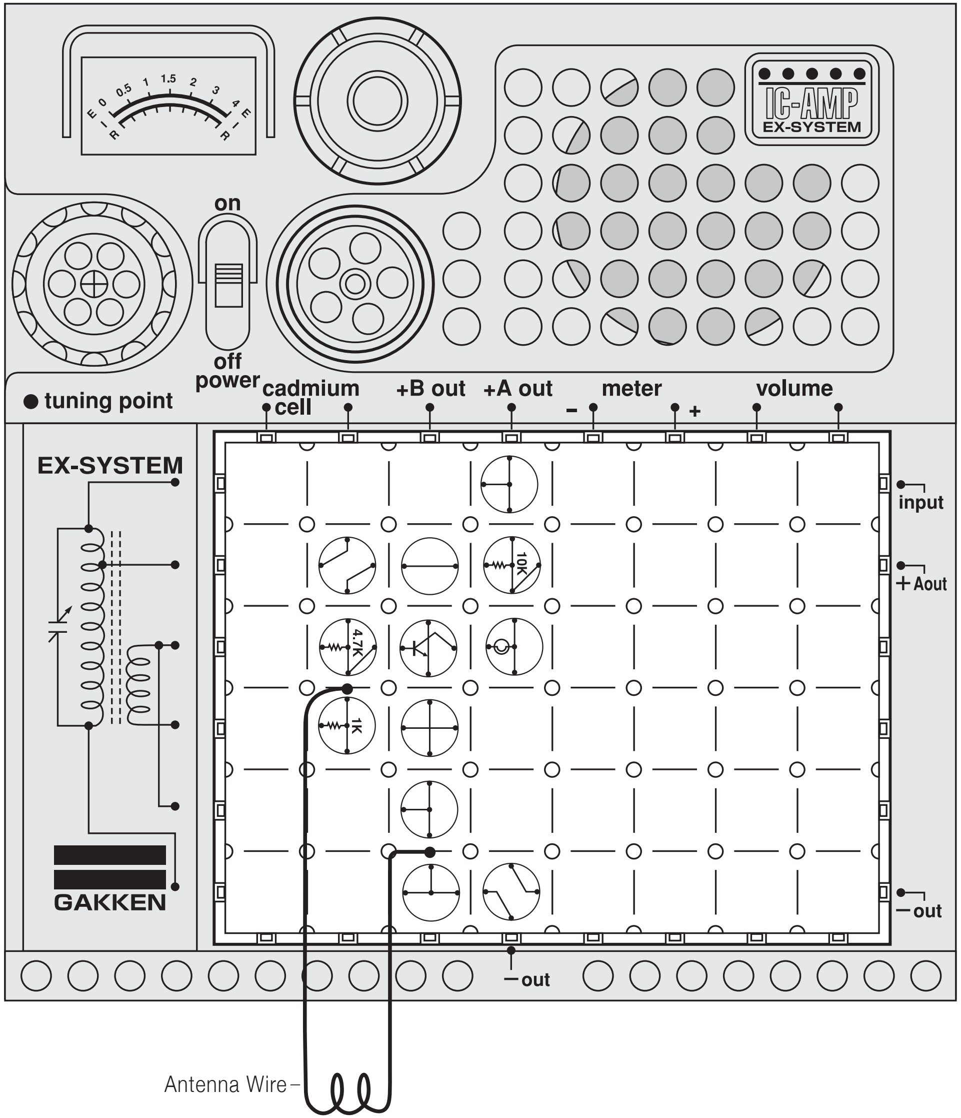
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

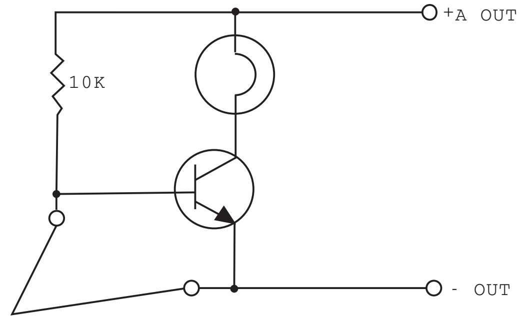


This is an experiment with a fiash lamp, using the charging and discharging of the capacitor. Arrange the blocks as illustrated at left. Turn on the main switch and the lamp will go on, remain glowing, and then go off. To light the lamp again, turn off the switch, wait 20 to 30 seconds, and turn on the switch again.

No. 15 Lamp-type Circuit Disconnection Warning Device

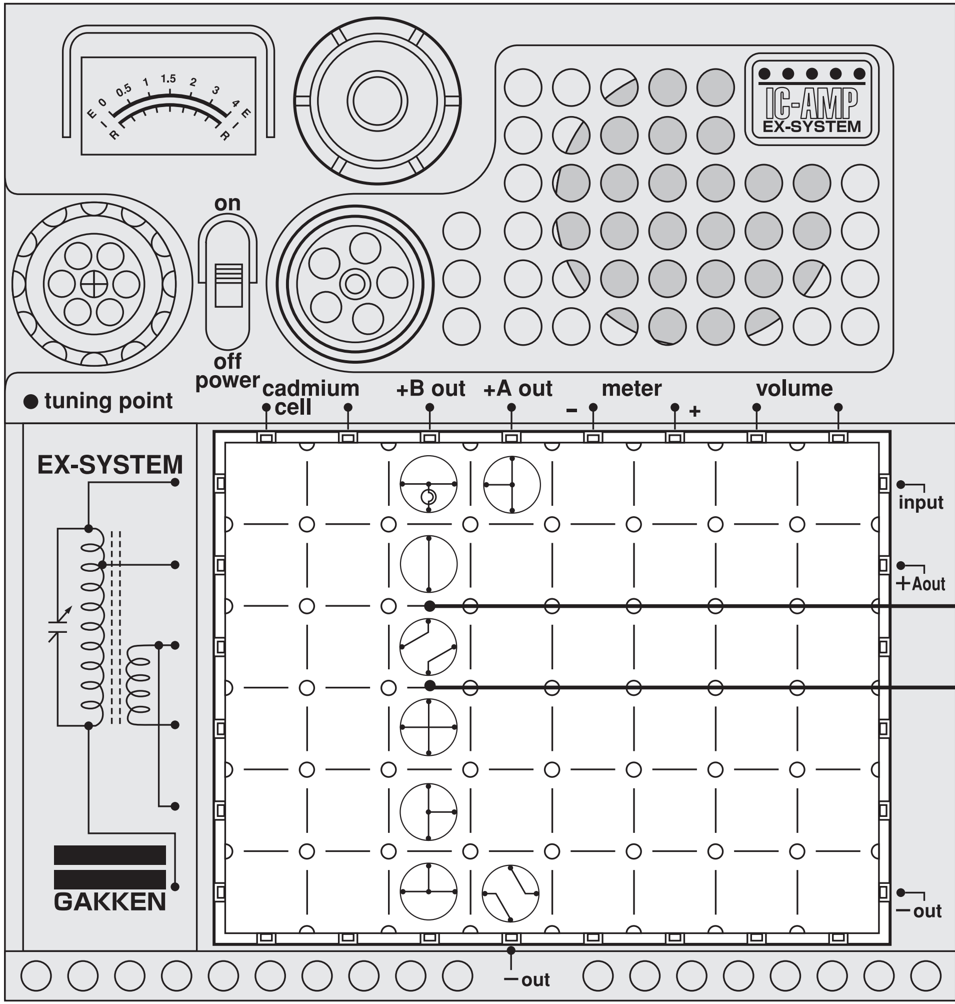


Circuit diagram for this experiment:

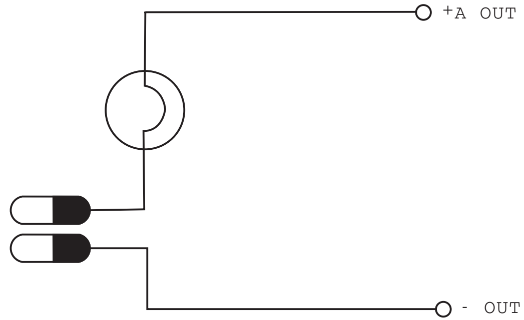


Let's do an experiment with a disconnected circuit warning device by using an antenna wire.
Arrange the blocks as illustrated at left, attaching the antenna wire. Turn on the power switch. The lamp will glow when the end of the antenna wire is disconnected from the blocks.

No.16 Conductors and Nonconductors (Insulator)



Circuit diagram for this experiment:

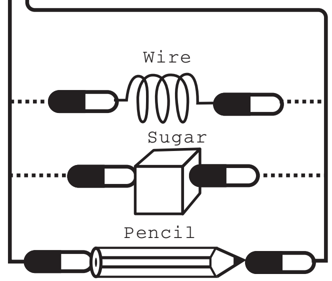


Have you successfully done Experiment No. 1~15? If so, let's go back to the fundamentals of electronics and do No. 16 and the related experiments that follow.

Arrange the blocks as illustrated at left, attaching the two 60cm cords. Turn on the power switch. Touch the ends of the two cords to the lead of a pencil, a cube of sugar, and a piece of wire. In which case did the lamp glow?

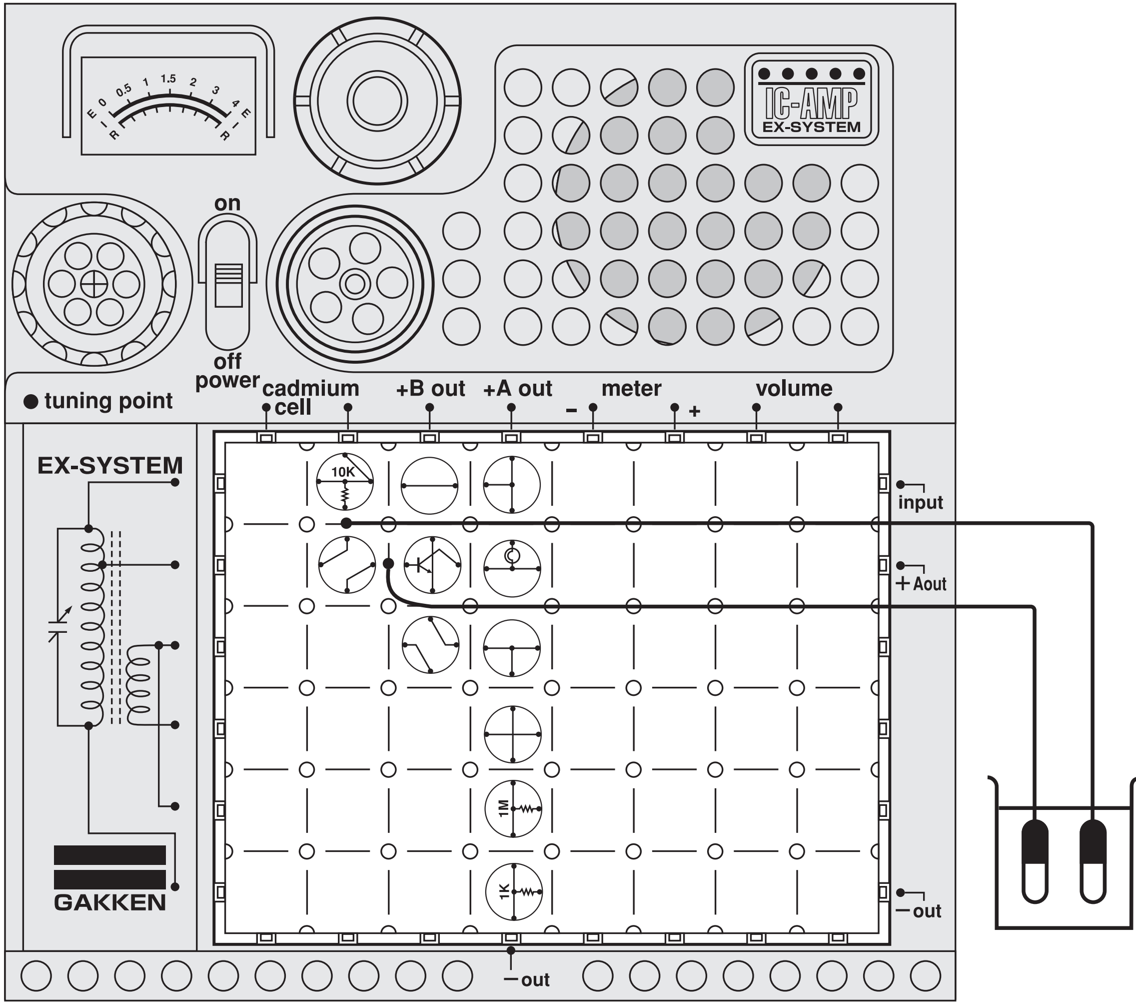
The lamp went on when the cords were connected to the pencil lead or to the wire; these substances are called "conductors." Substances such as sugar, which do not cause the lamp to glow, are "nonconductors. "

Experiment with various objects around you to see if they are conductors or nonconductors.

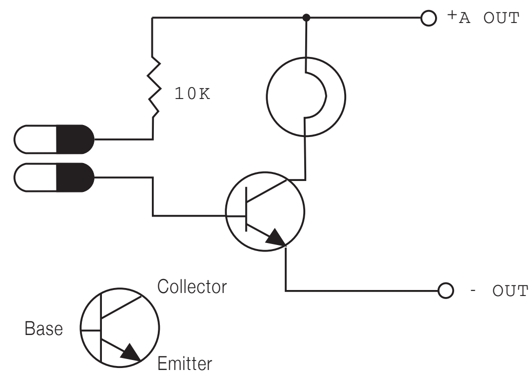


Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

No. 17 Current AmpIification Function of Transistors

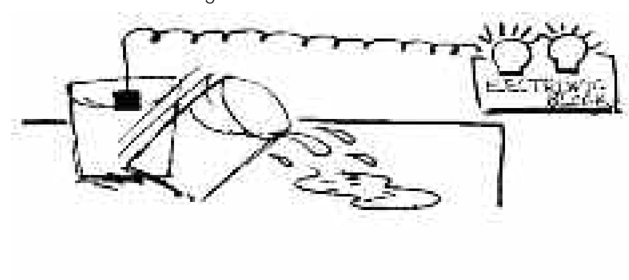


Circuit diagram for this experiment:



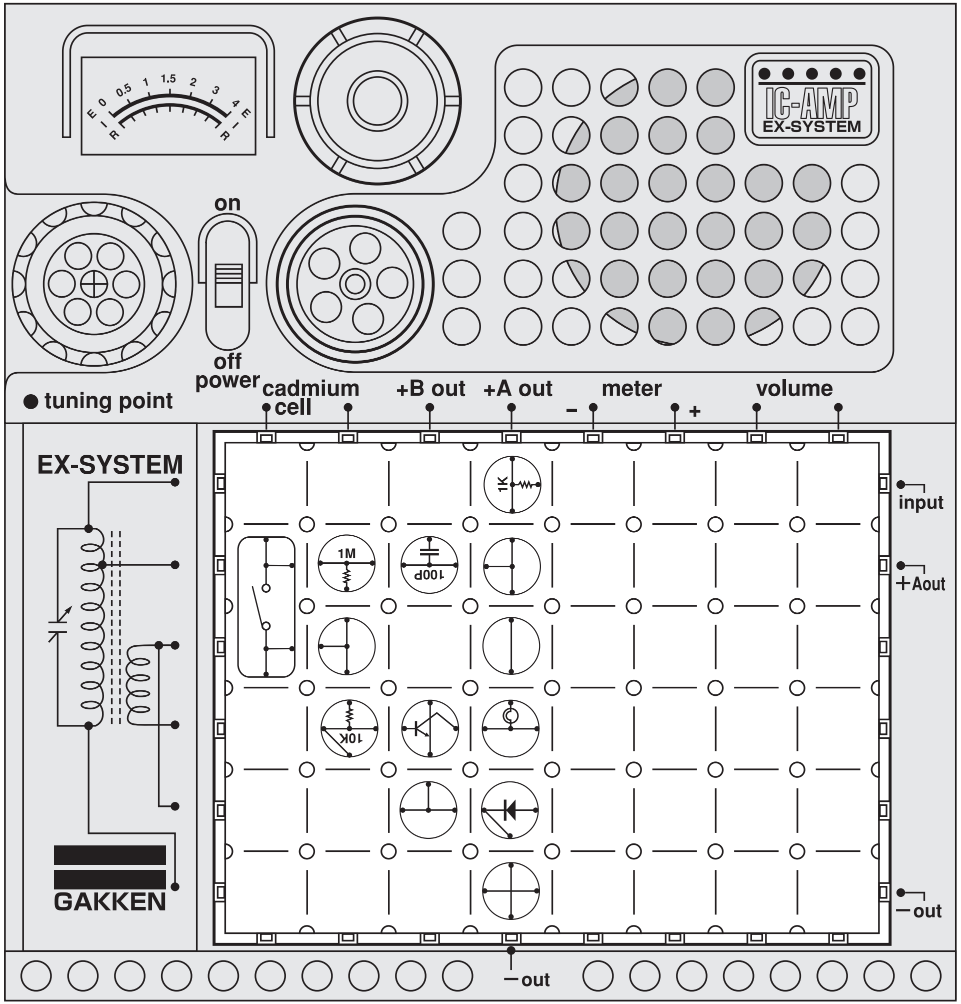
As you have already learned, amplification is one of the functions performed by transistors. Now let's do an experiment with this function of a transistor.

Arrange the blocks at illuslrated at left, attaching the two 60cm cords. Turn on the power switch; the lamp will not glow. Dip the ends of the two cords into salted water in a glass. Now the light will go on. This is because a large current flows between the collector and emitter of the transistor when the ends of the cords are immersed in salt water. With the transistor, it is possible to control a large current to light a lamp by a slight change in the current flowing to the base.



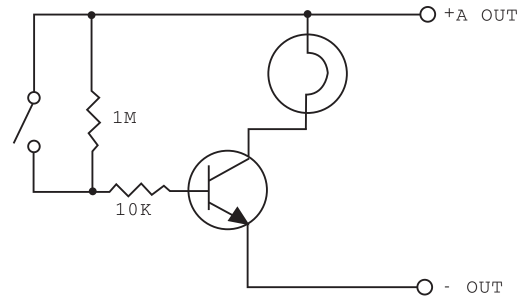
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

No. 18 Switching Function of Transistors



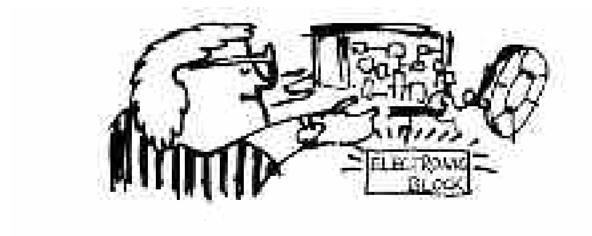
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

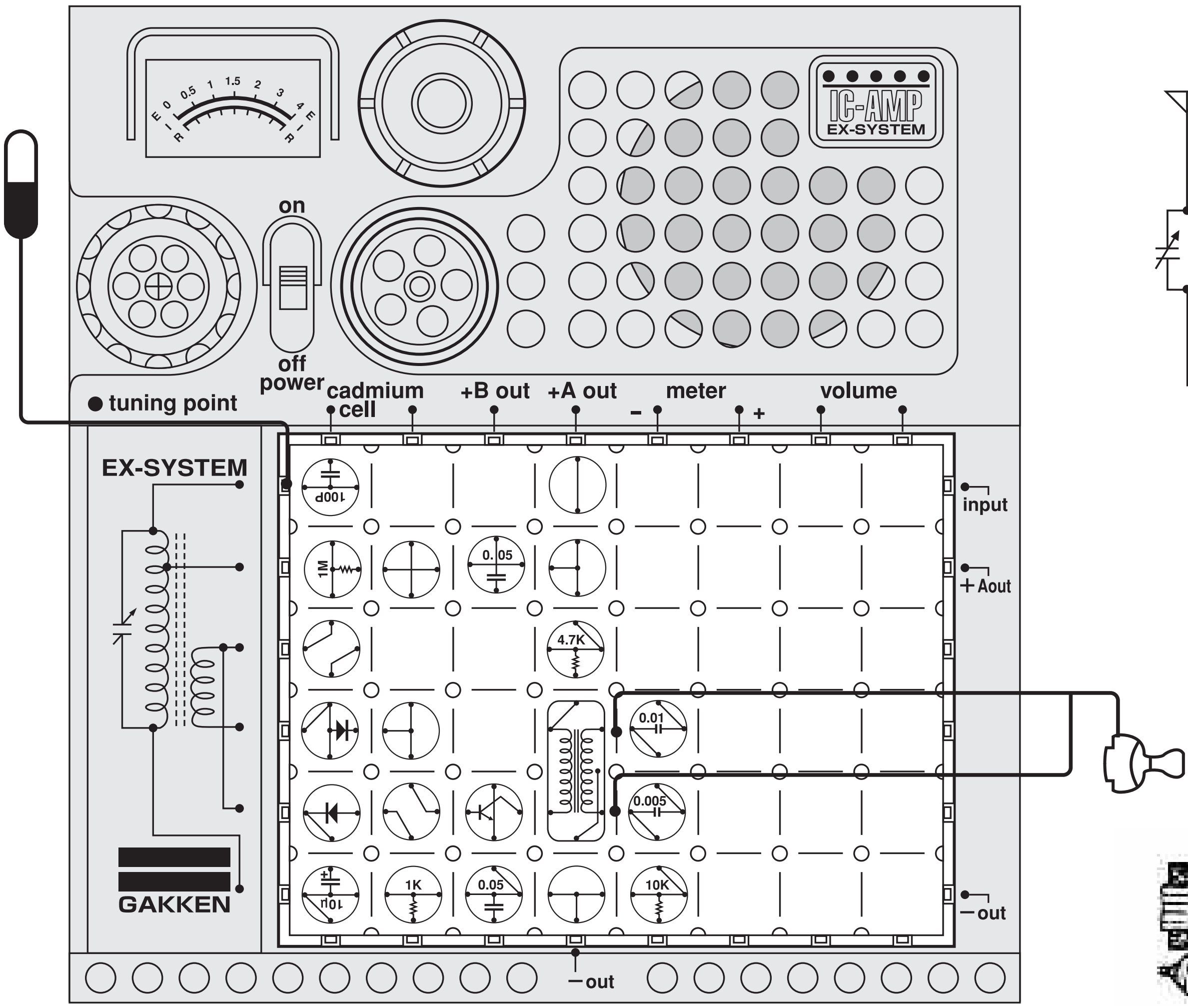


Switching is another function of transistors. There are many kinds of switches. There are the type that turn the lights in your house on and off. These switches are operated by hand. A transistor performs the function of switching by small variations of a current that flows to the base.

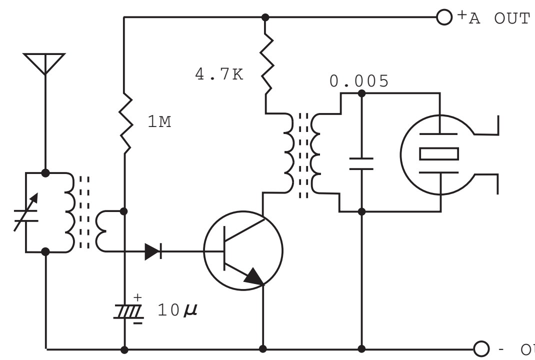
Now let's do the next experiment. Arrange the blocks as illustrated at left. Turn on the power switch. The lamp does not light. Press down on the large block, called the key switch, and the lamp will go on. This is because pressing down on the key switch allowed a large quantity of current to flow to the base. Consequently, the transistor's switching function went into action to light the lamp.



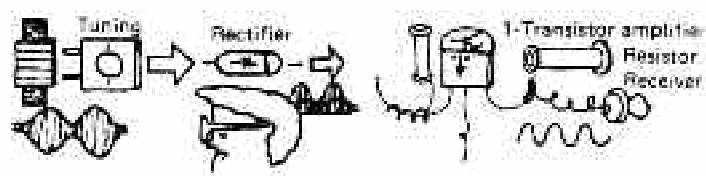
No. 19 Diode Detection 1-Transistor Radio (Transfomer



Circuit diagram for this experiment:



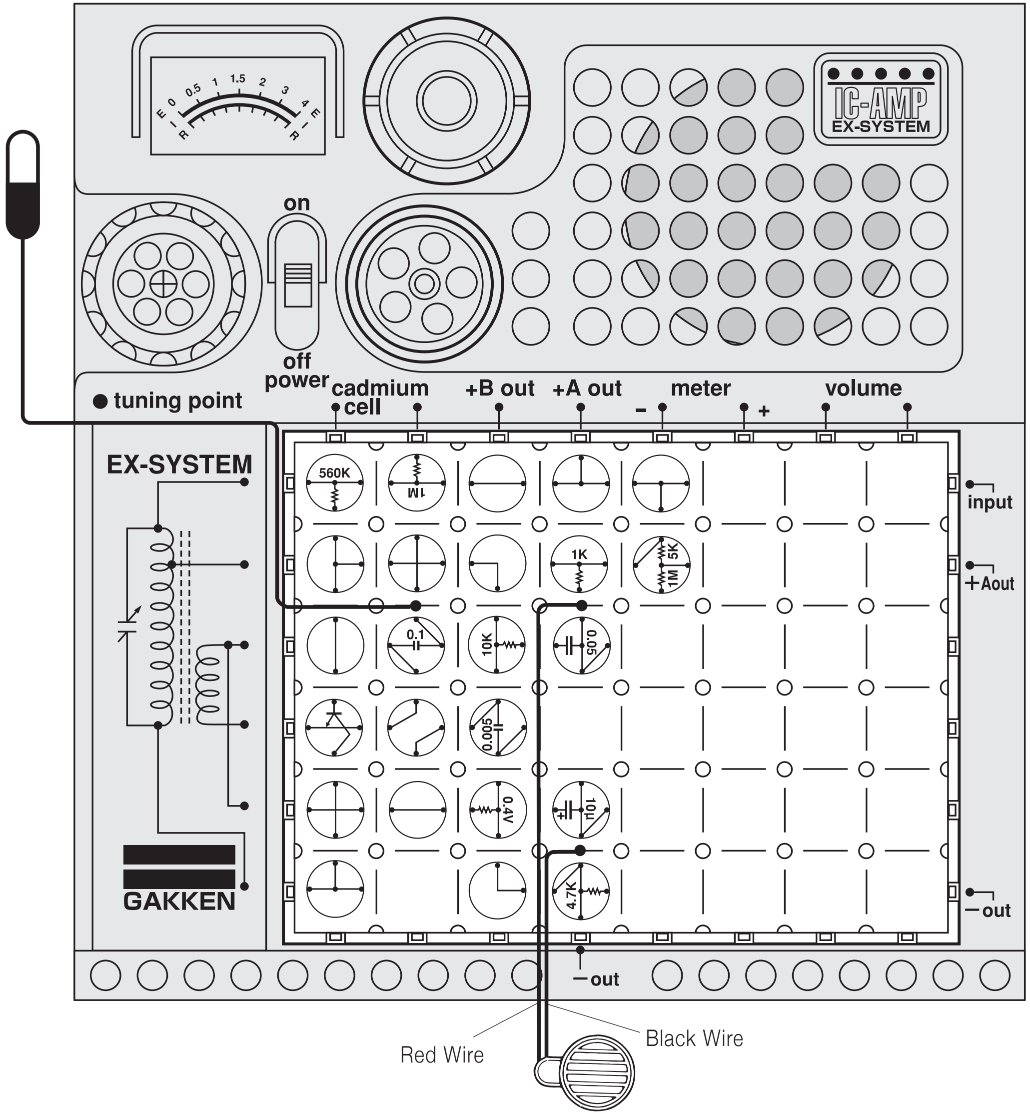
This experiment uses a circuit combining the diode detector radio and a 1-transistor amplifier. A transformer is used for the various amplifier circuits.
Arrange the blocks as illustrated at left, attaching the antenna and earphone. Place the earphone in your ear and turn on the power switch. The radio will play.
Various other amplifier circuits will appear in the follwing experiments. Compare their circuit diagrams and the one above to study their differeneces.



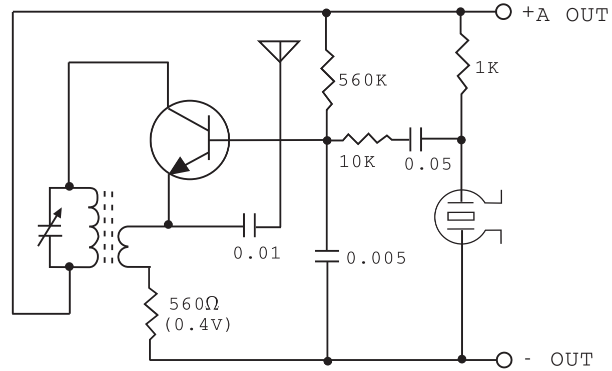
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

No. 20 1-Transistor Wireless Microphone

Antenna ●Dangerous! Do not insert antenna lead into an AC outlet.

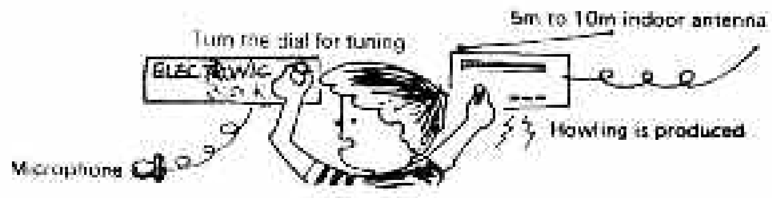


Circuit diagram for this experiment:

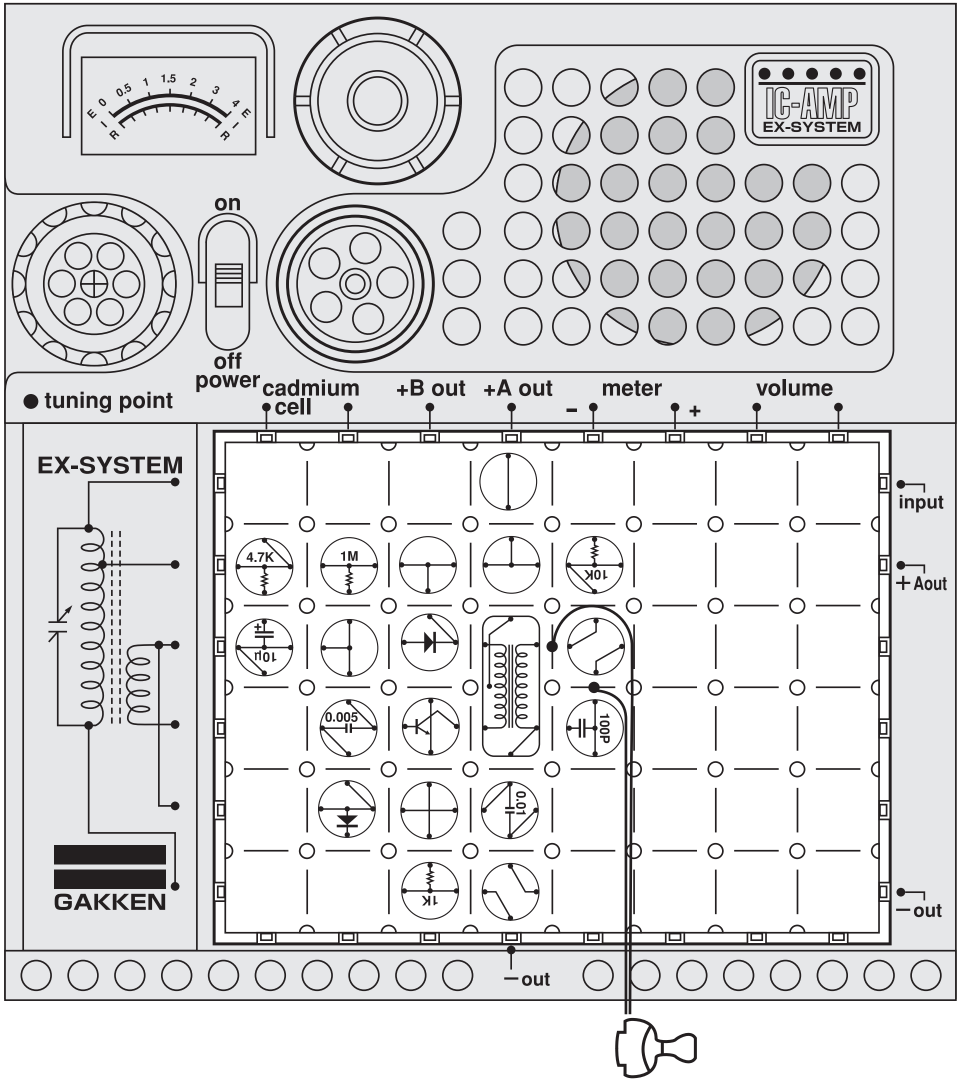


We have already done Experiment No. 10 with a simple wireless microphone. Next we will do one with a transformer.

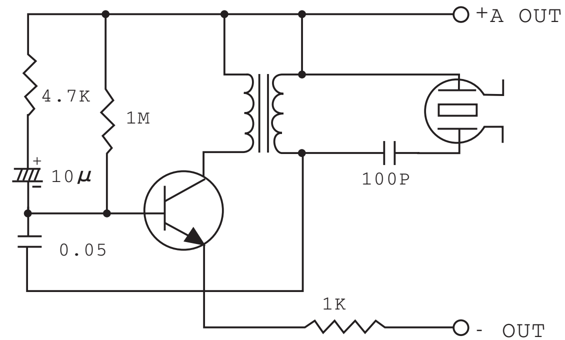
Set up the blocks, microphone, and antenna as illustrated at left. Then set up the AM radio as Experiment No.10. Turn on the radio, moving the antenna wire of the wireless microphone until a high-pitched tone comes out of the radio speaker. Then speak into the microphone, and your voice will come out of the radio.



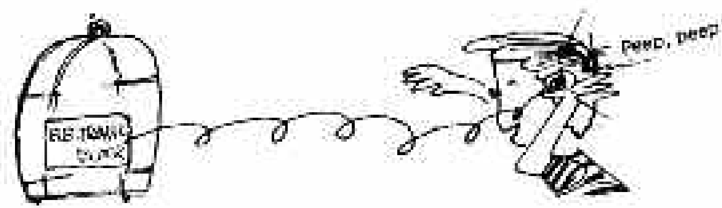
No. 21 Electronic Bird (Transformer Type)



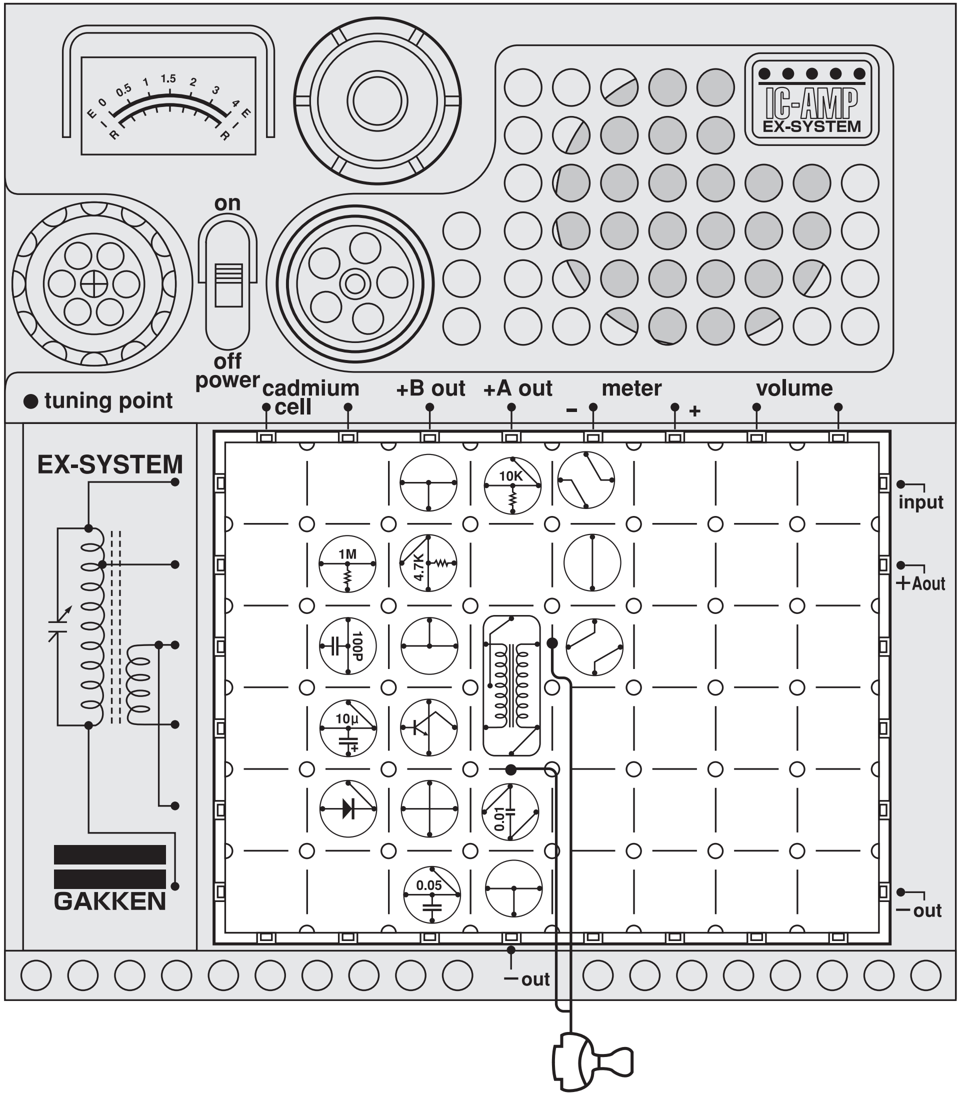
Circuit diagram for this experiment:



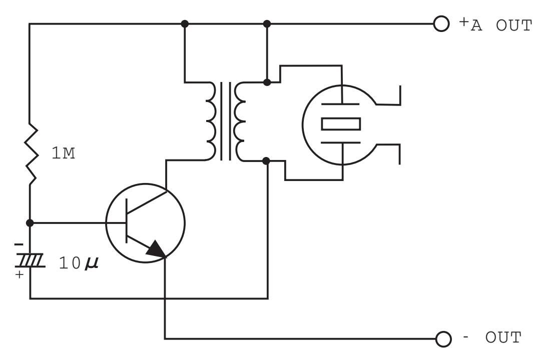
If a capacitor is added to the oscillatory circuit to make a slight alteration in its configuration, the circuit will produce a sound like a bird chirping. This is only one of various imitation sounds that can be produced by an oscillatory circuit.
Arrange the blocks as illustrated at left, attaching the earphone. Place the earphone in your ear and turn on the power switch. You will hear the chirping.



No. 22 Electronic Metronome (Earphone Type)



Circuit diagram for this experiment:

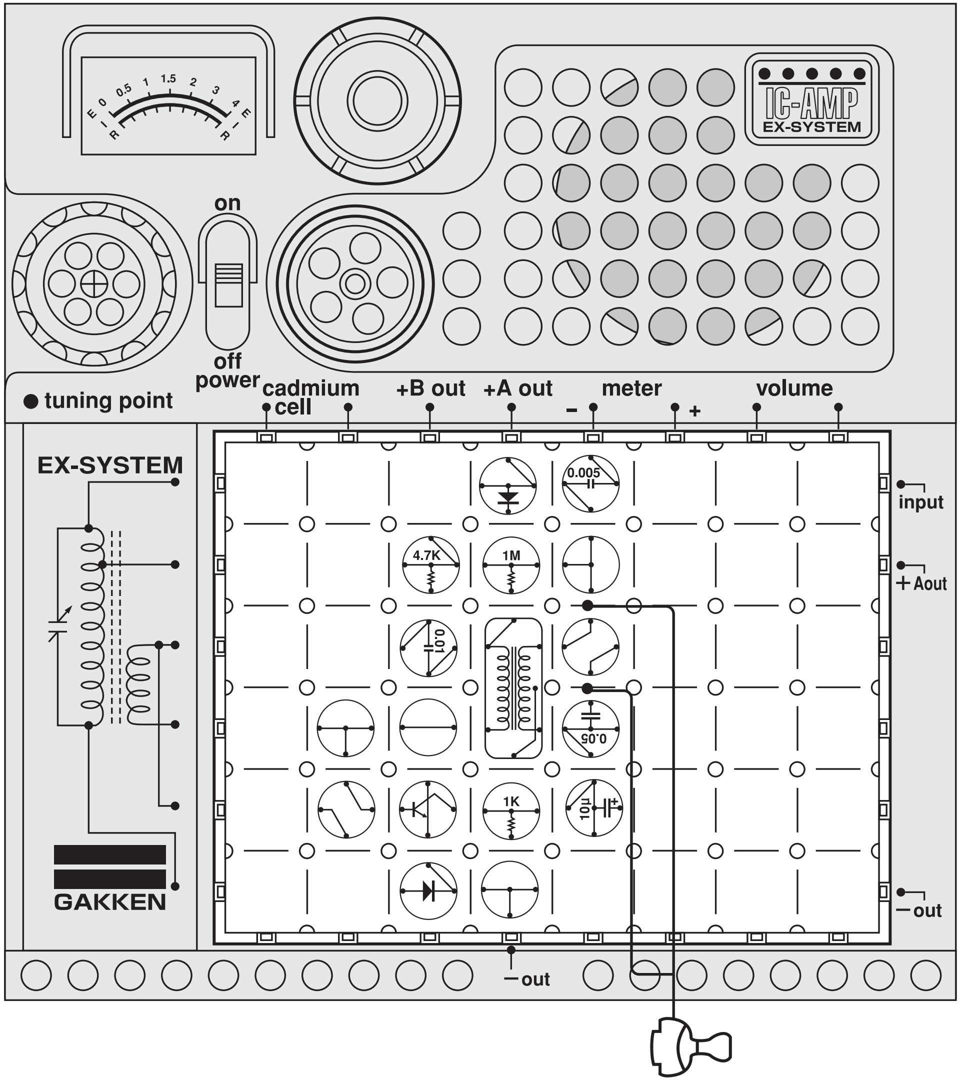


The ordinary metronome is used for practicing musical instruments and singing. Its clocworks and pendulum make a mechanical sound at regular intervals for marking musical time. Now that we are in the age of electronics, let's make an electronic metronome. It operates on the same principle as the traditional metronome, but, with our circuit, the tempo cannot be adjusted.

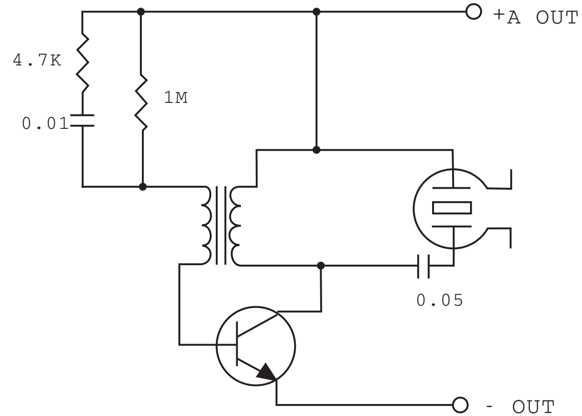
Arrange the blocks as illustrated at left, attaching the earphone. Place the earphone in your ear and turn on the power switch. You will hear the metronome marking time.

Note: Transistors and diodes are easily broken by over-current. Look at the circuit diagrams well to check if the placement is correct before turning on the switch.

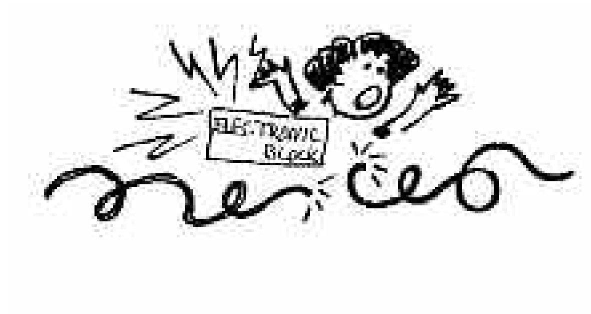
No. 23 Electronic Buzzer



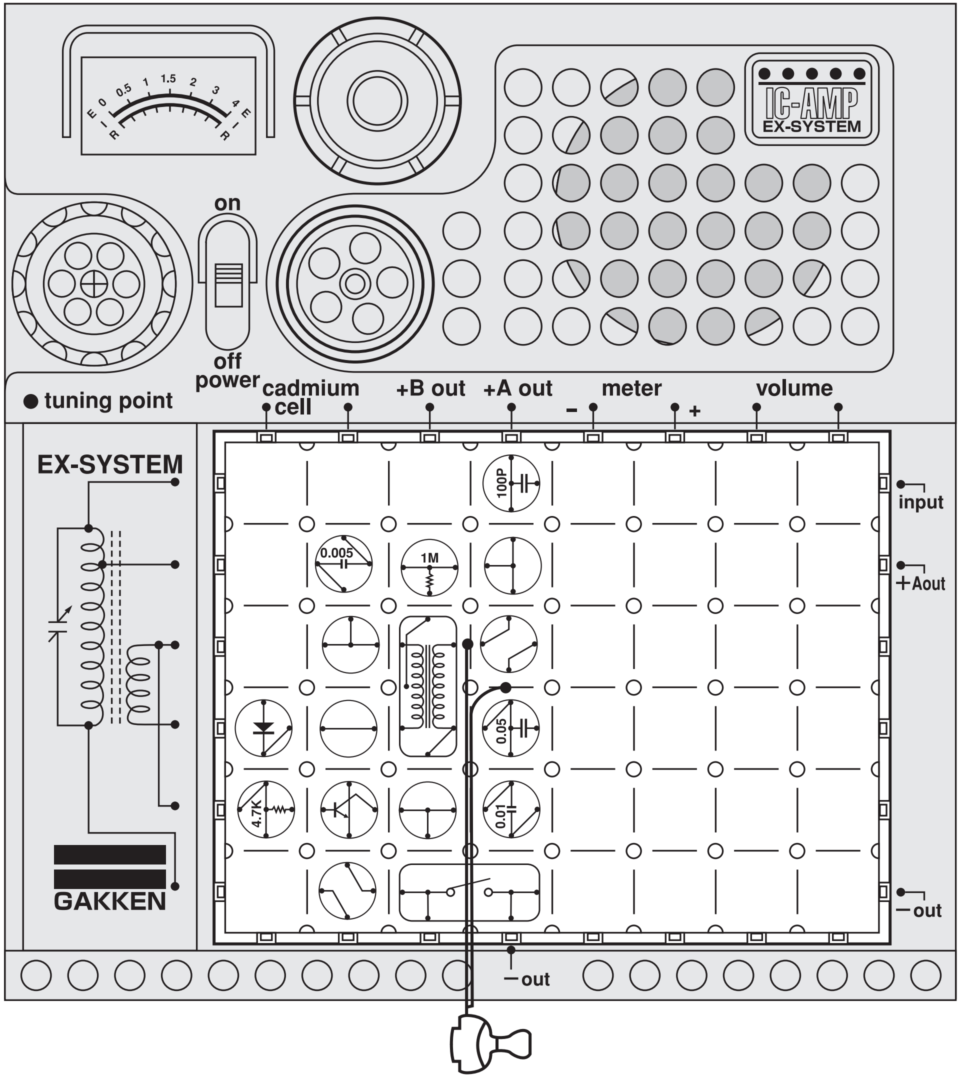
Circuit diagram for this experiment:



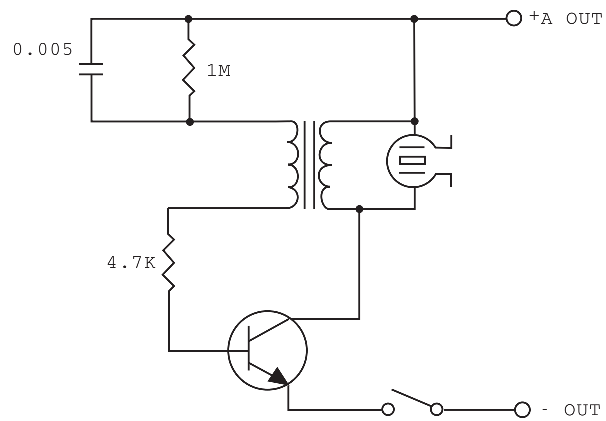
This experiment involves the oscillatory circuit. The result will be a sound like a warning buzzer. Arrange the blocks as illustrated at left, attaching the earphone. Place the earphone in your ear and turn on the power switch. You will hear a buzzing sound.



No. 24 Morse Code Practice Circuit (Earphone type)

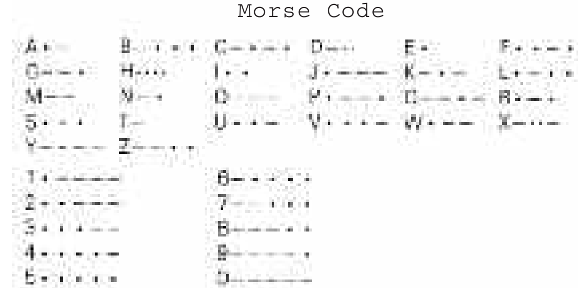


Circuit diagram for this experiment:

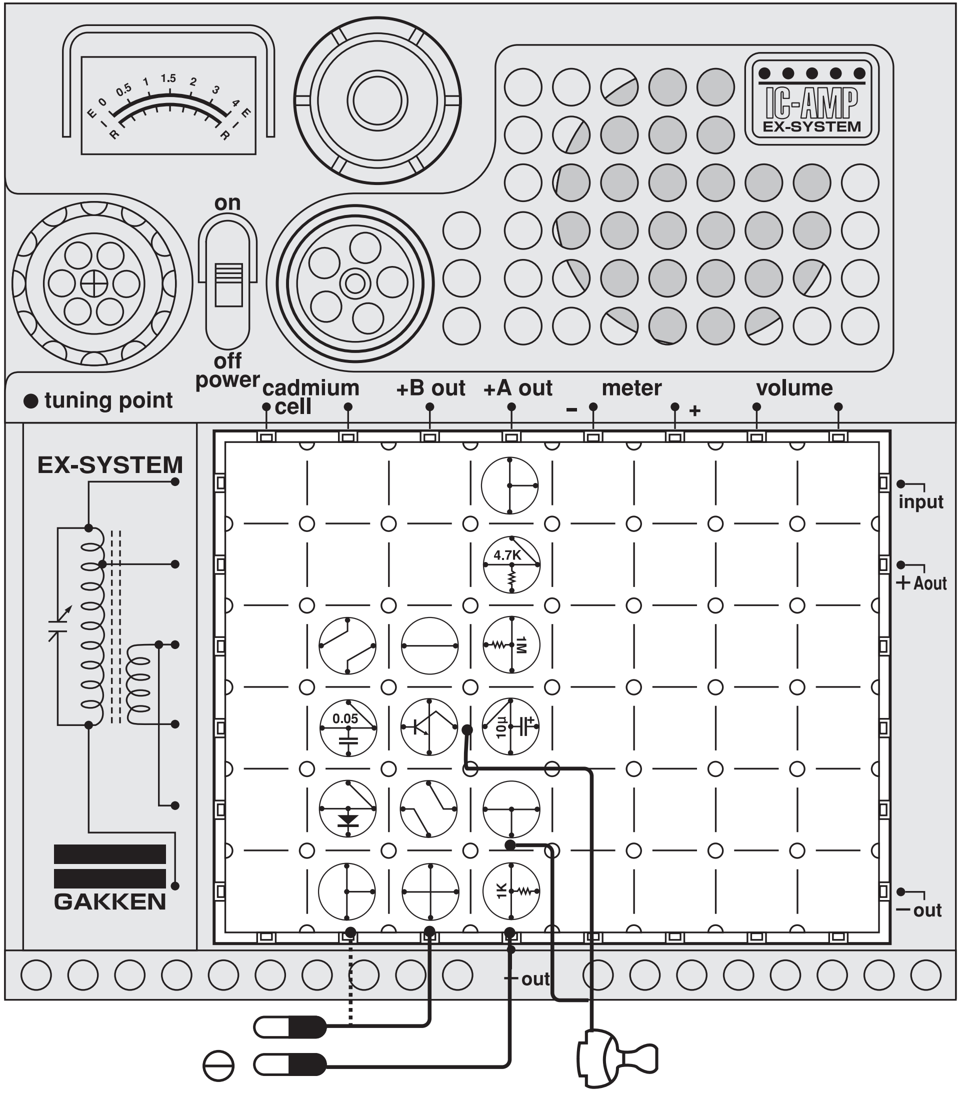


You can practice Morse code signals by using the key switch. Arrange the blocks as illustrated at left, attaching the earphone. Place the earphone in your ear and turn on the power switch. Then, using the Morse code signals given below, practice sending a message in code. You may also want to try to memorize the signals. They will be useful in later experiments.

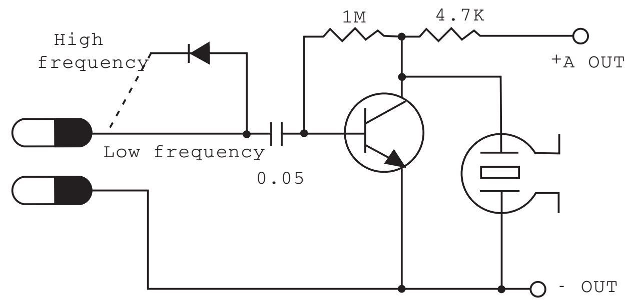
Morse Code



No. 25 Signal Tracer



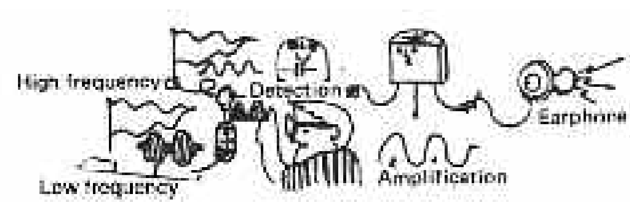
Circuit diagram for this experiment:



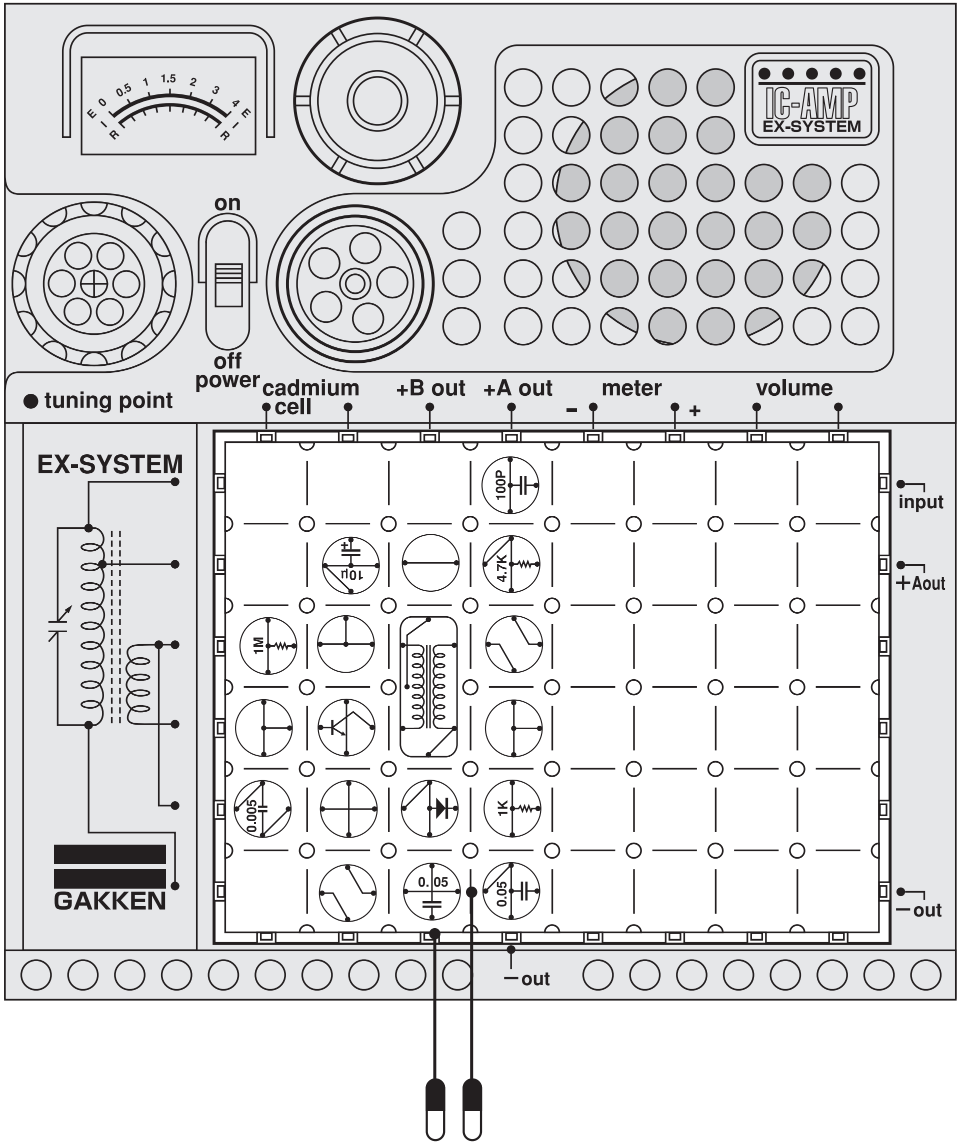
The signal tracer is a device to trace, or follow, a signal, when a radio receiver has gone out of order, for example, this device can be used to locate the trouble. You will easily find out where the source of trouble is in this experiment because the sound will stop coming out of the earphone.

Connect the negative -OUT of the 60cm cord to the negative -OUT of the radio set and touch the end of the other cord to the base and collector of the transistors, changing the connections for high frequency and low frequency.

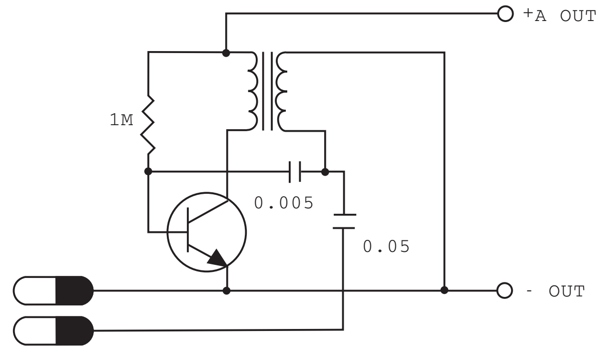
Be sure that the device which you are testing is entirely disconnected from the AC power.



No.26 Signal Injector

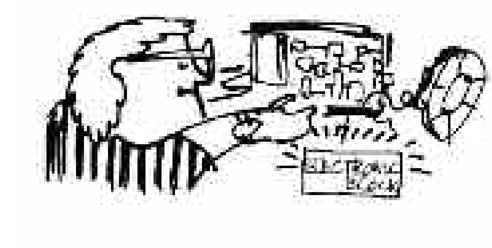


Circuit diagram for this experiment:

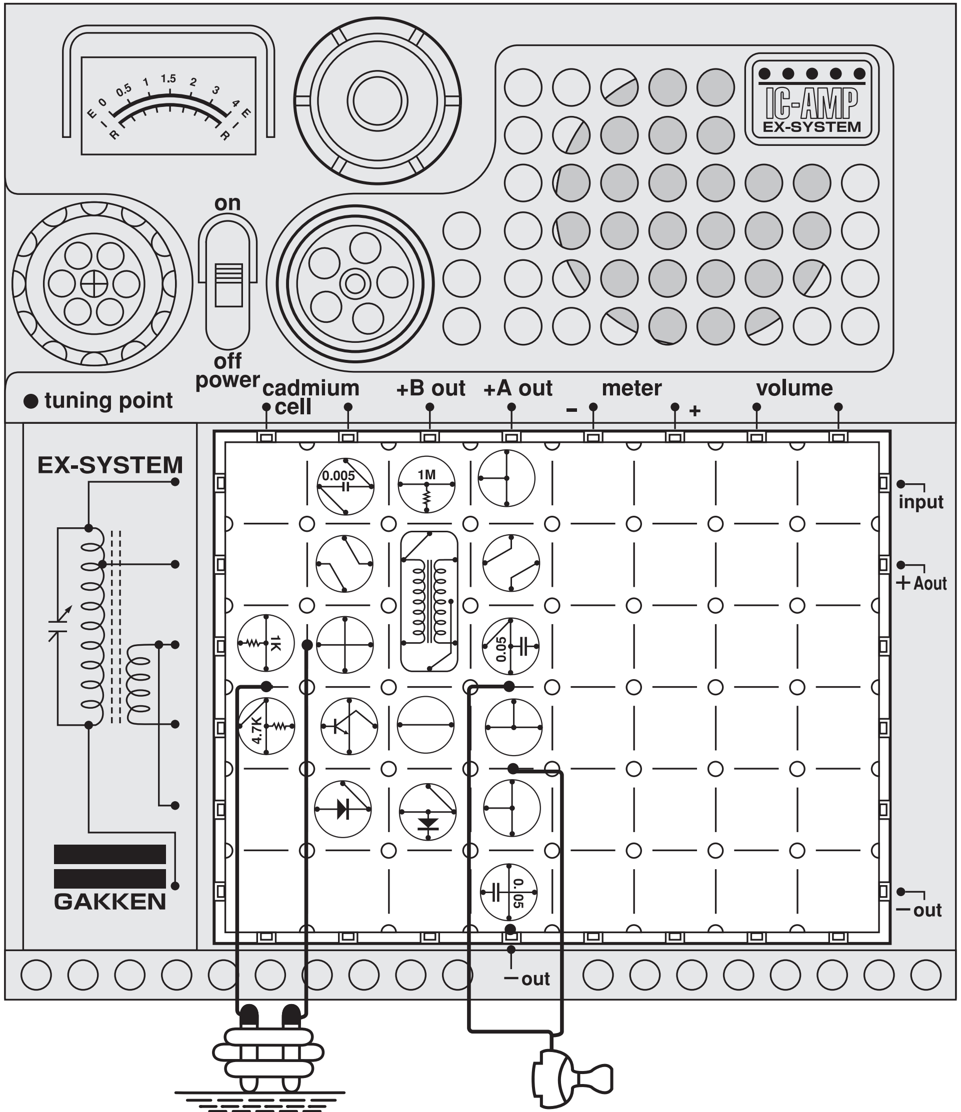


The signal injector is a device for applying a signal to an electronic circuit. When the tuning circuit in a radio receiver is out of order, the signal tracer on the preceding page cannot be used to check the low frequency and high frequency circuit coming next to see if they are working properly. In such a case, this signal injector can be used to inject a signal to the earphone or speaker of the radio to find where the source of trouble is.

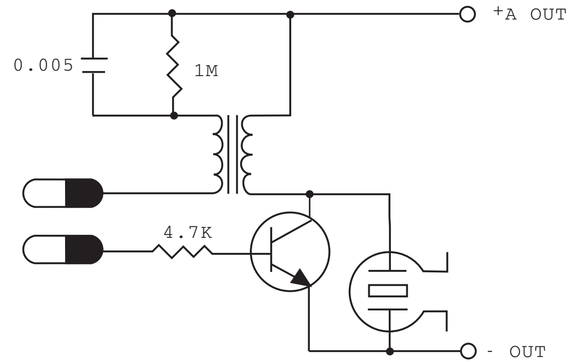
Be sure that the device which you are testing is entirely disconnected from the AC power.



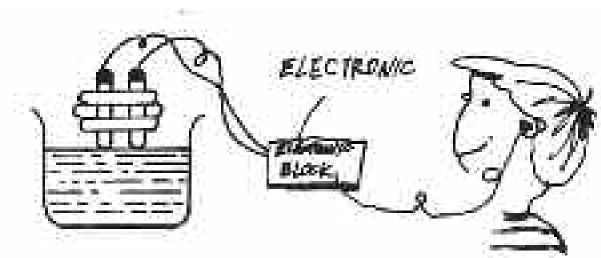
No.27 Water-Level Warning Device



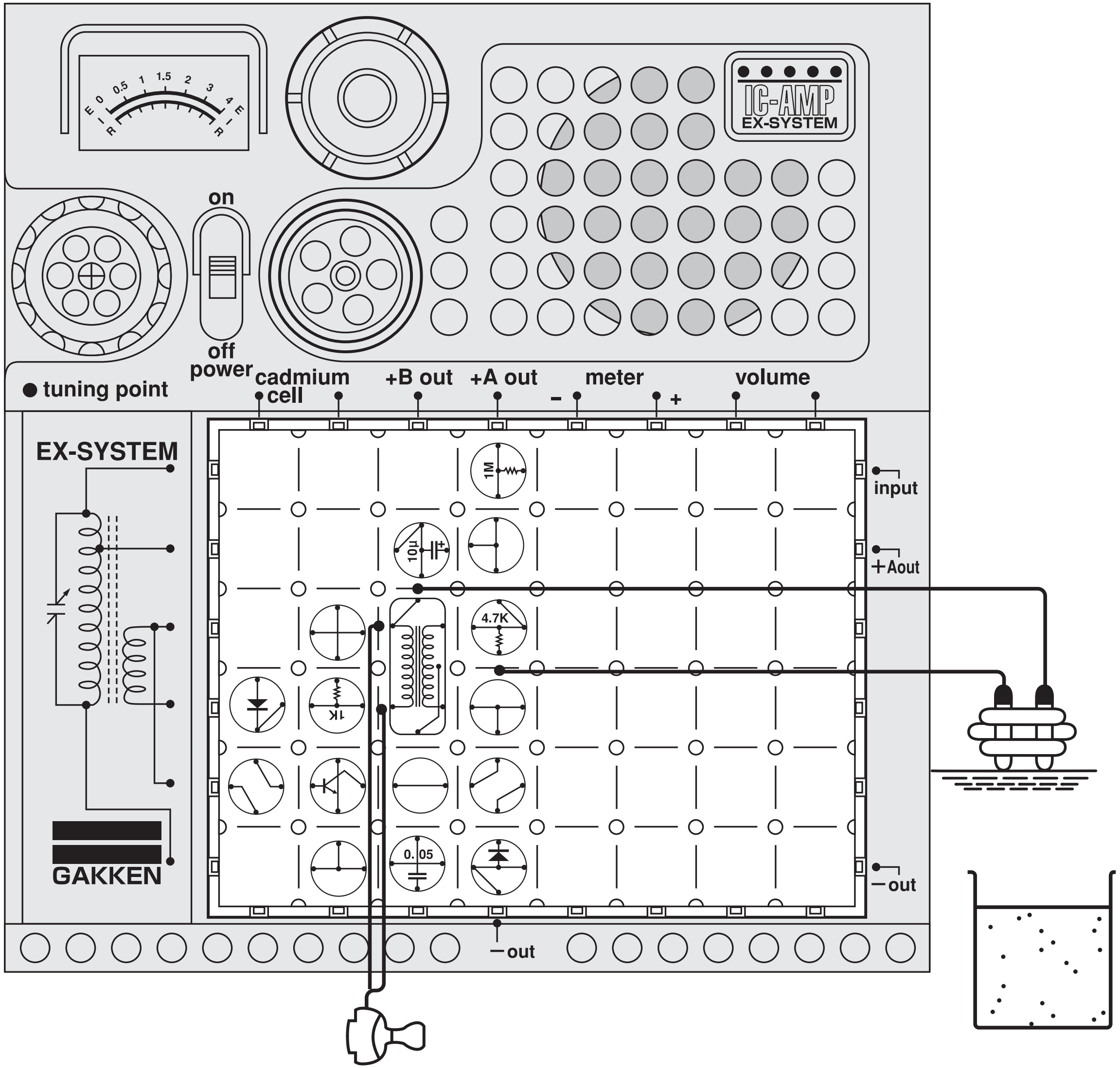
Circuit diagram for this experiment:



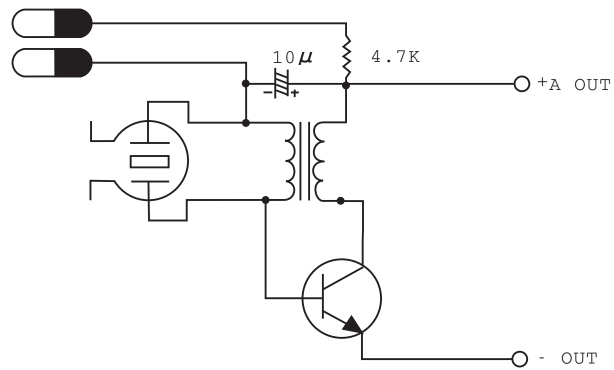
This experiment is another application of the oscillatory circuit. It can be easily done in a bathtub filled with water because ordinary water contains various impurities that allow a small current to pass through. Arrange the blocks as illstrated at left, attaching the earphone and 60cm cords. Hold the ends of the cords together with a plastic clip, as illustrated. Now immerse the ends in the bathtub water. Place the earphone in your ear and turn on the power switch. A current will flow between the two metal plates attached to the clip so that a bias current will flow to the base of a transistor to put it into operation. A high-pitched oscillatory note will be heard in the earphone.



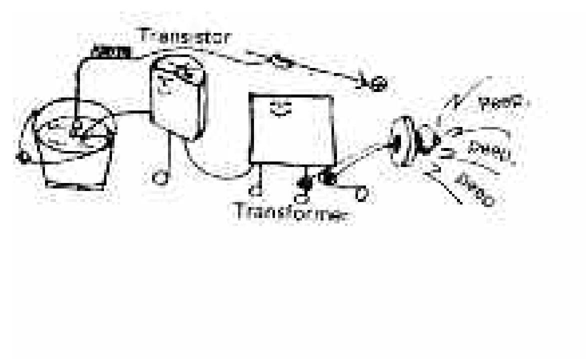
No.28 Simple Water Quality Indicator



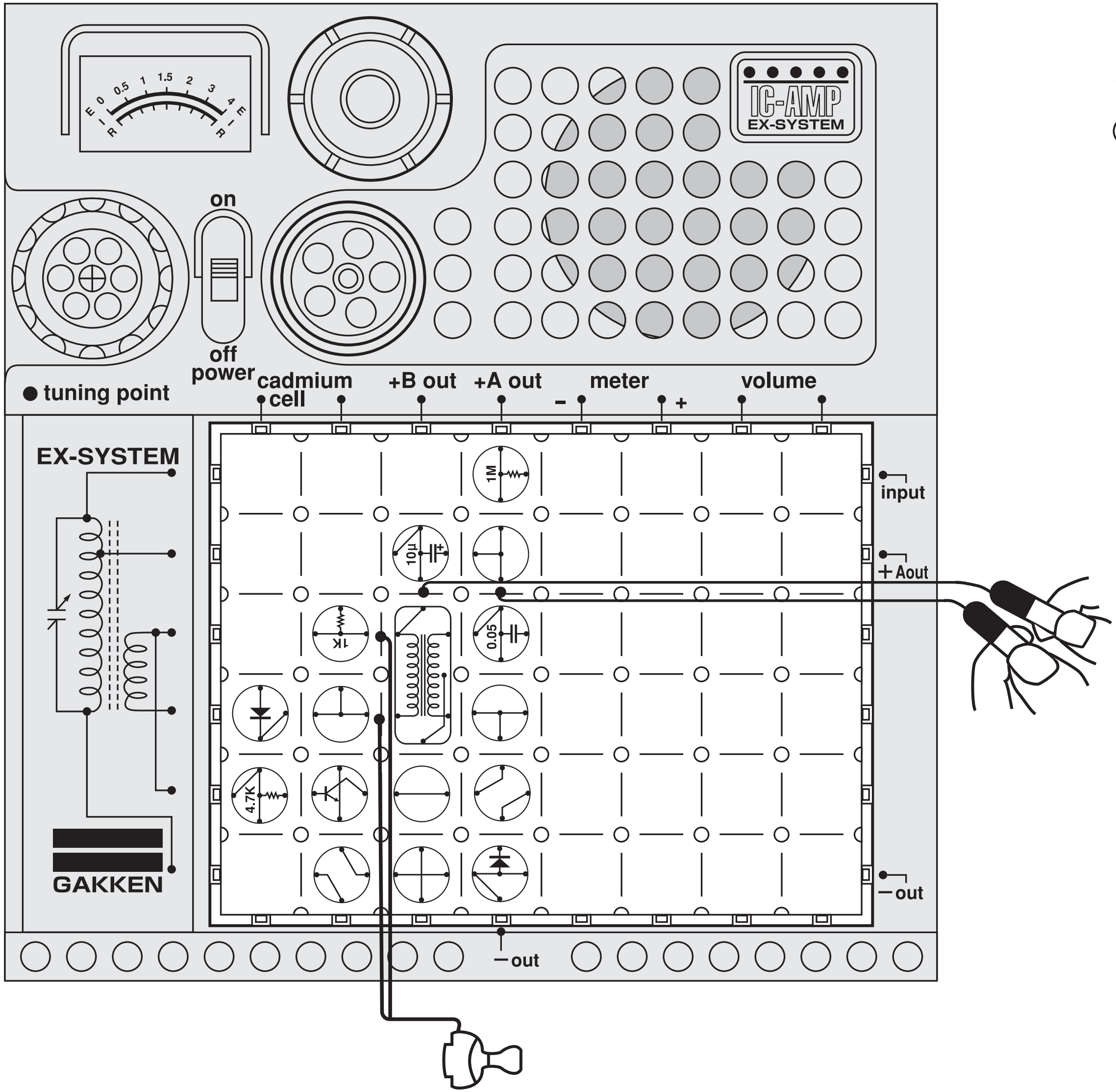
Circuit diagram for this experiment:



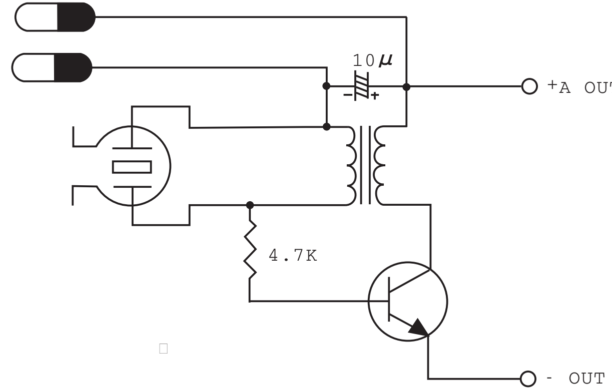
This circuit is used to examine various substances dissolved in water. Arrange the blocks as illustrated at left, attaching the earphone and 60cm cords. Place the earphone in your ear. Turn on the power switch. Hold the ends of the cords together with a plastic clip. Put the electrode, which you have created with the ends of the cords, in a glass of fresh water and then in a glass of salt water to see if you hear different tones in the earphone.



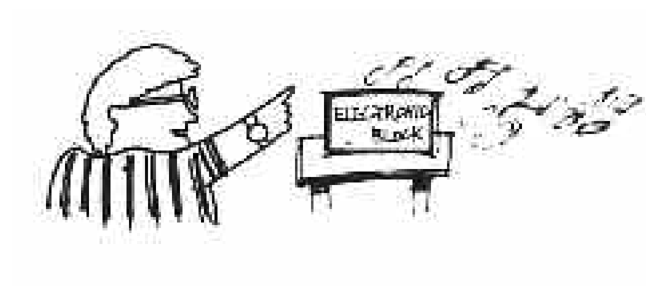
No.29 EIectronic Motorcycle



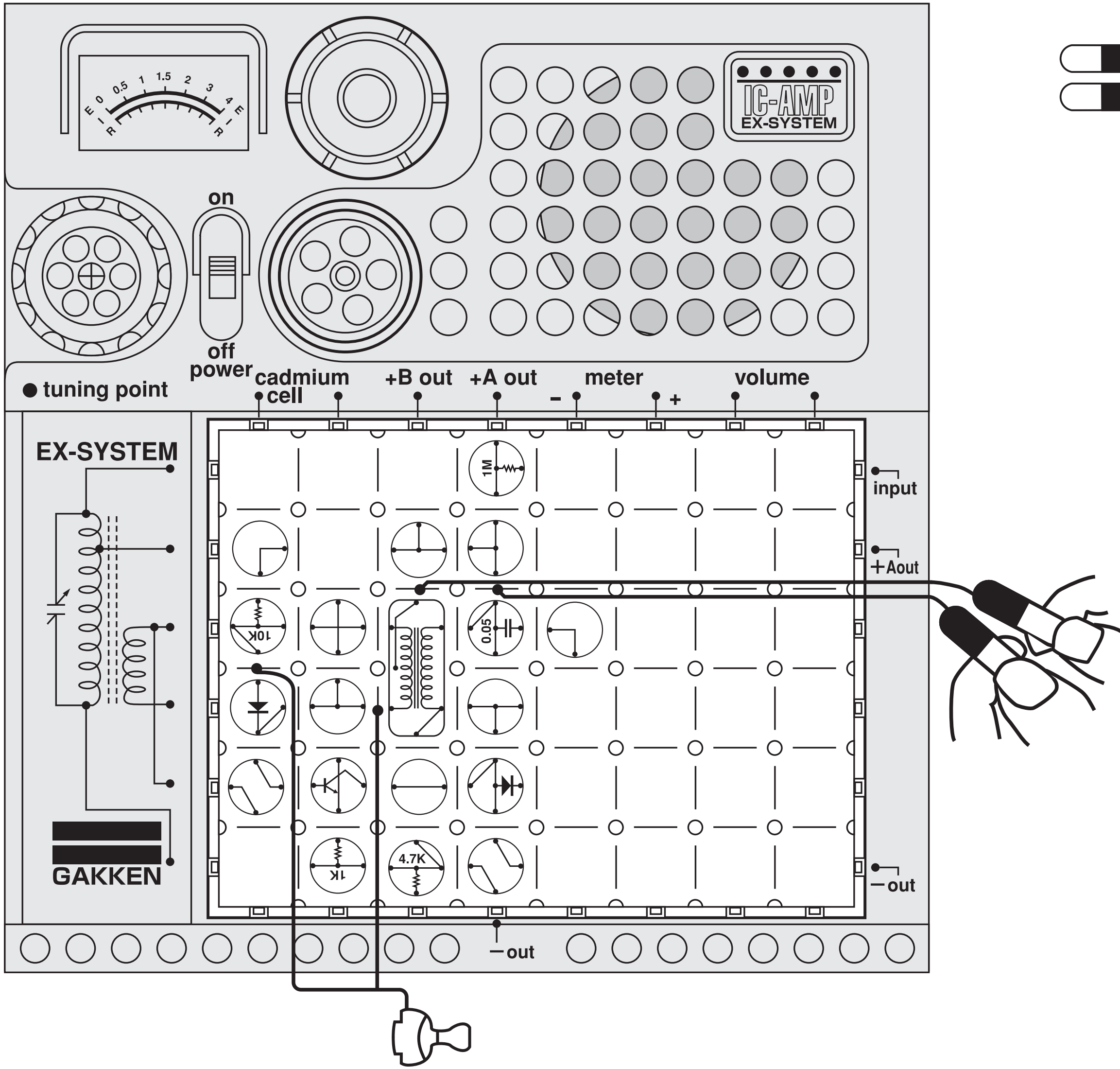
Circuit diagram for this experiment:



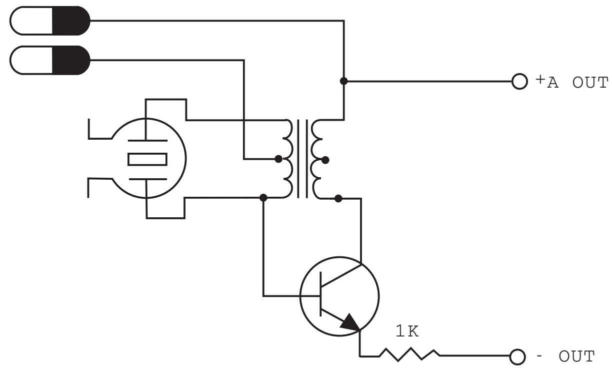
Arrange the blocks as illustrated at left, attaching the earphone and 60cm cords. Place the earphone in your ear and turn on the power switch. Grip the tips of the cords in the thumb and forefinger of both hands. If you alternately tighten and relax the grip, the circuit will produce a sound like a motrocycle. Vary the sound by controlling your finger pressure.



No.30 Lie Detector (Earphone Type)



Circuit diagram for this experiment:

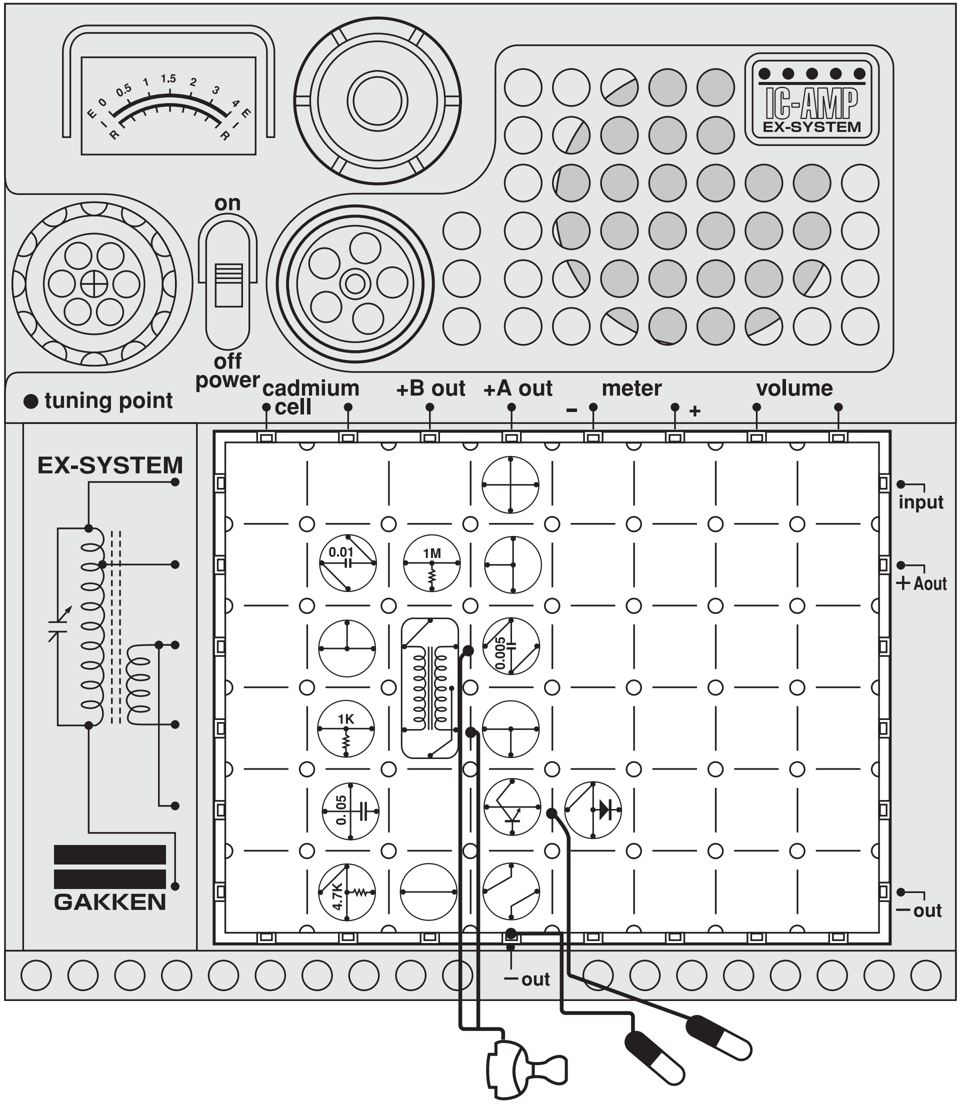


Arrange the blocks as illustrated at left, attaching the earphone and 60cm cords. Place the earphone in your ear and turn on the power switch. Have a friend hold the tips of the cords in the thumb and forefinger of both hands. Now ask questions to see if your friend is telling the truth.

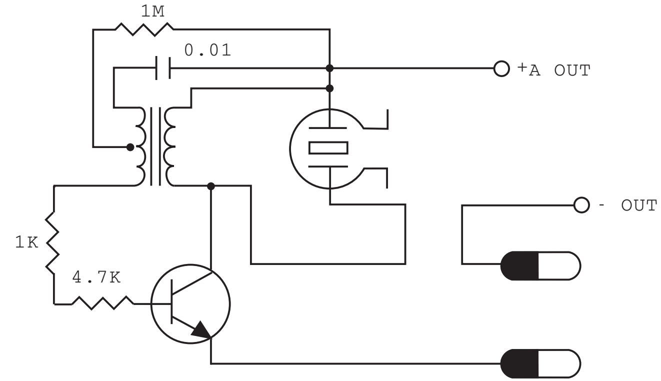
We usually perspire when we tell a lie, and the perspiration makes it easier for an electric current to fiow. The changes in the sound that you hear in the earphone will tell you if your friend is lying or telling the truth.

Note: The experiment is only for fun.
Please note that the result is not always reliable.

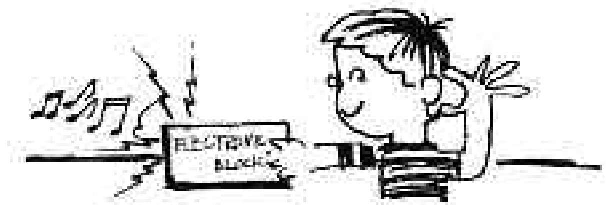
No.31 Continuity Tester



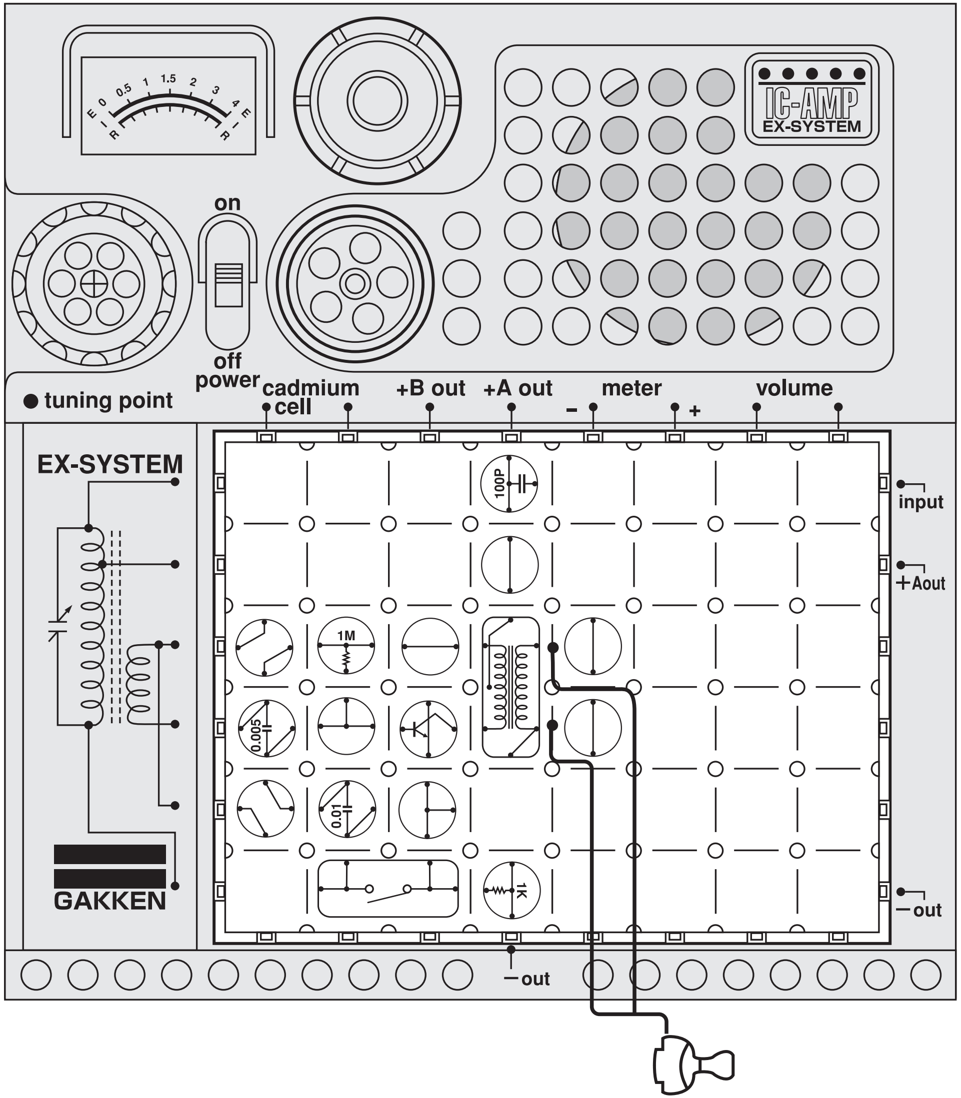
Circuit diagram for this experiment:



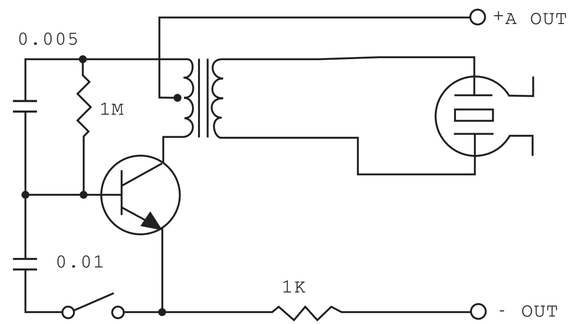
The continuity tester is a device used to check for broken wire in electrical apparatus. For this experiment, you will need two light bulbs; a good one and a burned-out one. Arrange the blocks as illuslrated at left, attaching the earphone and 60cm cords. Place the earphone in your ear and turn on the power switch. Place the cords near one of the light bulbs, then near the other. You will hear a high-pitched note where the circuit inside is closed, but no sound will be heard from the burned-out bulb.



No.32 Electronic Siren (Earphone Type)

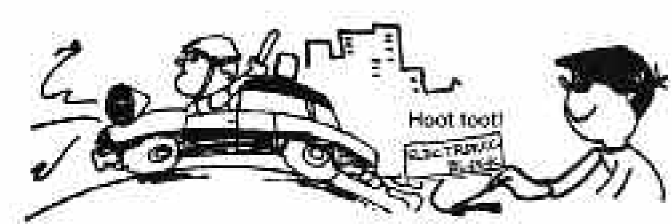


Circuit diagram for this experiment:

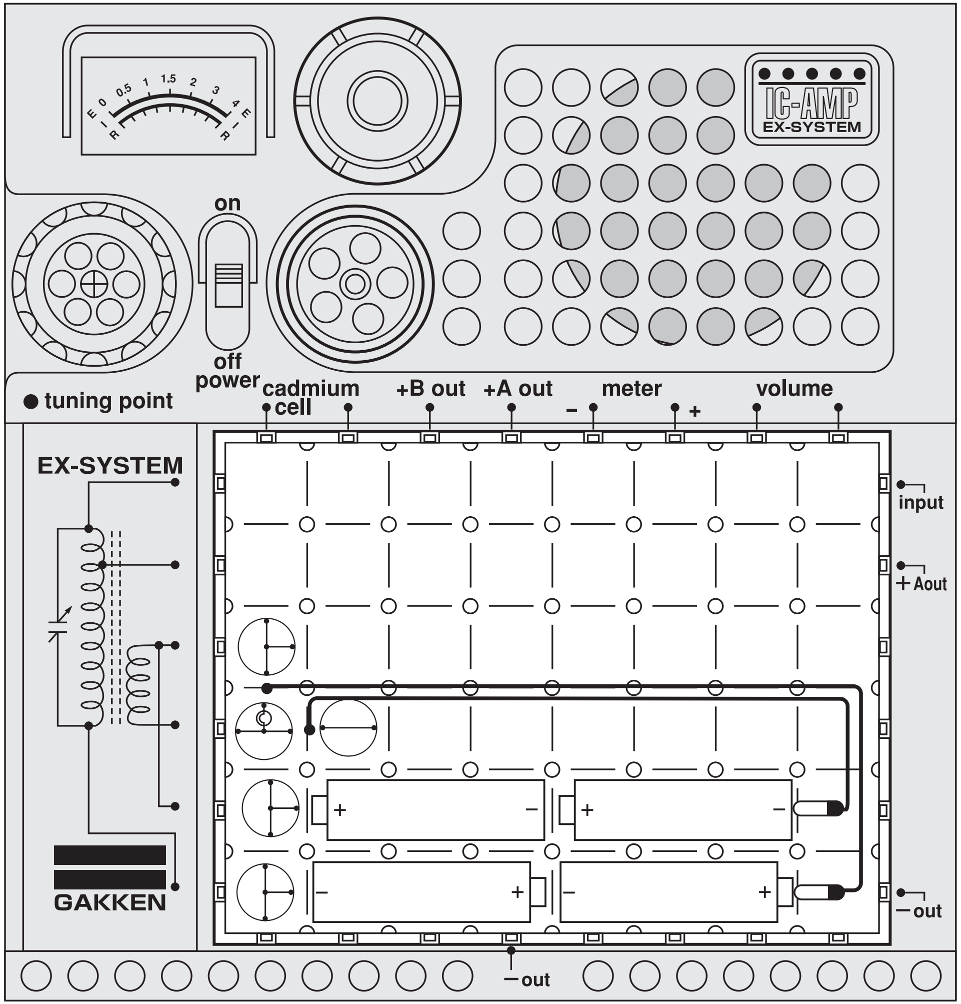


This experiment is also an application of the oscillatory circuit. This time, the circuit is interesting because it produces two different tones.

Arrange the blocks as illustrated at left, attaching the earphone. Turn on the power switch. Press down on the key switch to produce one tone, then release to produce the other.

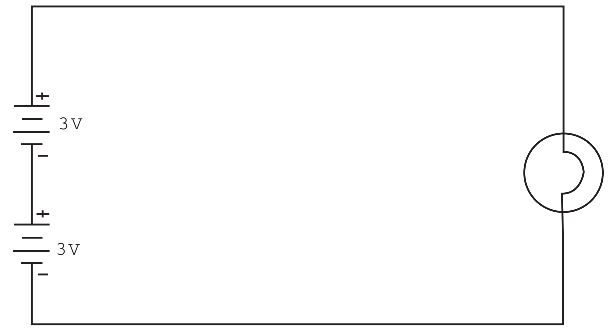


No.33 Series Connection Dry Batteries



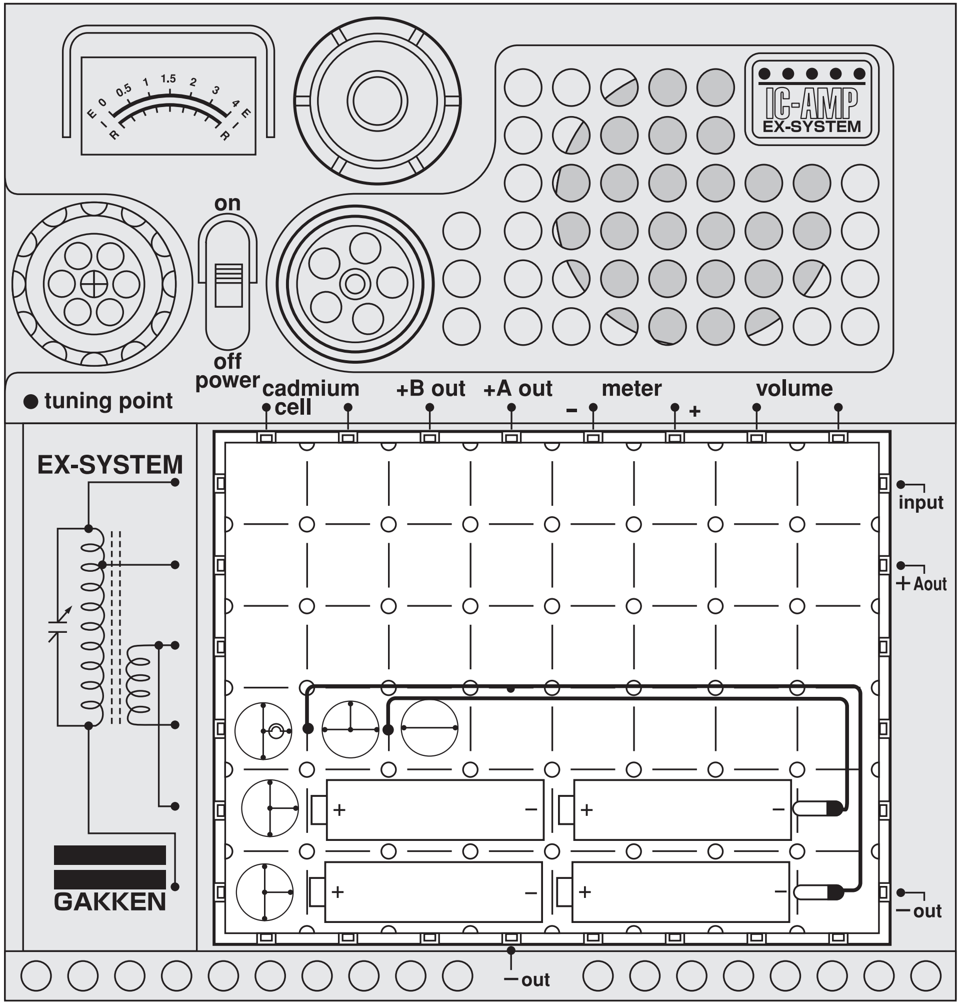
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:



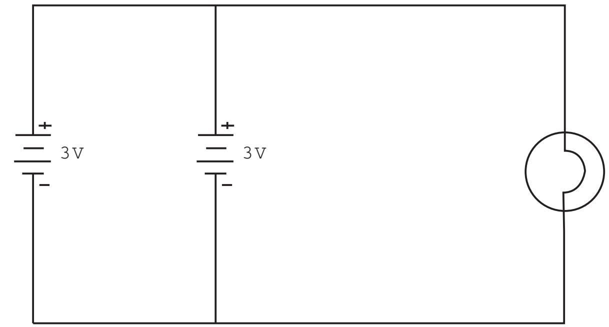
Remove the batteries from your kit to do this experiment on series connection of batteries. Arrange the blocks and set the batteries in place as illustred at left, taking care to position the ⊕ and ⊖ sides of the batteries properly. Connect the 60cm cords to the ⊕ and ⊖ terminals of the batteries, turn on the power switch, and you will see the lamp glow brightly.
In this arrangement of batteries, the resulting power is 6V (3V ⊕ 3V). When the batteries are connected in series like this, the lamp will glow brightly, but it consumes so much power from the batteries that they will not last so long as in the case of a parallel connection. For an experiment with a parallel connection of batteries, see the following page.

No.34 Parallel Connection Dry Batteries

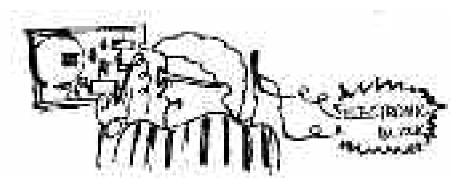


Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

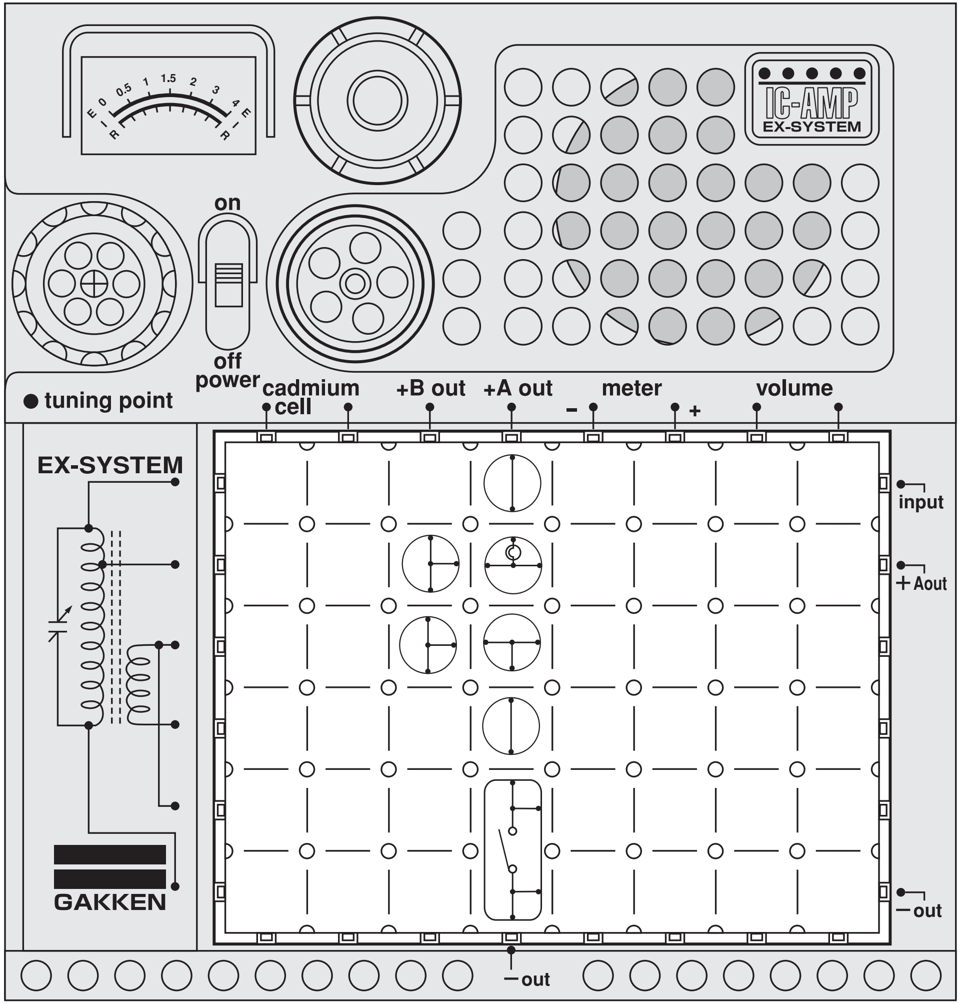
Circuit diagram for this experiment:



We experimented with a series connection of batteries on the preceding pape. There is another way of connecting batteries; that is, a parallel connection. Arrange the blocks and set the batteries as illustrated at left, positioning the ⊕ and ⊖ sides of the batteries properly. Now, connect one of the 60cm cords to the ⊖ side of a battery. Turn on the main switch, and the lamp will glow. Next, connect both cords to the batteries as illustrated, and again the lamp will glow. When parallel-connected, the consumption of power of individual batteries is less than in the case of a series connection. The batteries will last longer, but the bulb does not glow so brightly. This kind of circuit is called a "parallel circuit".

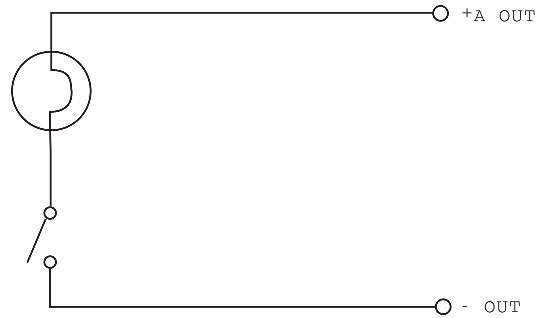


No.35 Morse Code Practice Circuit by Light (Lamp Type



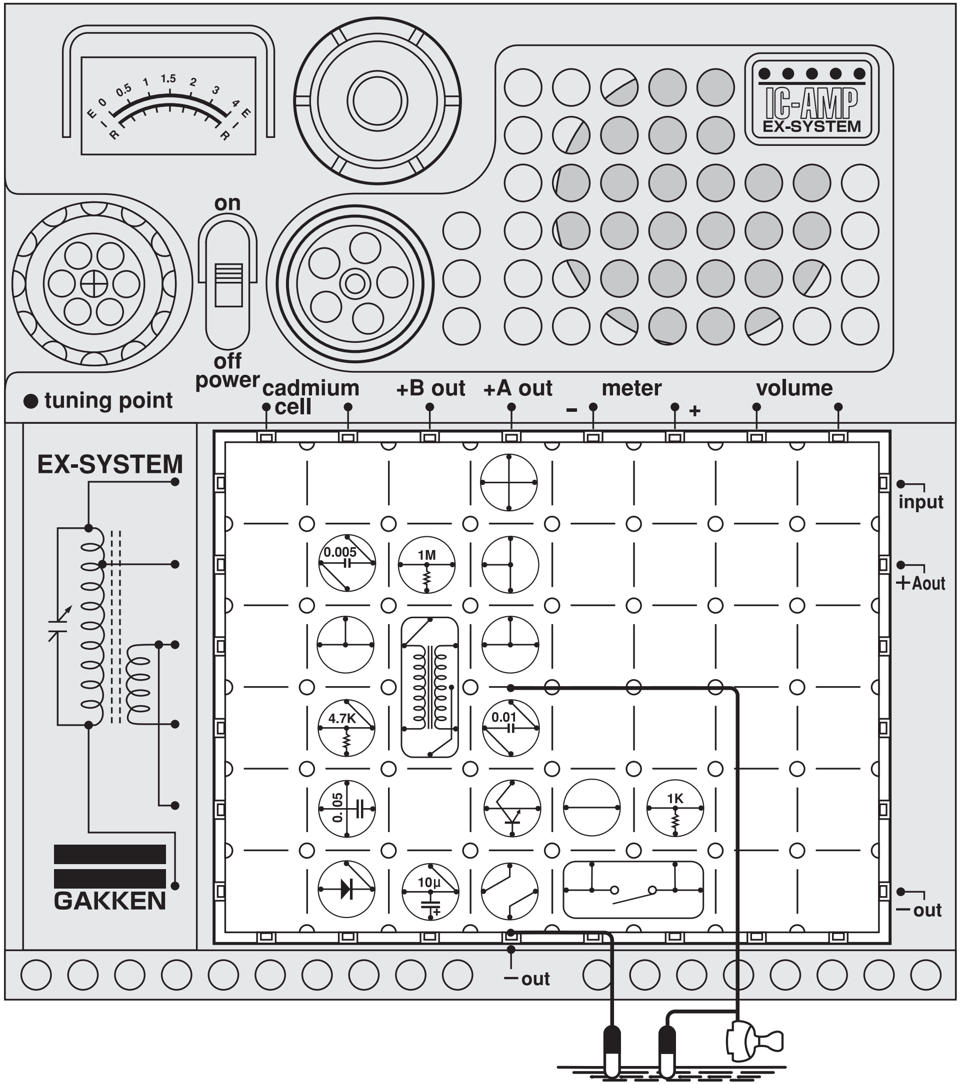
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

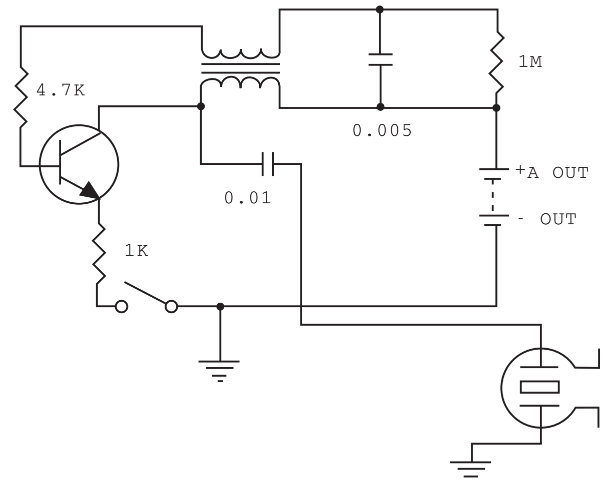


This is a very simple circuit that enables you to practice the Morse code. The circuit uses light, not sound.
Arrange the blocks as illustrated at left and turn on the power switch. The bulb will glow. Signal light flashes when you press down and release the key switch. See Experiment No.24 for Morse code signals.
Using flashes of light for secret communication is an excellent method because no radio waves are used.

No.36 Grounded Morse Code Transmitter



Circuit diagram for this experiment:



When we experimented with the water-level warning device, we learned that water is a conductor of electricity. This grounded telegraph experiment is a mechanism for testing whether the ground is also a conductor of electricity. In this telegraph, the electrical lead is connected to the ground.

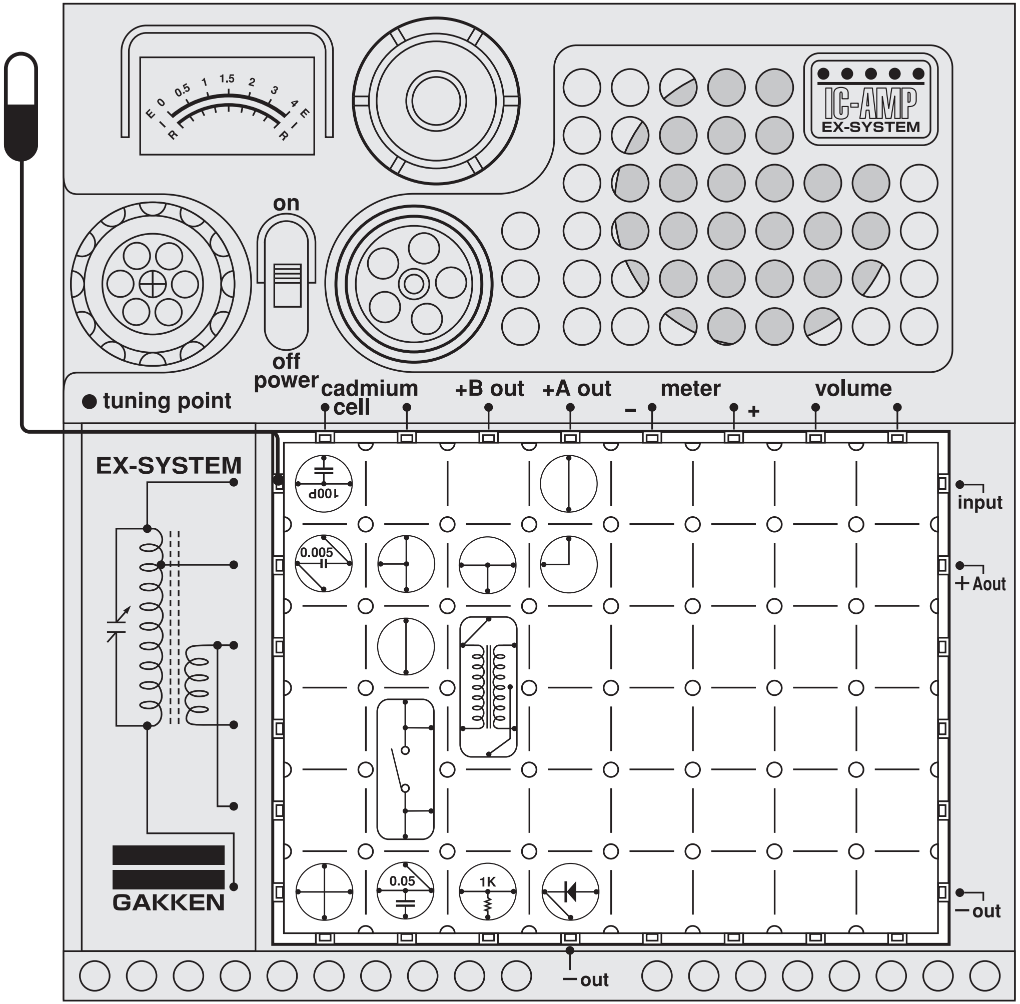
Arrange the blocks as illustratated at left attaching one end of the antenna to the kit. Carefully unwind the two ends of the eraphone and attach one end to the kit.

Place the other end of the antenna and earphone in the ground.

Have a friend place the earphone in his ear. Turn on the power switch. Using the Morse code signals in Experiment No.24, press down on the switch to see if you can send your friend a message. If the ground is a conductor of electricity, your friend will be able to hear the message.

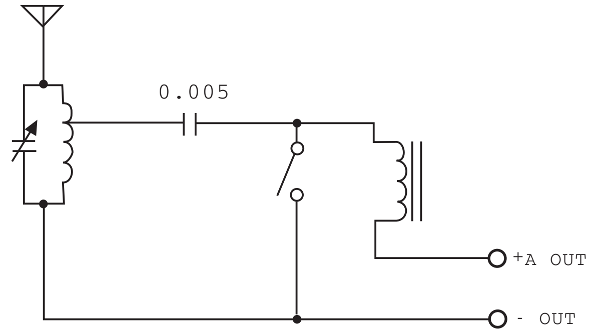
No.37 Marconi's Spark Telegraph

Antenna ●Dangerous! Do not insert antenna lead into an AC outlet.



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:



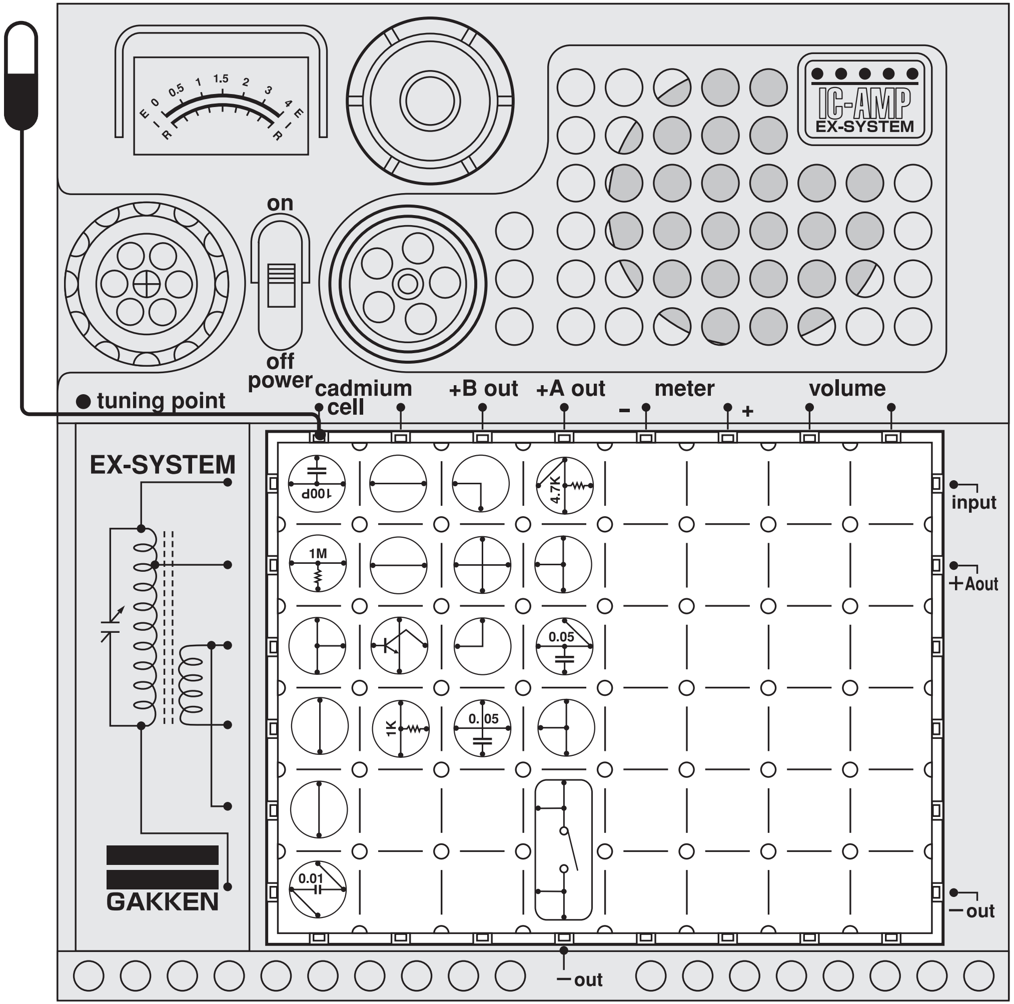
Now let's experiment with the spark telegraph invented by an Italian electrical engineer named Marconi,who brought experimental radio communication into practice. Around 1900, he succeeded in transmitting and receiving messages by radio waves over a distance of about 15 kilometers. He won the Nobel Prize for his work in 1901.

Now we can do an experiment on the theory of the radio circuit invented by Marconi by using the electronic blocks. Arrange the blocks and antenna as illustrated at left. Then set up the AM radio as for Experiment No.10, tuning the circuit you have built with the blocks to the radio. Then operate the key switch to send Morse code signals to the radio. Use the Morse code signals in Experiment No.24 to send your mesages.

In the transitting experiments, please put the transmitting antenna close to the radio's receiving antenna to have a better reception.

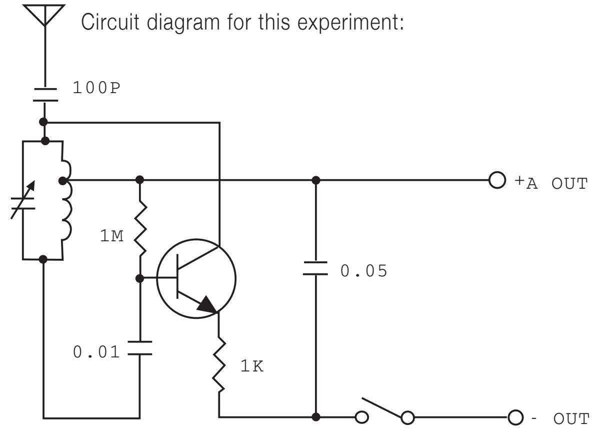
No.38 Radio Telegraph (A_1 Wave)

Antenna ●Dangerous! Do not insert antenna lead into an AC outlet.

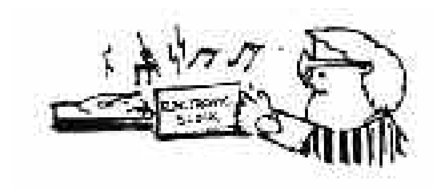


Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

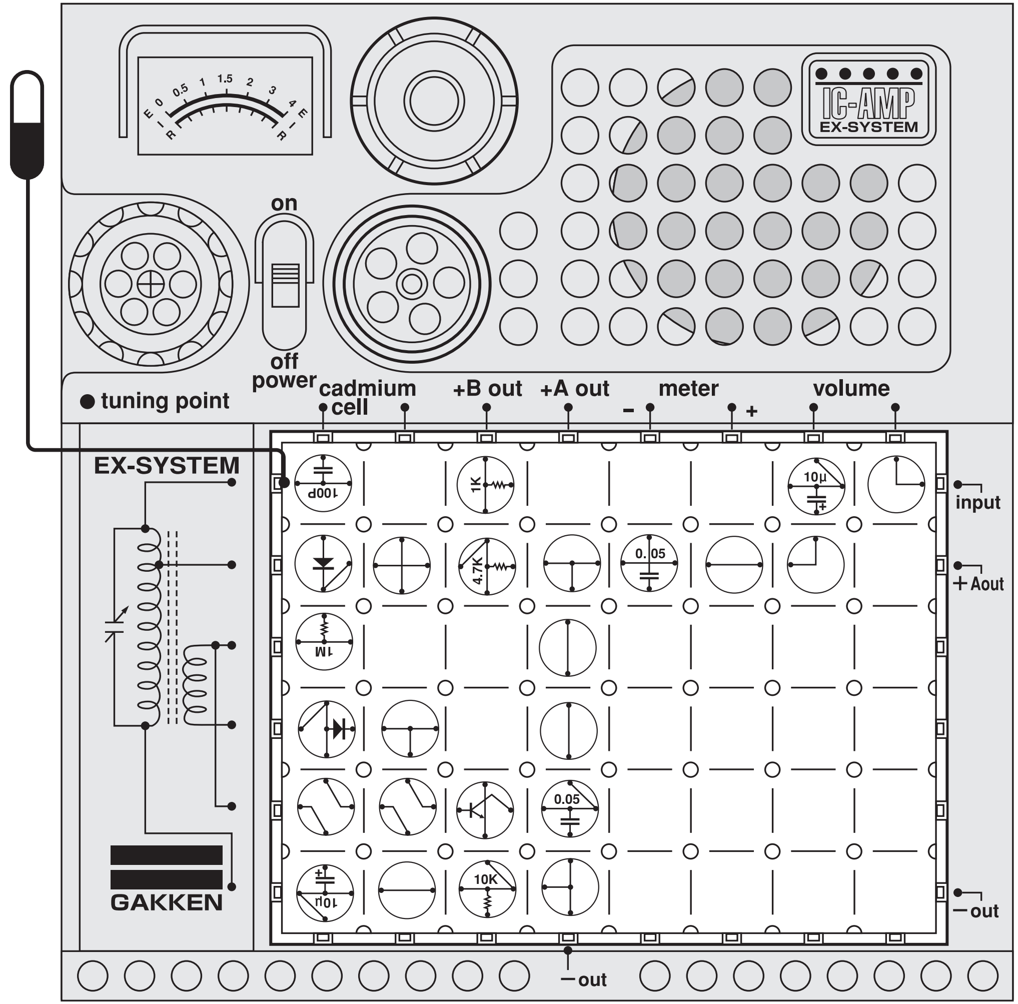


This is another experiment with a radio telegraph. This one is more sensitive than the one in Experiment No.37. It can be built in the same manner.
Arrange the blocks and antenna as illustrated at left. Then set up the AM radio as for Experiment No.10, tuning the circuit you have built to the radio. Then operate the key switch to send Morse code signals to the radio. Use the Morse code signals in Experiment NO.24 to send your messages.
In the transmitting experiments, please put the transmitting antenna close to the radio's receiving antenna to have a better reception.



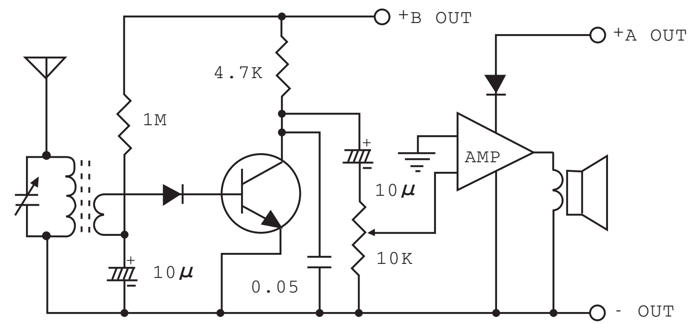
No.39 1-Diode Detector + IC Radio Amplifer (Fixed Bia

Antenna ●Dangerous! Do not insert antenna lead into an AC outlet.

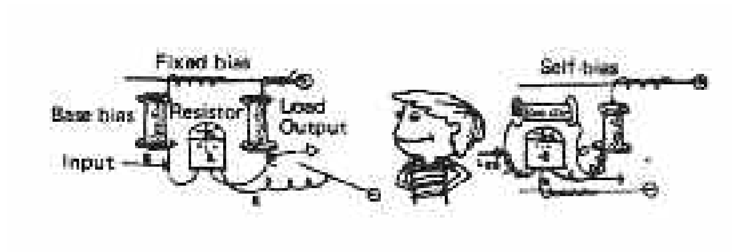


Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

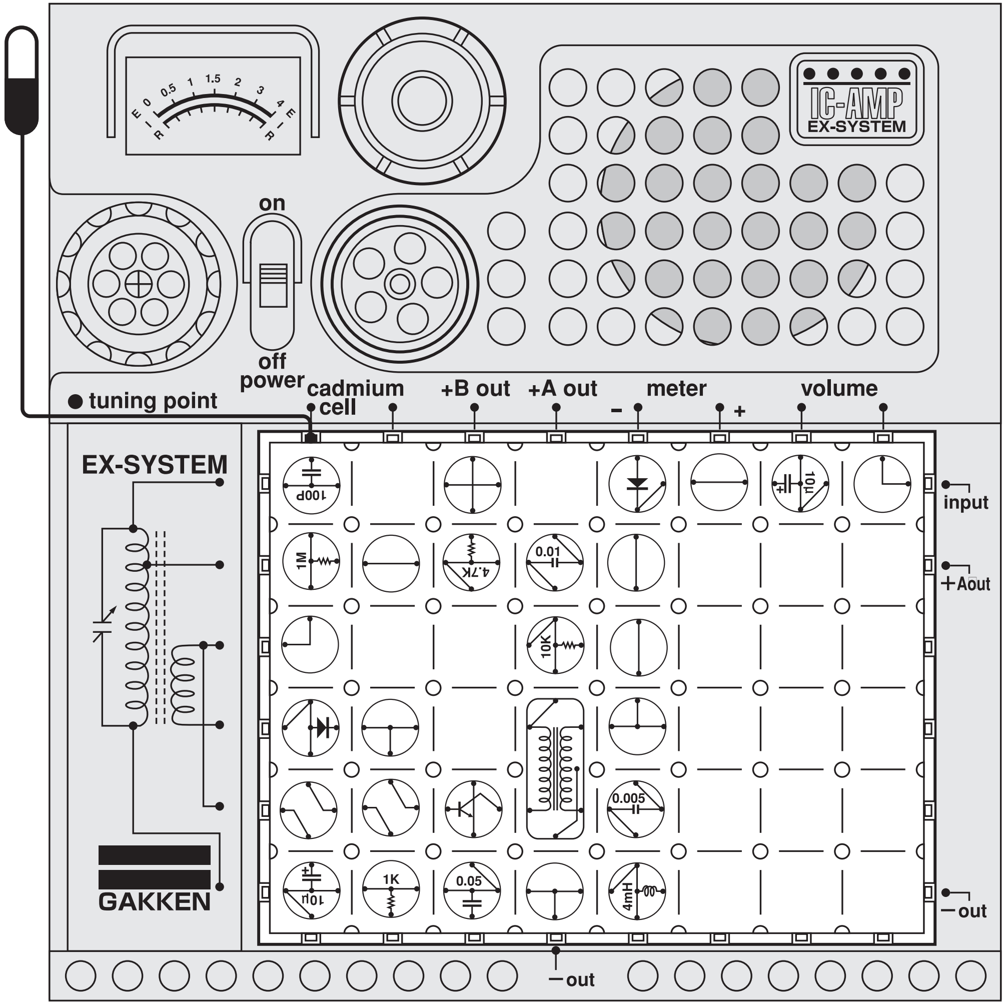


In this experiment, we use an IC amplifier for the first time. After being detected by a diode and amplified by a transistor, the current is further amplified by the IC amplifier. The IC amplifier has the circuit network shown below. Arrange the blocks and antenna as illustrated at left. Turn on the power switch, and the radio will play.



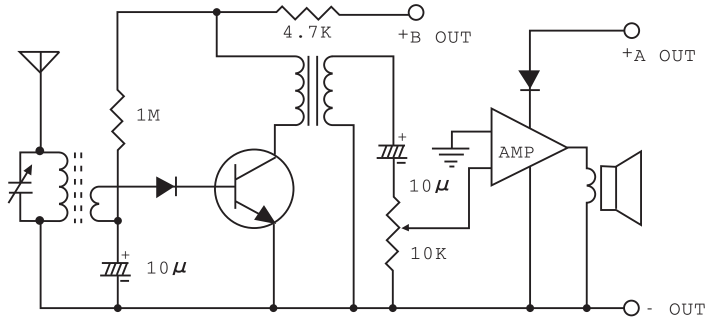
No. 40 1-Diode Detector + IC AmpIifier Radio (Self-bias

Antenna ●Dangerous! Strictly avoid inserting antenna lead into an AC outlet.

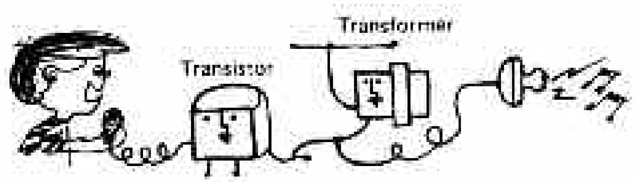


Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

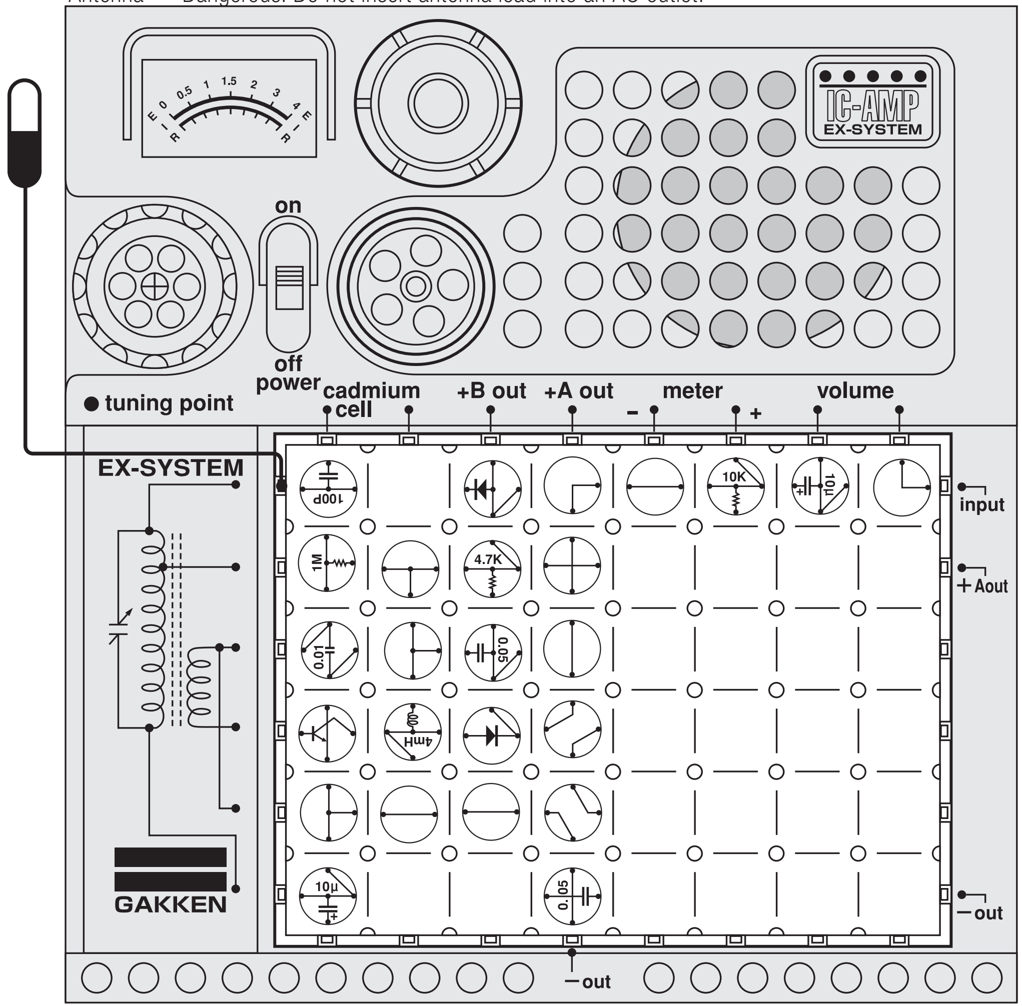


There are many kinds of radio circuits. This one is the self-bias type. Let's do this experiment to see how this circuit differs from the one in Experiment No.39, and which of the two circuits is the more sensitive. Arrange the blocks and antenna as illustrated at left. Turn on the power switch, and the radio will play.



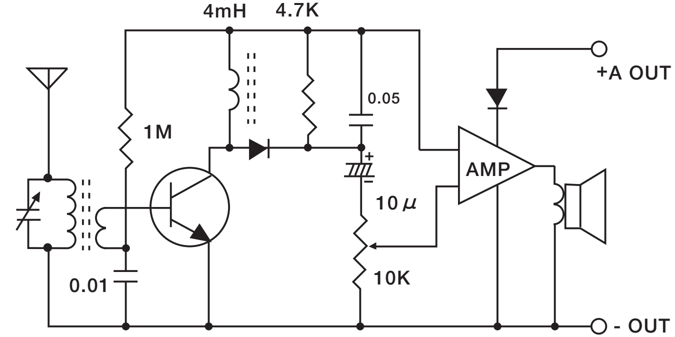
No. 41 1-Transistor High-Frequency Amplifier + IC Amplifier Radio (Resistive Load)

Antenna ●Dangerous! Do not insert antenna lead into an AC outlet.



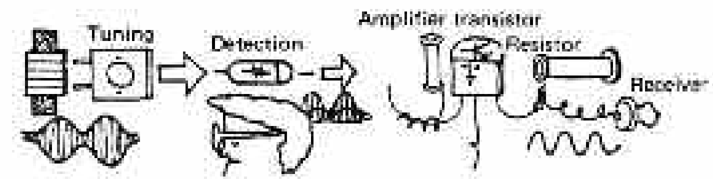
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

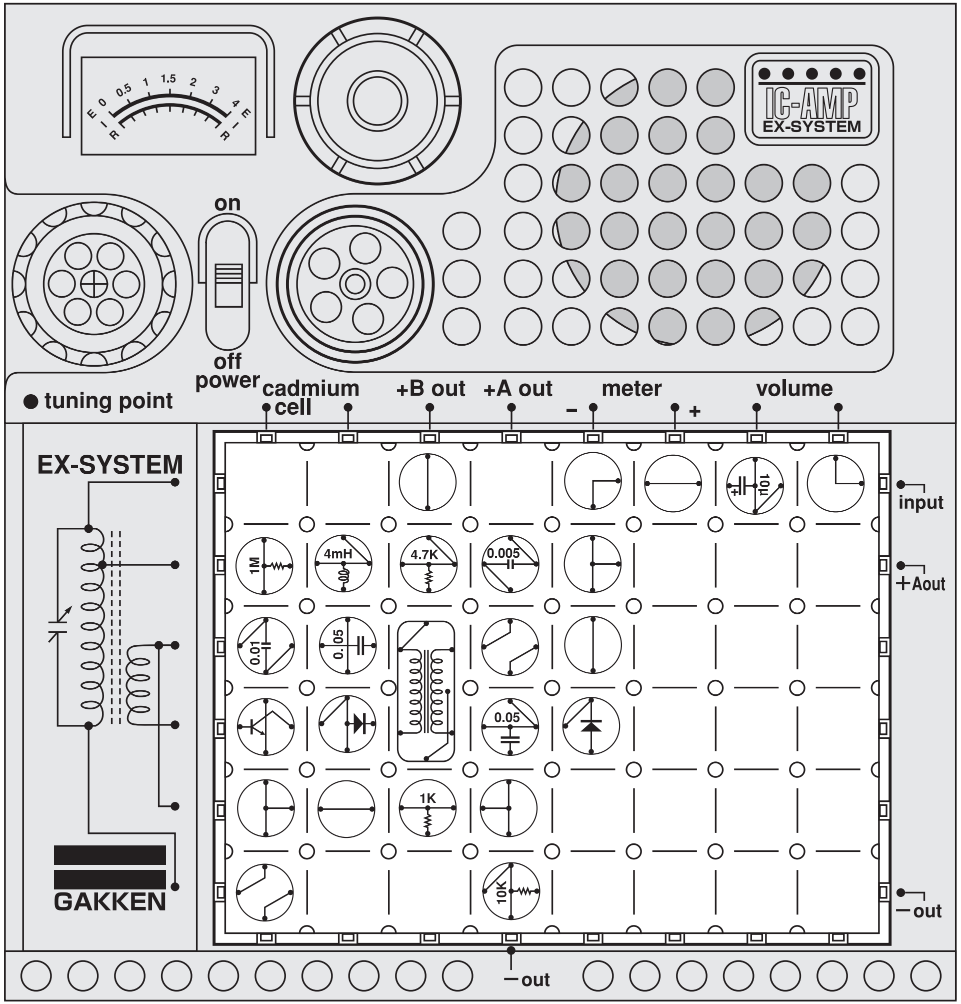


This experiment will teach you the method called "high-frequency amplification", which increases the strength of weak radio slgnals coming from a distant radio station. Arrange the blocks and antenna as illustrated at left. Turn on the power switch, and the radio will play.

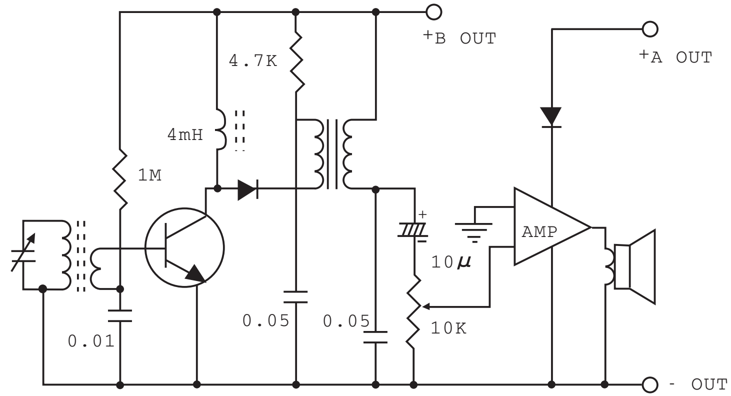
The weak incoming radio signal is amplified by the transistor you have just built. In order to further amplify the radio signal, second and third amplifier stages may be used, but the process is technically so difficult that the single high-frequency amplifier stage is widely employed.



No.42 1-Transistor High-Frequncy Amplifier + IC AmpIifi (Transformer Load)



Circuit diagram for this experiment:



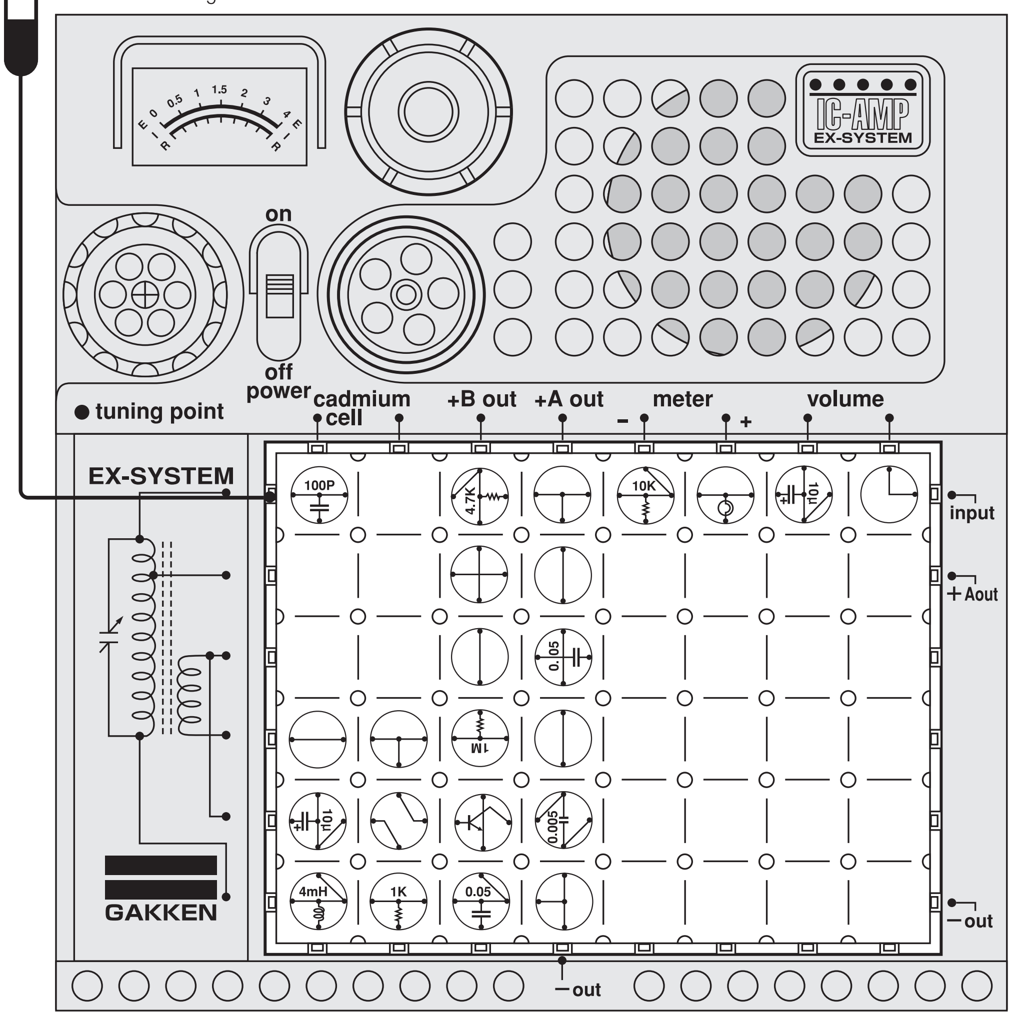
There are many kinds of high-frequency amplifier radios. In this experiment, we will study the type using a transformer. This is not so sensitive as the reflex radio circuit. It will help you understand a radio circuit, however, because such circuits as tuning, high-frequency amplifier, detector, and power amplifier are arranged in that order in this circuit.

Arrange the blocks as illustrated at left. Turn on the power switch, and the radio will play.

Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

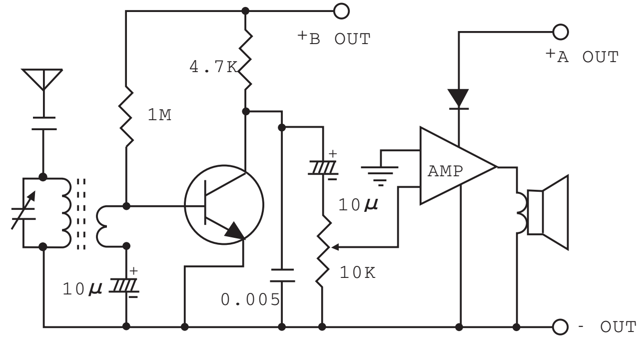
No. 43 1-Transistor Detector + IC Amplifier Radio

Antenna ●Dangerous! Do not insert antenna lead into an AC outlet.



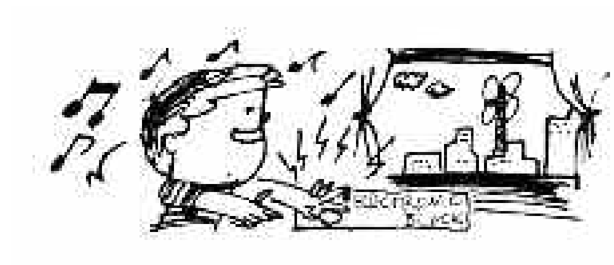
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

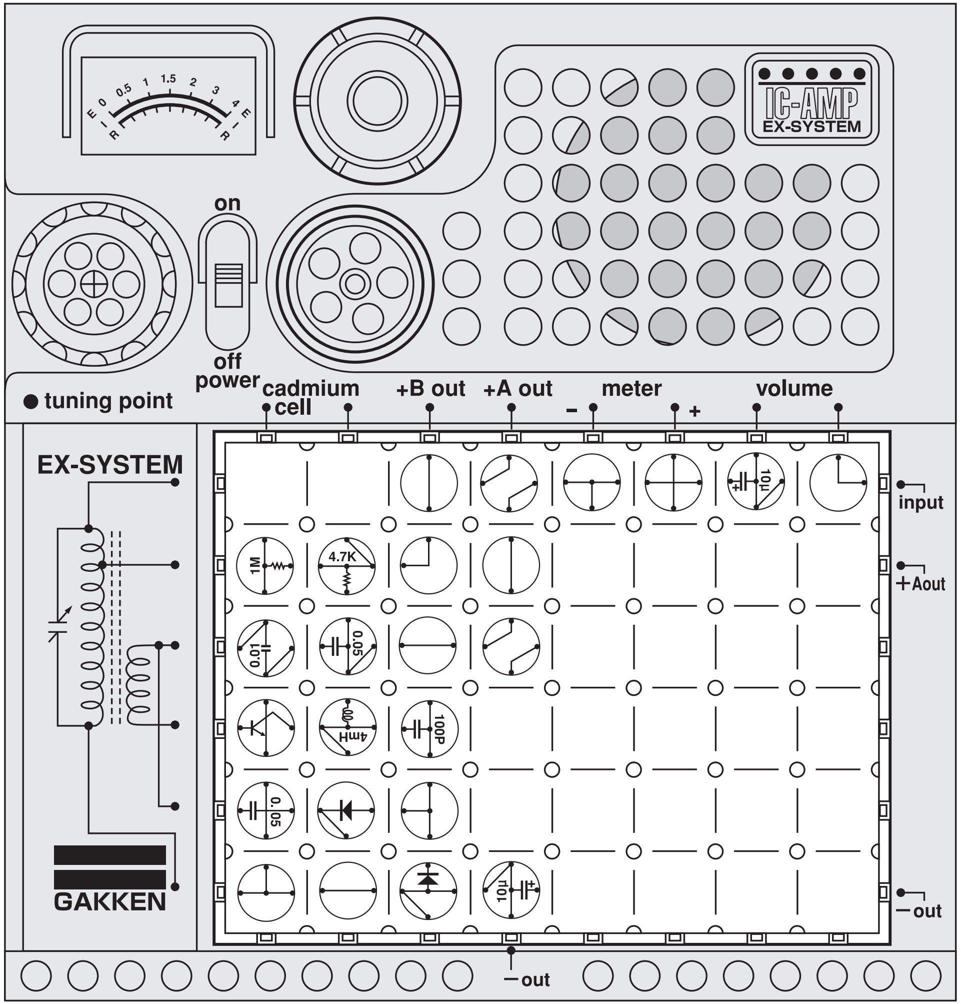


There are many radio broadcasting stations, and they all radiate different radio waves. They come into our home through antennas and electric lines, including telephone wires. The antenna that is provided with the electronic blocks works to pick up these radio waves. Now let's experiment with a radio receiver using a transistor detector. In this radio, both detection and amplification are achieved by the transistor, and therefore no diode is used.

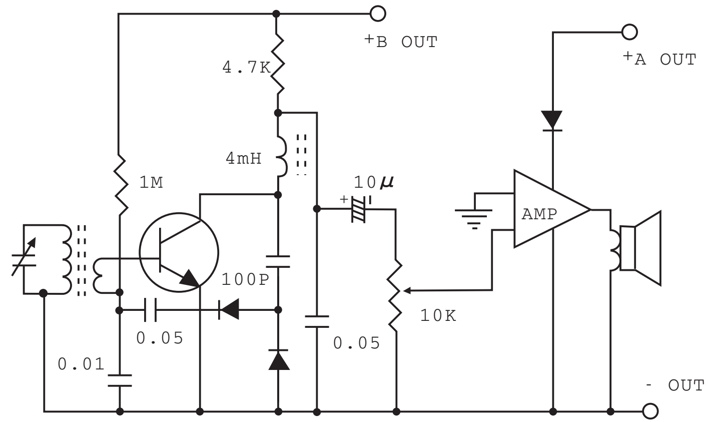
Arrange the blocks and antenna as illustrated at left. Tun on the power switch, and the radio will play.



No. 44 1-Transistor + IC Amplifier Reflex Radio (Res:

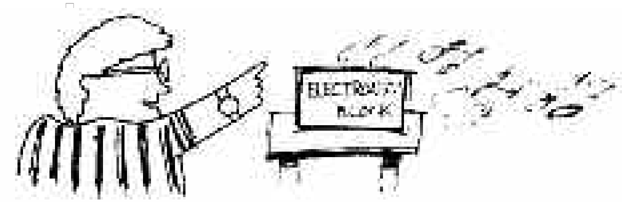


Circuit diagram for this experiment:



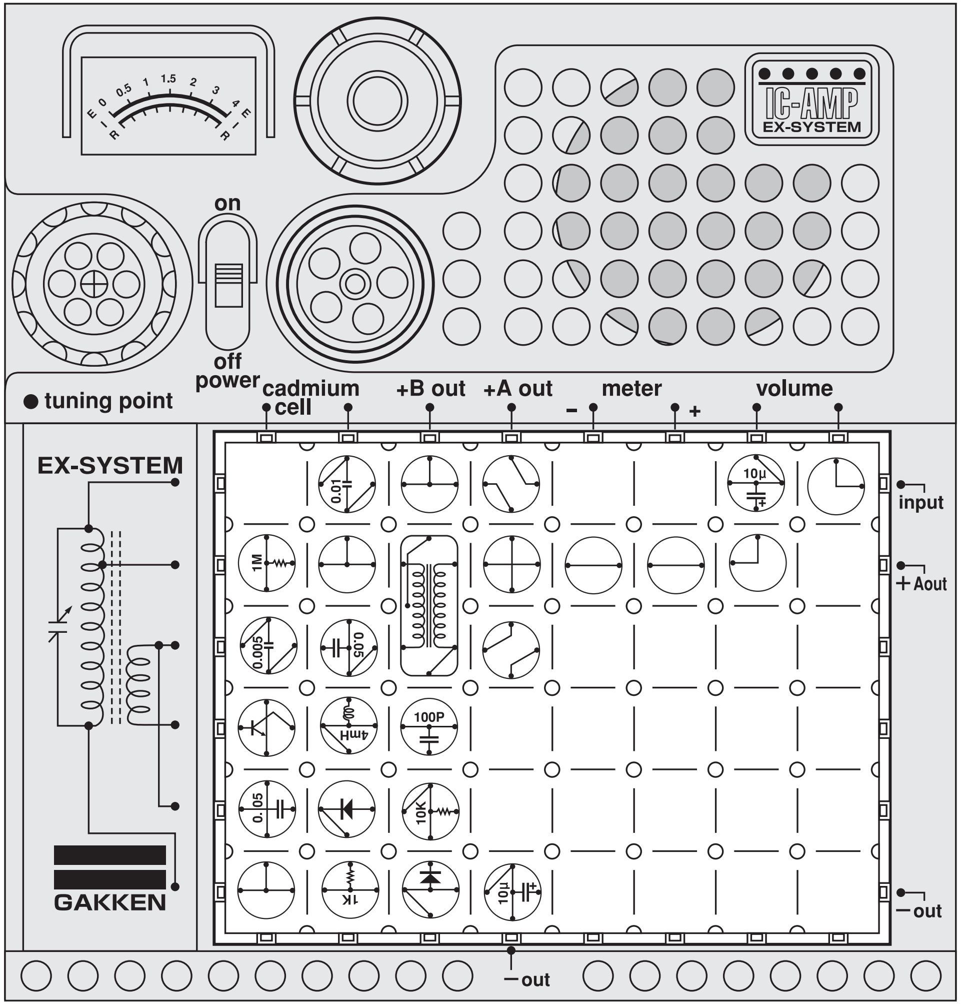
The reflex circuit was developed when transistors were expensive. It is useful because it reduces the number of transistors but increases sensitivity. In the arrangement illustrated at left, one transistor is used to act as an amplifier for both high frequencies and low frequencies; that is, only one transistor is needed to perform the functions of two transistors.

Arrange the blocks as illustrated at left. Turn on the power switch, and the radio will play.



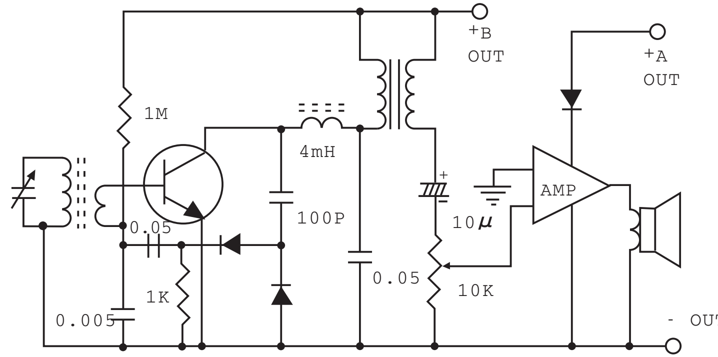
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

No. 45 1-Transistor + IC Amplifier Reflex Radio (Transformer Load)



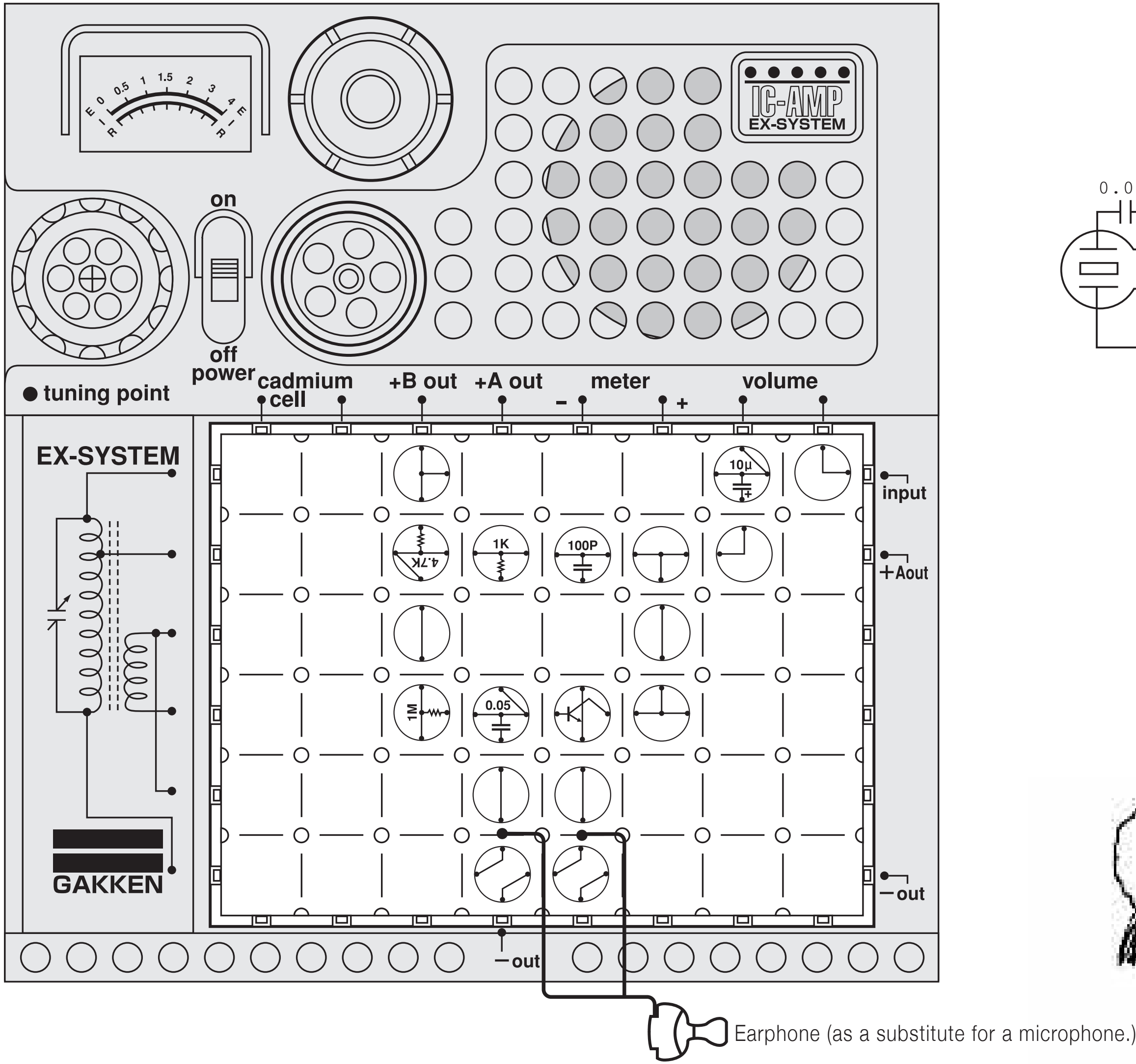
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

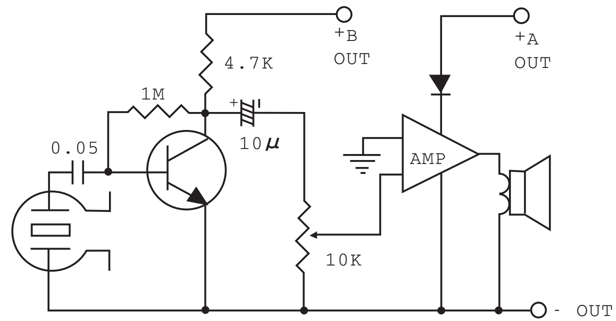


Unlike the Morse code practicing circuit and amplifier experiments, the antenna is very important for radio circuits. When the radio broadcasting stations are far away or the radio waves are weak due to the reinforced concrete buildings, it is necessary to set up a sufficiently large antenna to improve the reception in the case of one or two transistor radio sets. When you set up a large antenna out side your house, you will understand the importance of an antenna for this type of radio receiver.

No. 46 Self-bias 1-Transistor + IC Amplifier (Resistiv



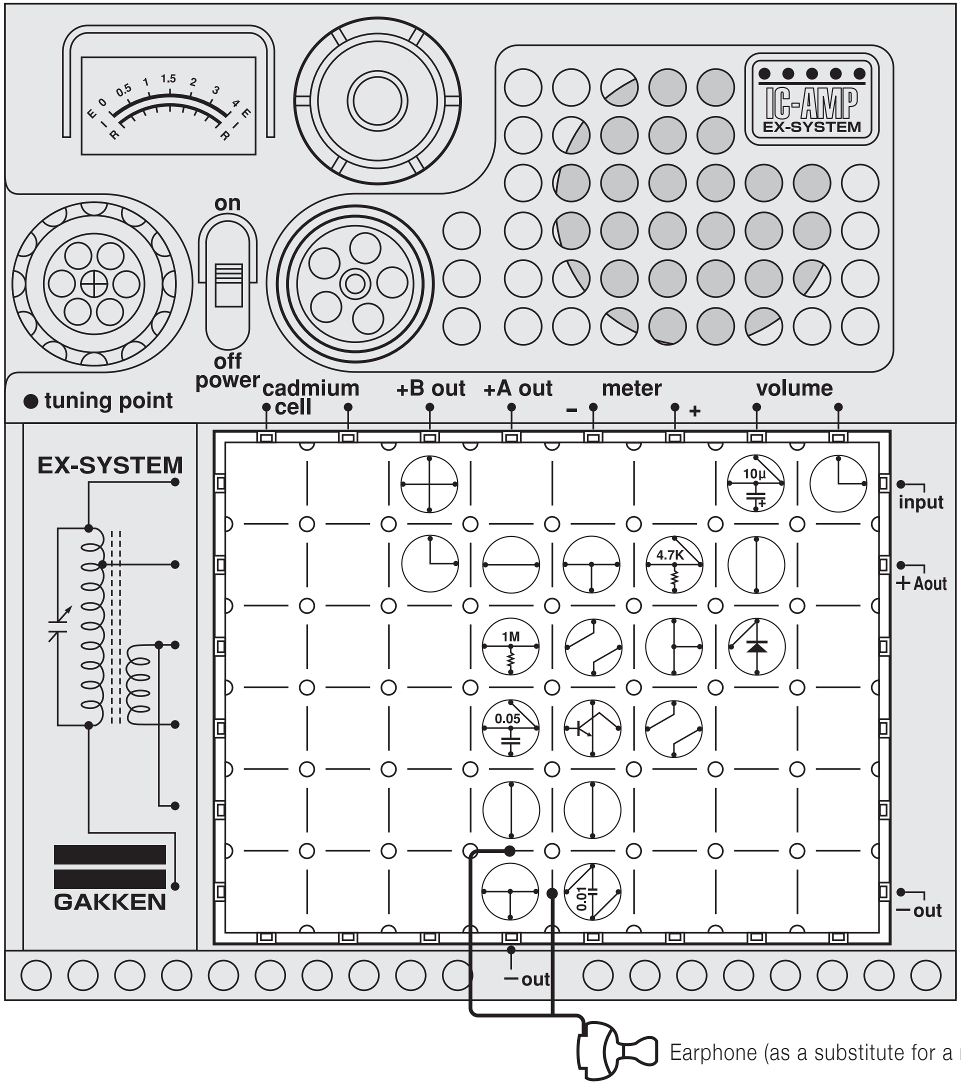
Circuit diagram for this experiment:



Just imagine what it would be like if there were no microphone and amplifier in your school auditorium. Without such a public address system, a person could not make his or her voice audible to a large audience. In the amplifier circuit you will build for this expeiriment, the audio voltage produced by the intensity variations and vibrations of the human voice and various other sounds is fed to the base of the transistor. Then it comes out amplified to the collector, where the signal is controlled and fed to the amplifier circuit.

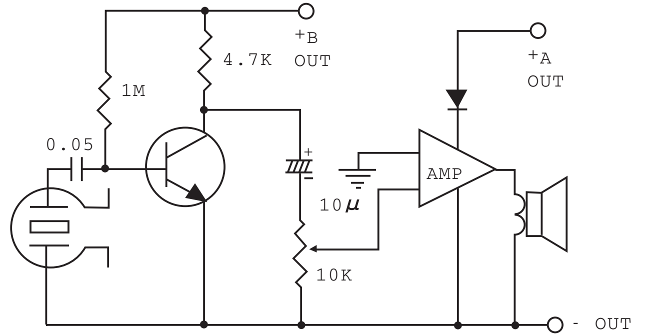
Arrange the blocks as illustrated at left, attaching the earphone. Turn on the power switch, and the microphone (earhone) and amplifier are in operation.

No.47 Fixed-bias 1-Transistor + IC Amplifier (Resisti



Earphone (as a substitute for a microphone.)

Circuit diagram for this experiment:

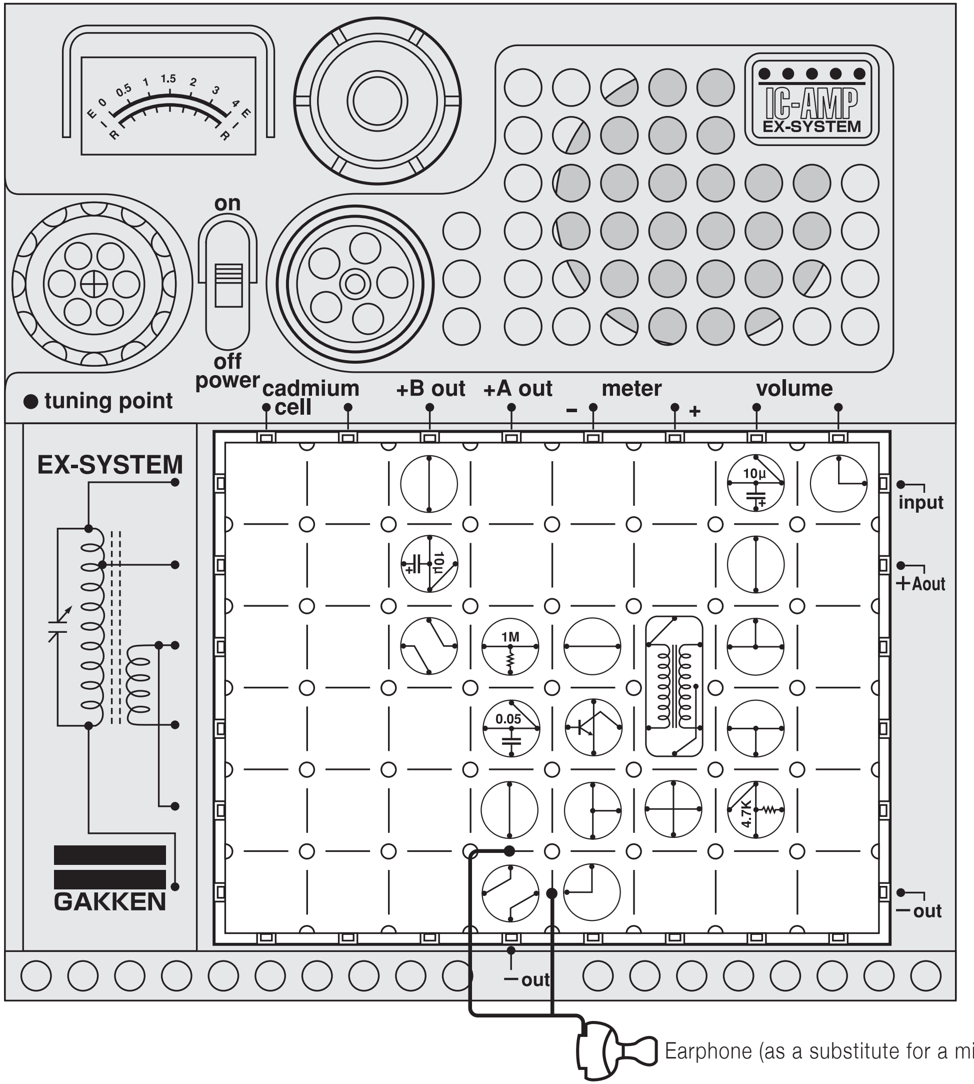


Electronic devices are becoming more and more compact, and it is becoming out of date to use a large part like a transformer. So this time, experiment with a very "streamlined" amplifier circuit.

There are various kinds of amplifier circuits. Compare this one with the others you have built when you complete this experiment.

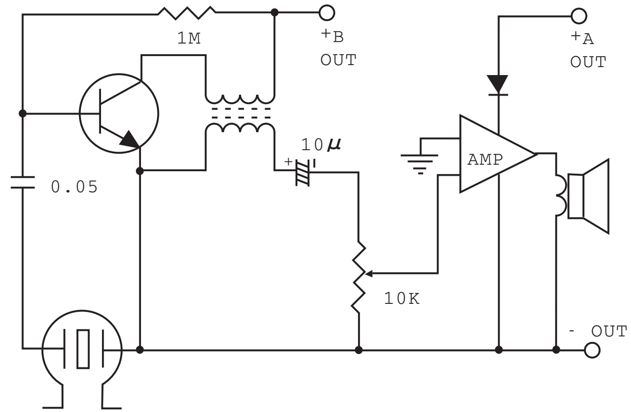
Arrange the blocks as illustrated at left, attaching the earphone. Turn on the main switch, and the microphone (earphone) and amplifier are in operation.

No.48 Fixed-bias 1-Transistor + IC Amplifier (Transform



Earphone (as a substitute for a microphone.)

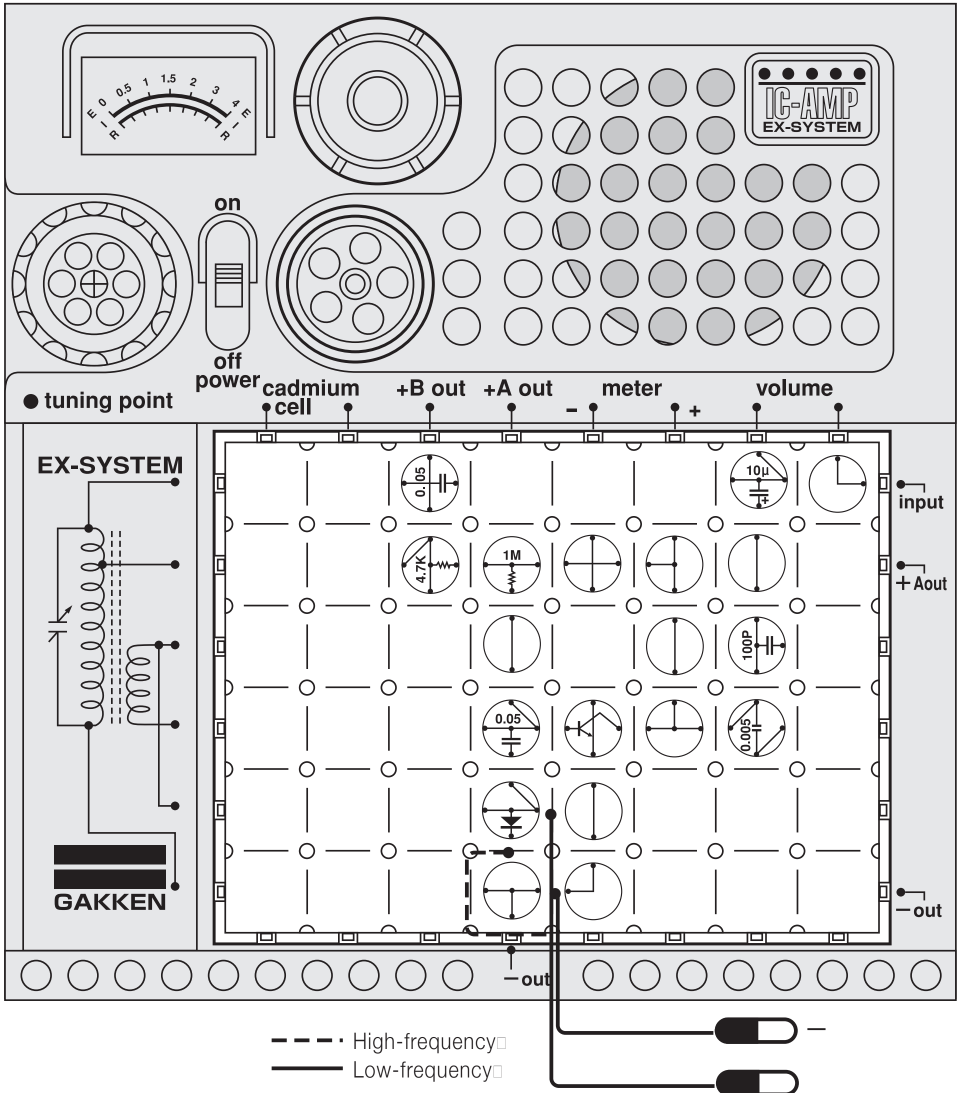
Circuit diagram for this experiment:



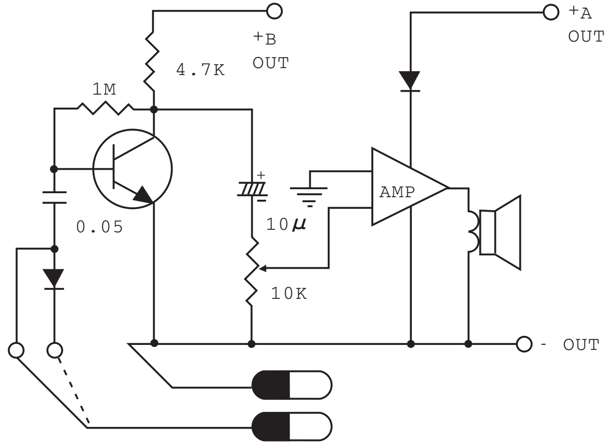
An amplifier output is measured in watts(W). About 1W is sufficient for ordinary home radio sets. Amplifiers larger than 20W in output are used in Hi-Fi sets. Most of the amplifiers used in public address systems have an output over 500W.

Now let's experiment with an amplifier circuit using a transformer. Arrange the blocks as illustrated at left, attaching the earphone. Turn on the power switch, and the microphone (earphone) and amplifier are in operation.

No.49 1-Transistor + IC Amplifier Signal Tracer



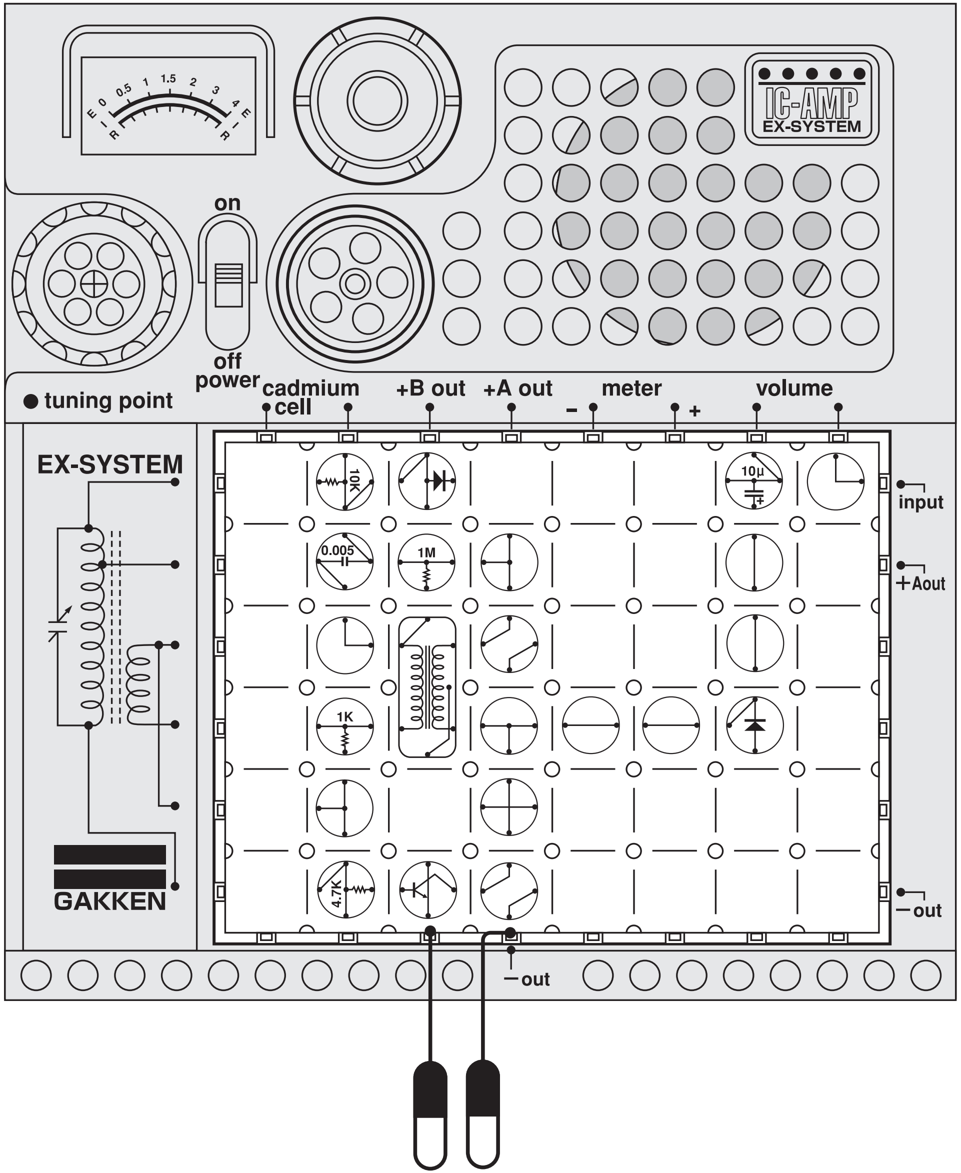
Circuit diagram for this experiment:



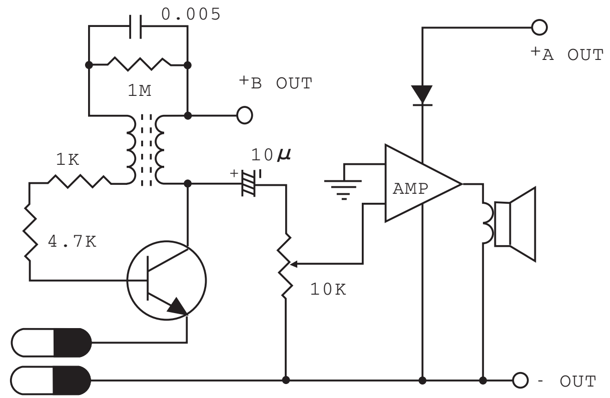
Arrange the electronic blocks and connect the 60cm cords as illustrated. Use the cord connection for high frequencies when you want to check the high frequencies in the radio set.

Turn on the radio to be examined. With the negative -OUT of the cord held in contact with the negative (-) side of the radio. use the positive -OUT of the other cord to trace the path of signals from the tuning circuit to the diode. When there is nothing wrong with the high frequency parts, a broadcast signal will come out of the speaker.

No. 50 Continuity Tester (Speaker Type)

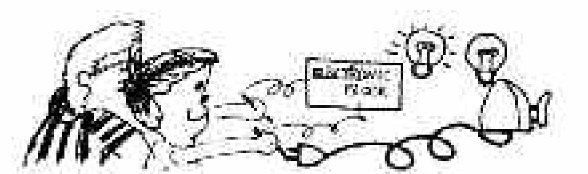


Circuit diagram for this experiment:

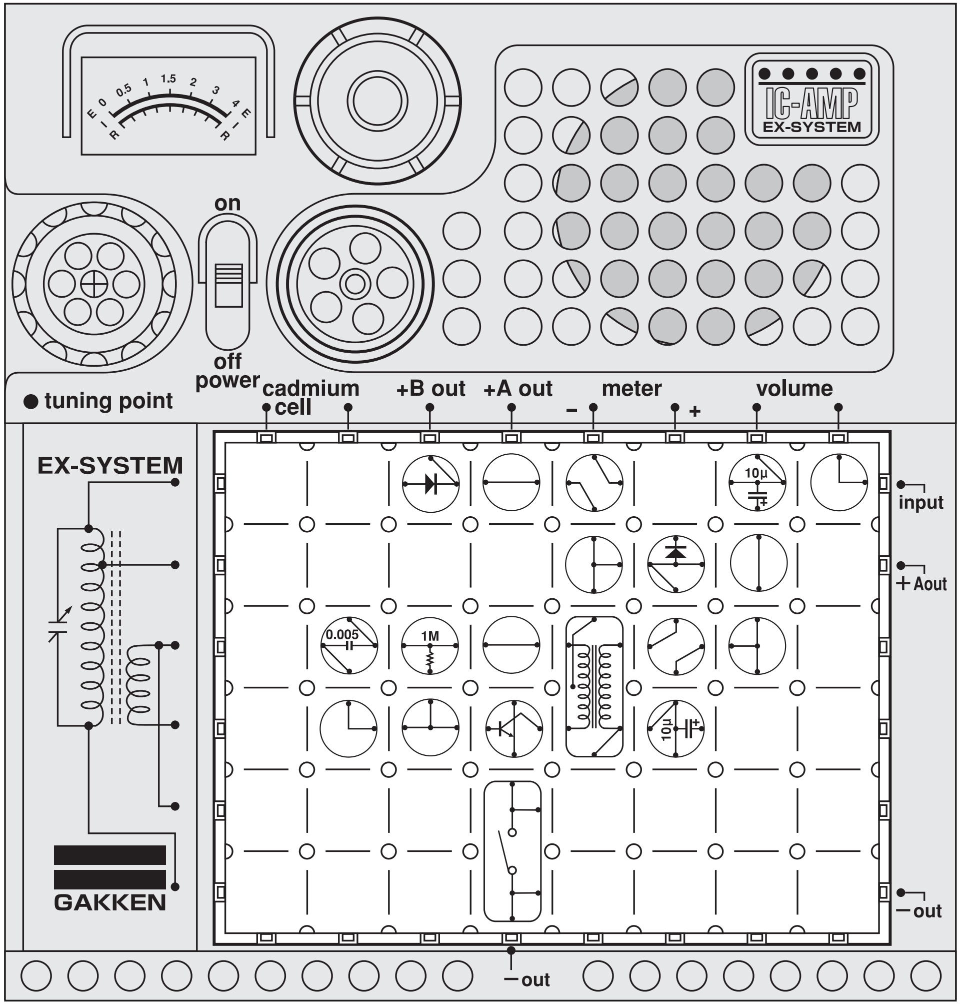


Continuity tester is an instrument for checking to see if there is any broken wire in electric apparatus. Let's build up a continuity tester and check for broken wires in pressing irons, electric lamps, motors and so forth. When there is no broken wire, a high-pitched note comes out of the speaker but no sound is heard when there are broken wires.

Be sure to disconnect the device you are testing from AC power.

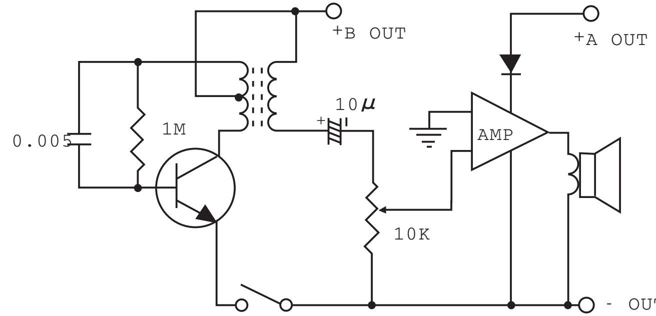


No.51 Morse Code Practice Circuit (Speaker Type)



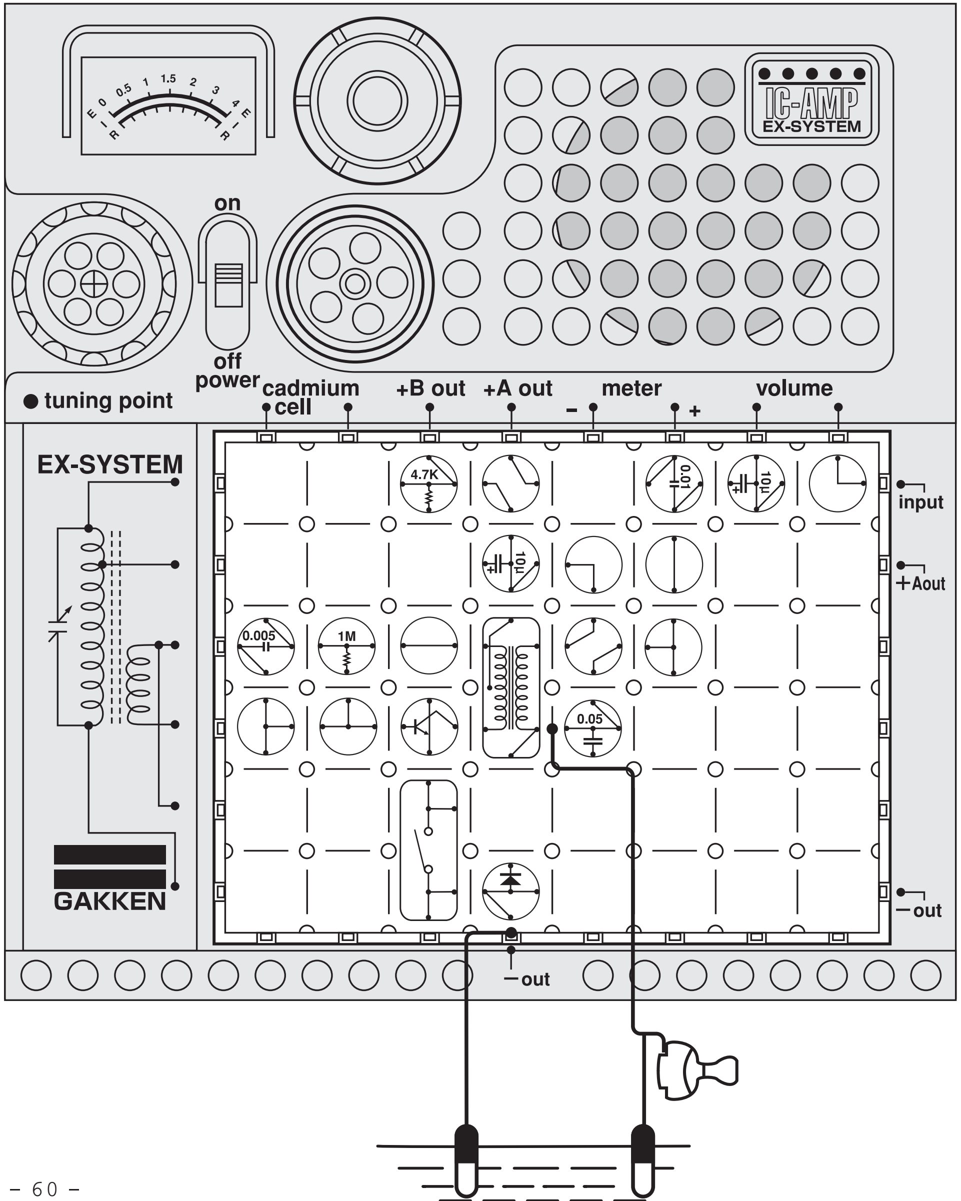
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

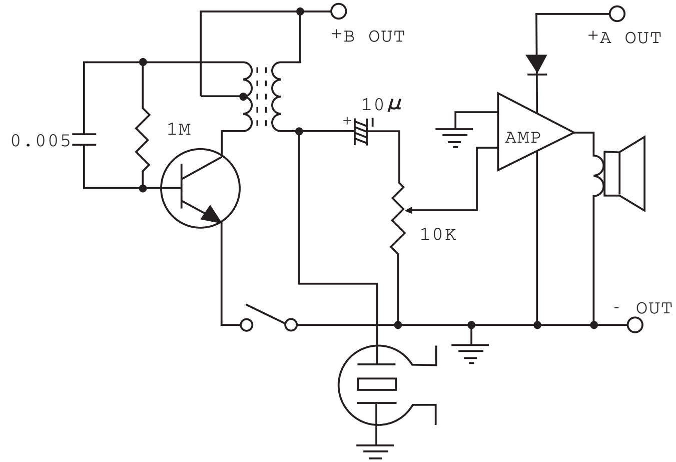


You should be skillful in sending Morse code messages by now. This time, let's build a speakertype Morse code practice circuit.
Arrange the blocks as illustrated at left and turn on the power switch. Then, send messages by pressing down and releasing the key switch. See Experiment No. 24 for Morse code signals.

No.52 Grounded Morse Telegraph (With Monitor)

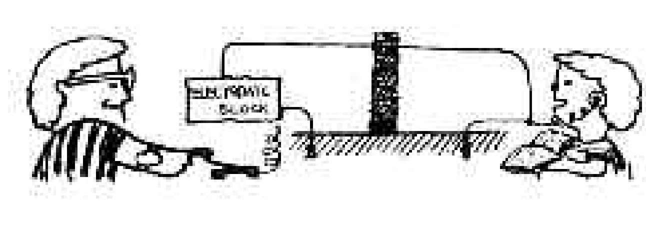


Circuit diagram for this experiment:

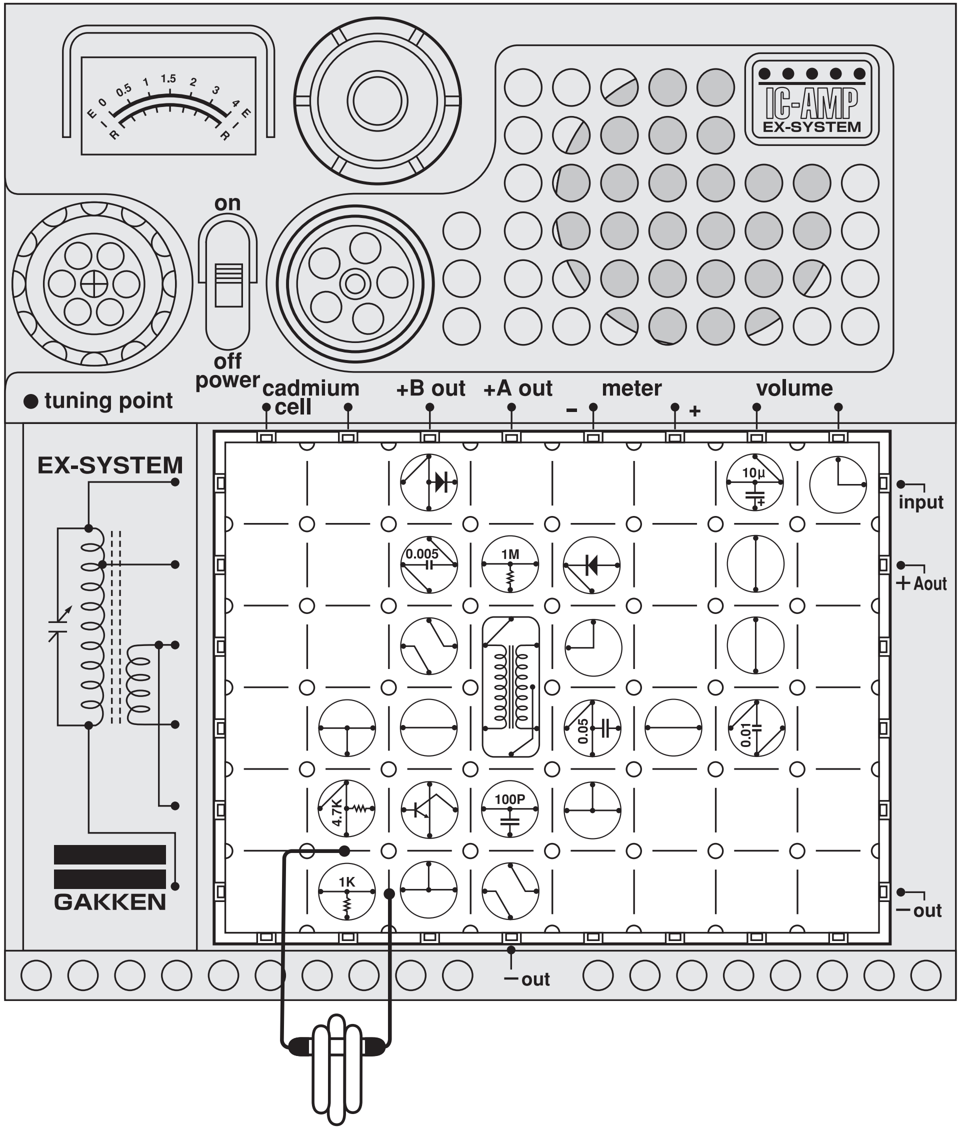


In this type of telegraph, one end of the circuit is grounded to the earth. A message can be sent by a single wire, and therefore the length of the circuit can be reduced with this telegraph, you can send your messages while monitoring them.

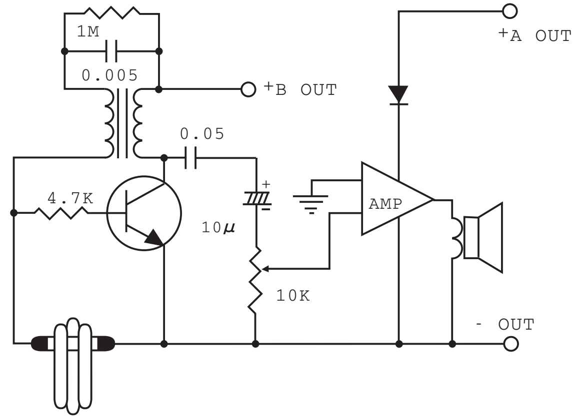
Arrange the blocks, earphone,and antenna as illustrated at left. Turn on the power switch,and send messages by pressing down and releasing the key switch. Your friend will receive the messages through the earphone attached to your kit. See Experiment No.24 for Morse code signals.



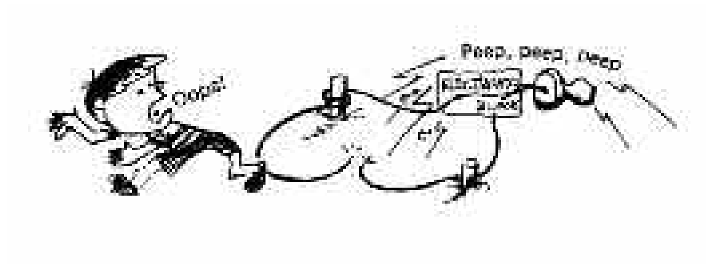
No.53 1-Transistor + IC Disconnected Circuit Warning



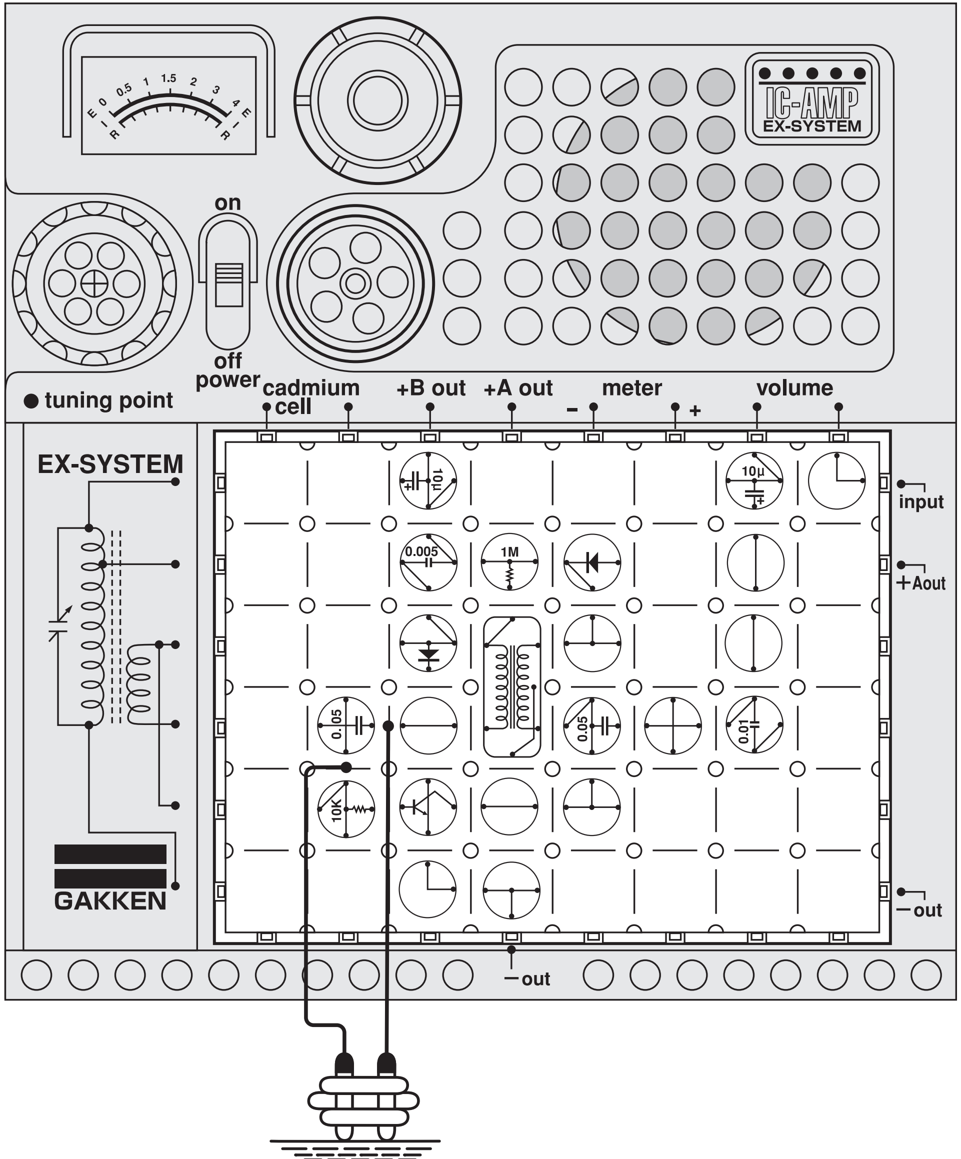
Circuit diagram for this experiment:



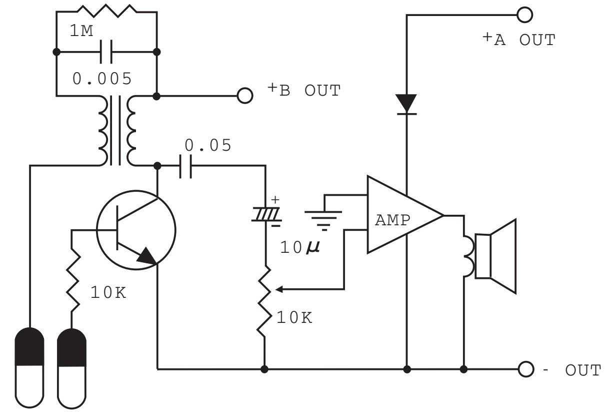
This waring device contains a circuit utilizing the switching function of a transistor and an oscillatory circuit. The mechanism is set off by a disturbance to the 60cm cords connecled to it. Arrange the blocks as illustrated at left. Attach the cords, holding the ends together with a plastic clip to prevent oscillation. Now turn on the power switch. Whenever something touches the cords and disconnects them, the transistor will start oscillation to produce a warning sound from the speaker.



No.54 1-Transistor + IC Water-LeveI Warning Device

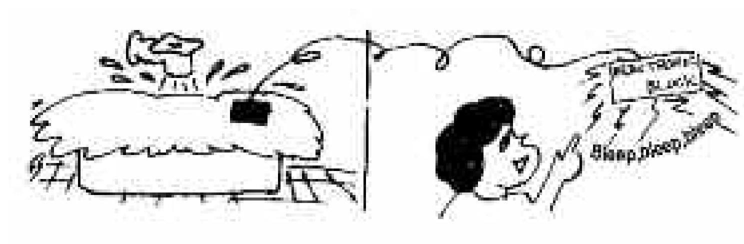


Circuit diagram for this experiment:

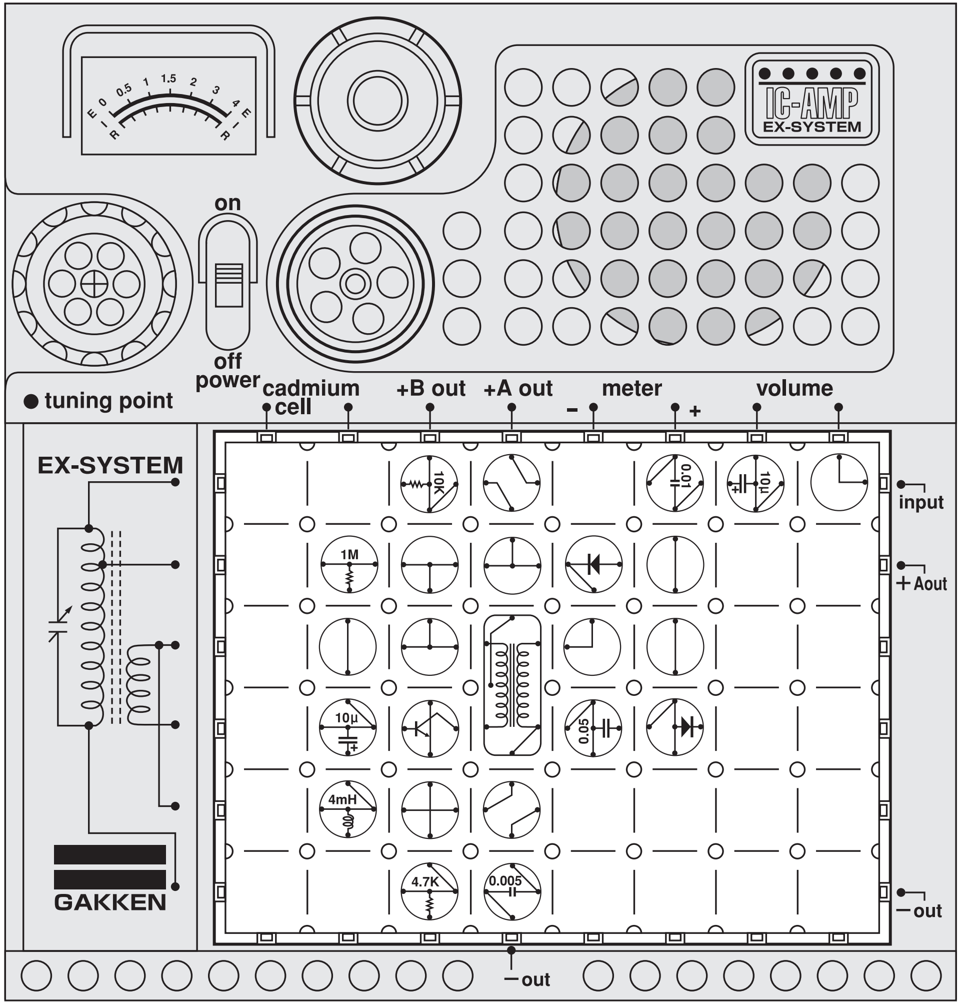


This water-level warning device also utilizes an oscillatory circuit. Tap water can be used in this experiment because it conducts electricity, although only a small quantity.

Arrange the blocks as illustrated at left, attaching the 60cm cords. Hold the ends of the cords together with a plastic clip and set them at a suitable height in a bathtub before filling it with water. Turn on the power switch. When the water level reaches the terminals, a current will flow between the two to cause a bias current to the base of the transistor, and a warning will sound to indicate that the bathtub has been filled to the proper level.

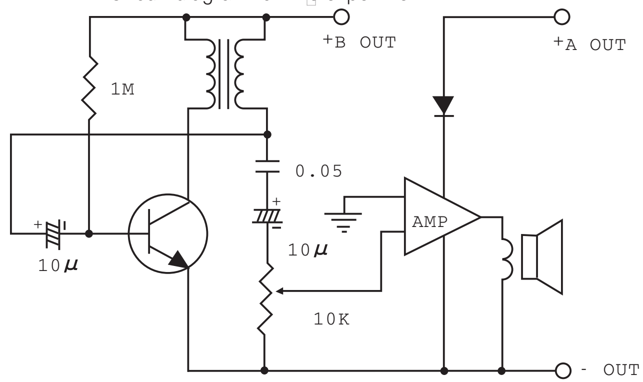


No.55 1-Transistor + 1C Electronic SIeeping Aid

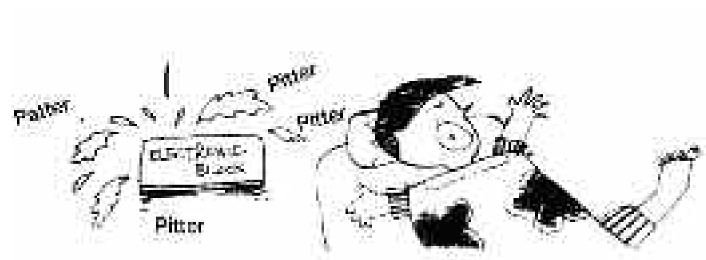


Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

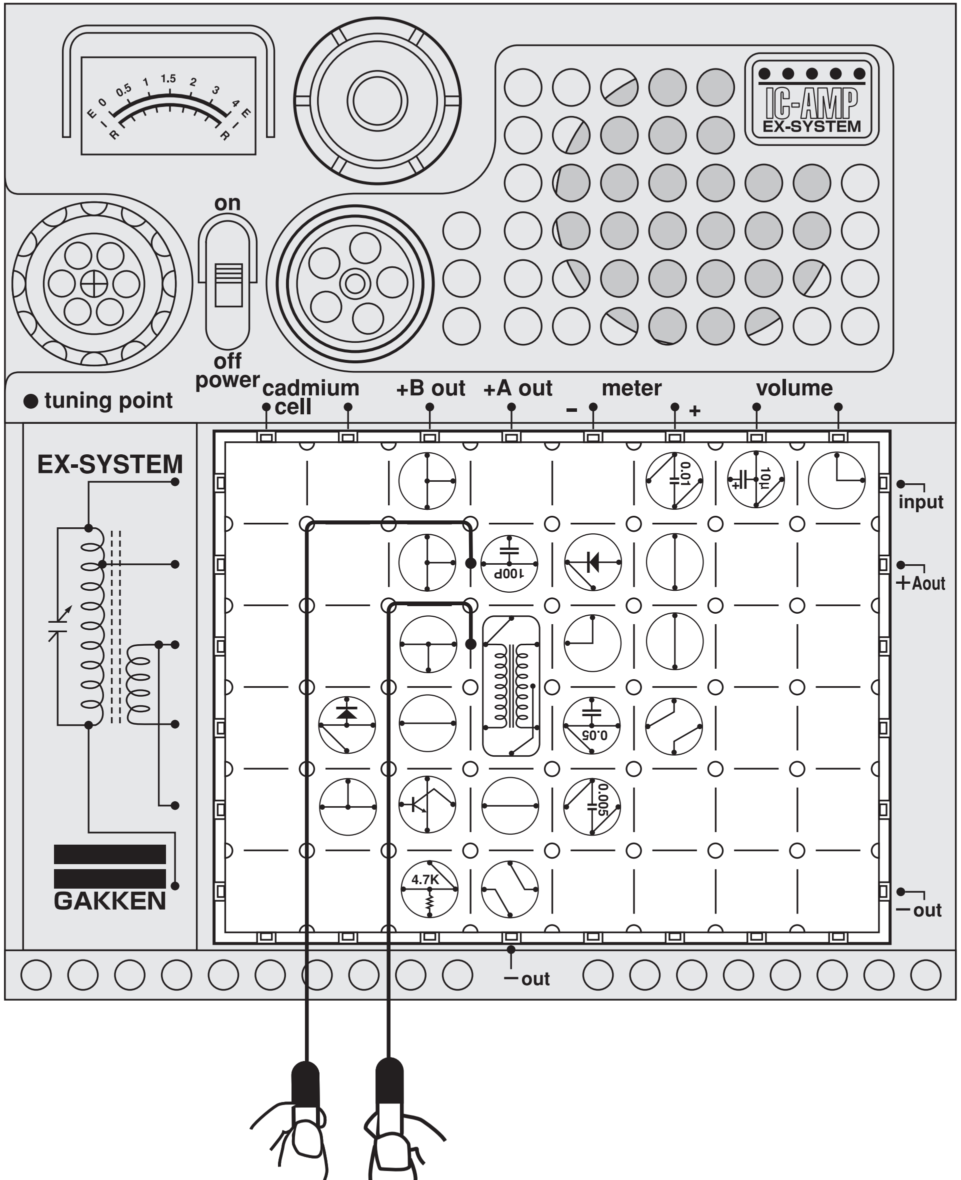
Circuit diagram for this experiment:



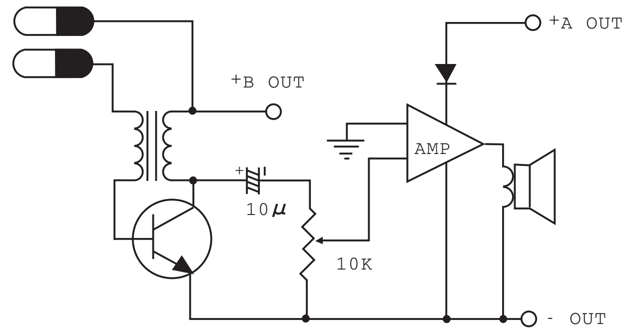
This electronic sleeping aid is similar in effect to the one you built in Experiment No.12, but no earphone is required. Arrange the blocks as illustrated at left and turn on the power switch. Does the sound make you drowsy?



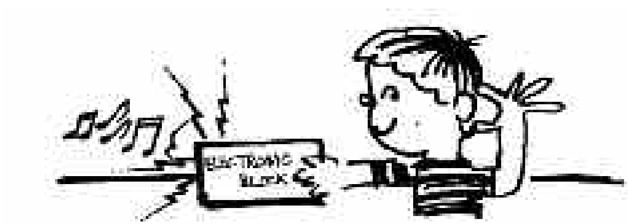
No.56 1-Transistor + IC Lie Detector



Circuit diagram for this experiment:

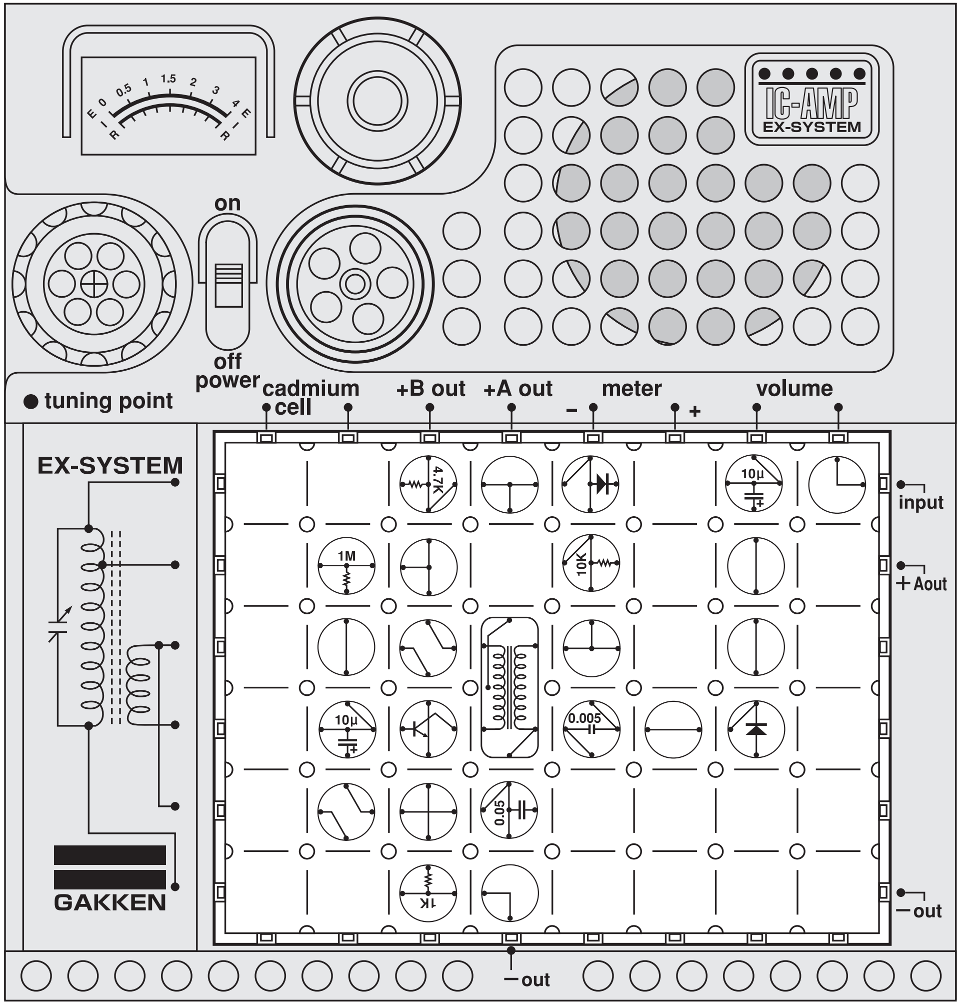


This lie detector operates on the same principle as the one in Experiment No.30, but no earphone is required. Arrange the blocks and 60cm cords as illustrated at left. Turn on the power switch. Have a friend grip the ends of the cords, then ask various questions. The oscillation will increase when your friend lies because the skin is more moistened with perspiration and its electrical conductivity has increased.



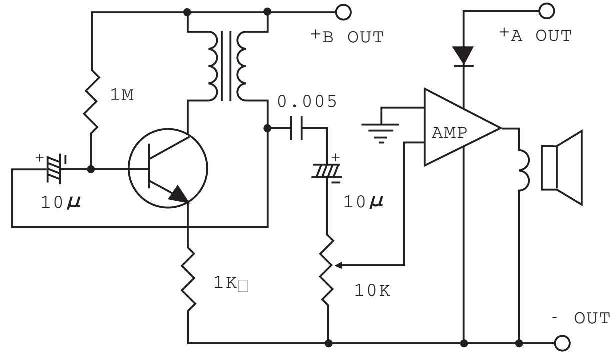
Note: The experiment is only for fun.
Please note that the result is not always reliable.

No.57 1-Transistor + 1C Metronome (Speaker Type)

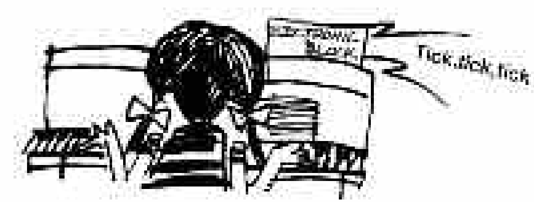


Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

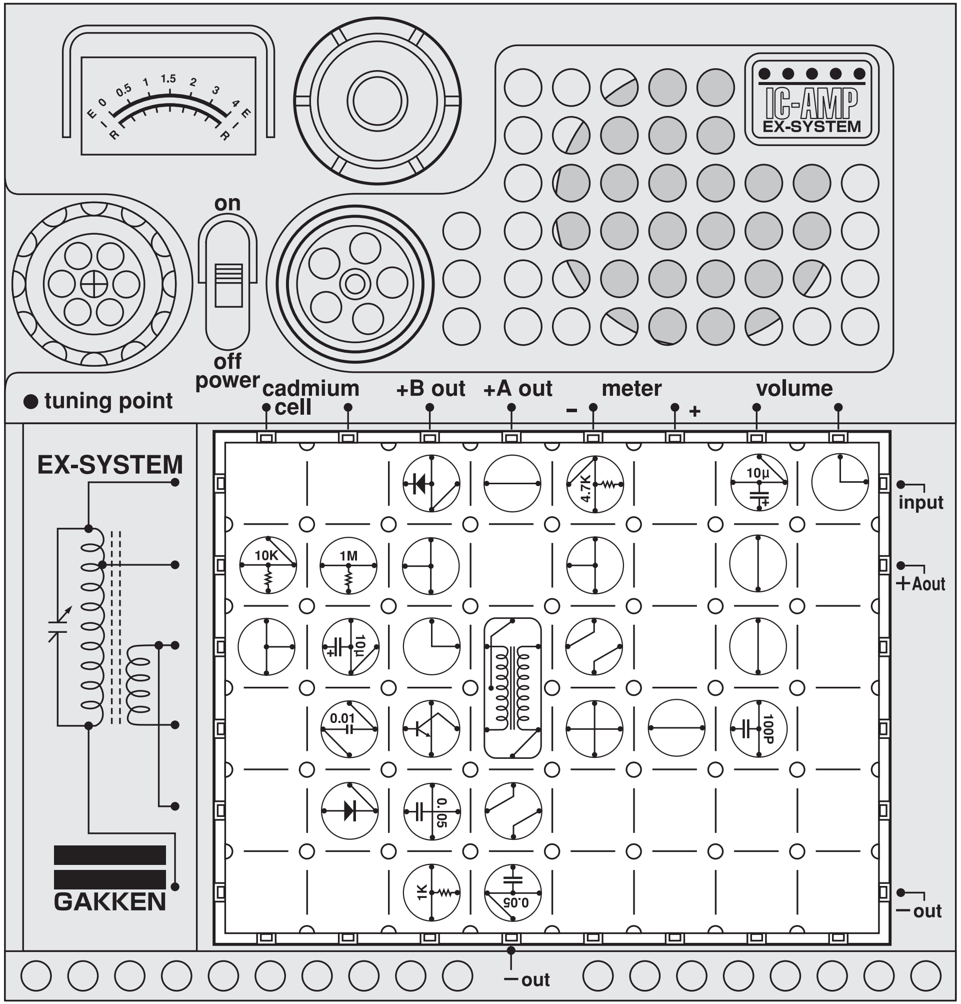
Circuit diagram for this experiment:



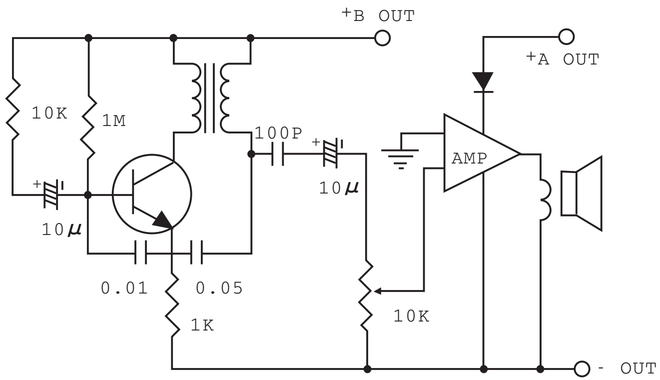
This metronome operates on the same principle as the one in Experiment No.22, but no earphone is required. Arrange the blocks as illustrated at left. Turn on the power switch, and the metronome will mark time.



No.58 1-Transistor + IC Electronic Bird (Speaker Type)

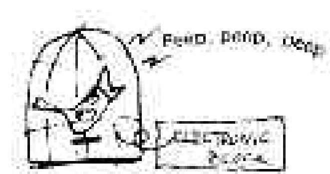


Circuit diagram for this experiment:



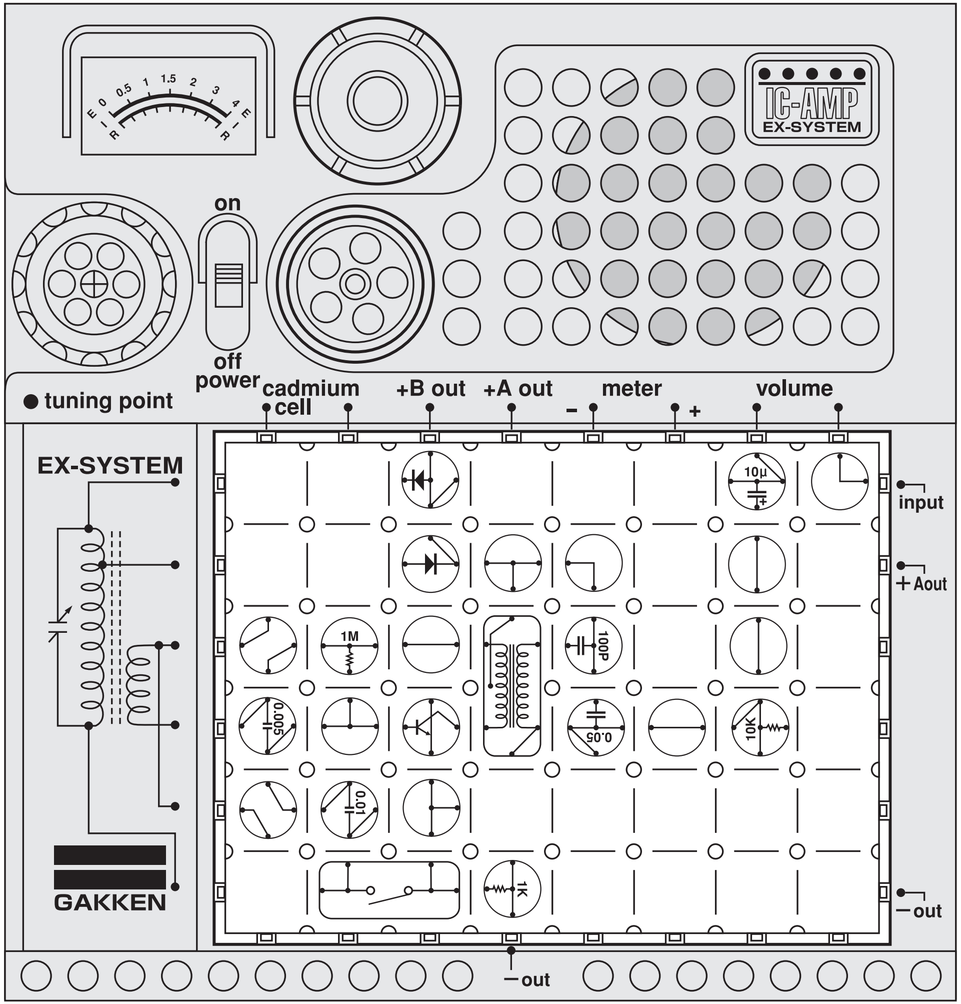
This electronic "chirper" operates on the same prinicple as the one in Experiment No.21, but no earphone is required. Arrange the blocks as illustrated at left and turn on the power switch. You will hear birds singing.

Very low-frequency oscillation is caused by a resistor and the charging and discharging of a capacitor. A low-frequency oscillation note is added to produce the charming "peep, peep, peep".



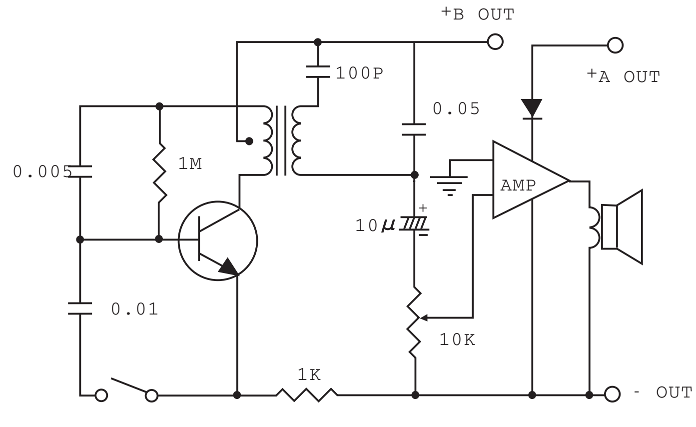
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

No.59 1-Transistor + IC Electronic Siren (Speaker Typ

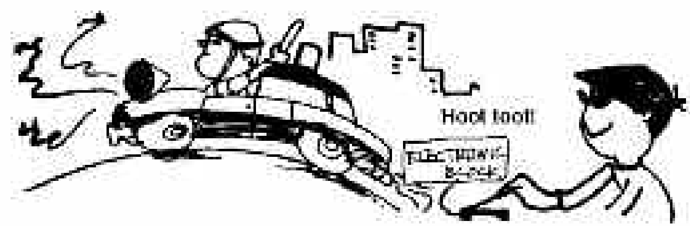


Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

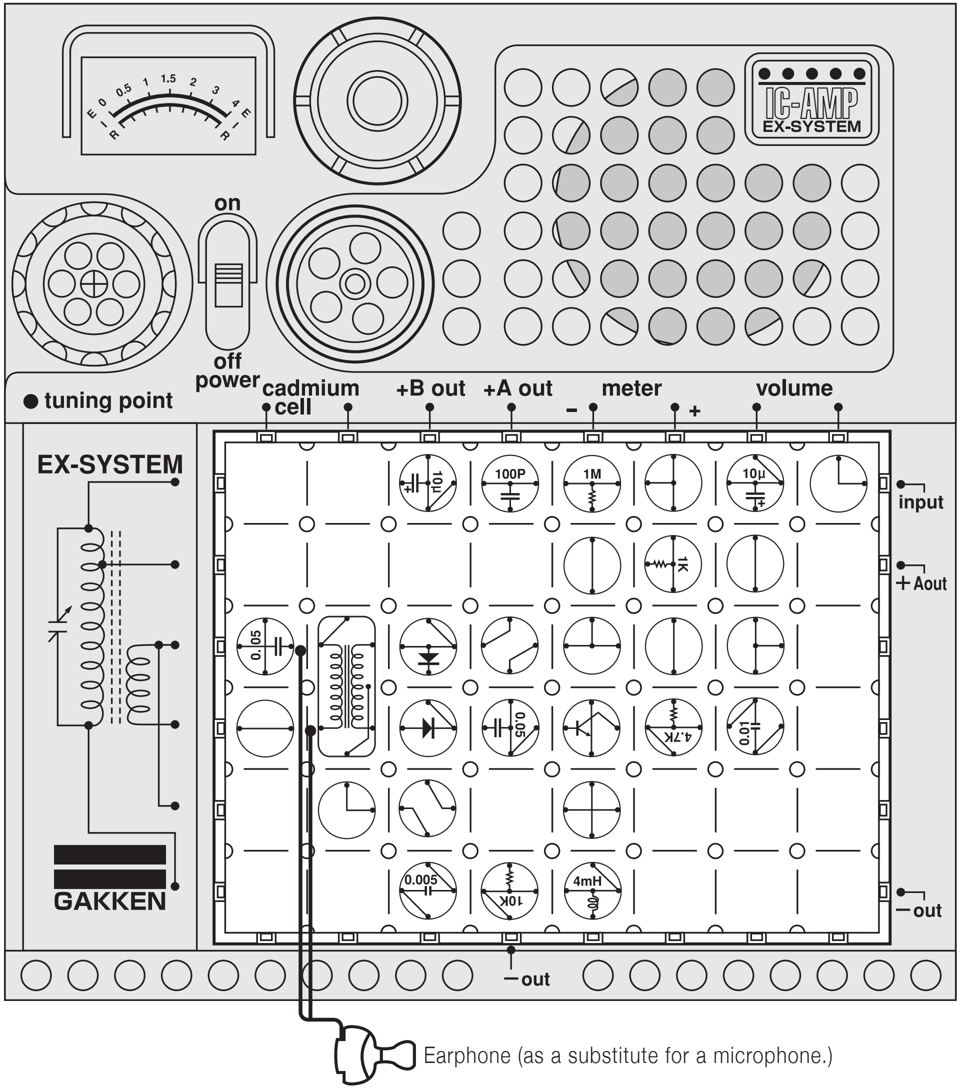
Circuit diagram for this experiment:



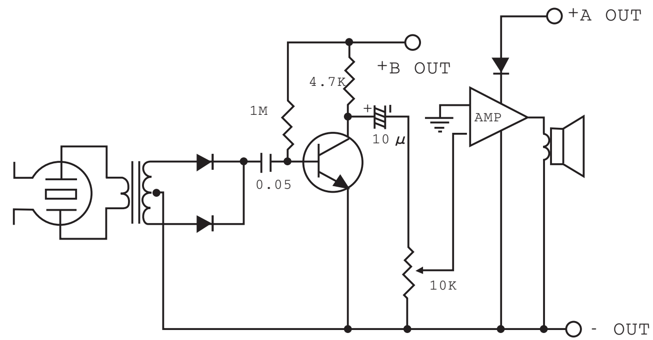
This experiment operates on the same principle as Experiment No.32, but no earphone is required. Arrange the electronic blocks as illustrated at left. Turn on the power switch and press down on the key switch. A sound like that of a siren will come out of the speaker.



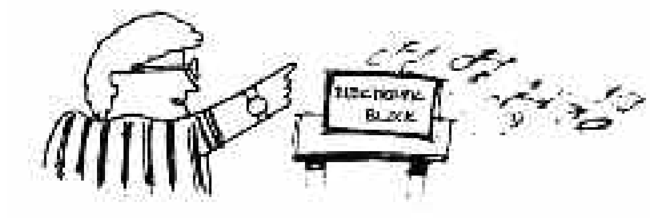
No.60 1-Transistor + IC Frequency Doubling Circuit



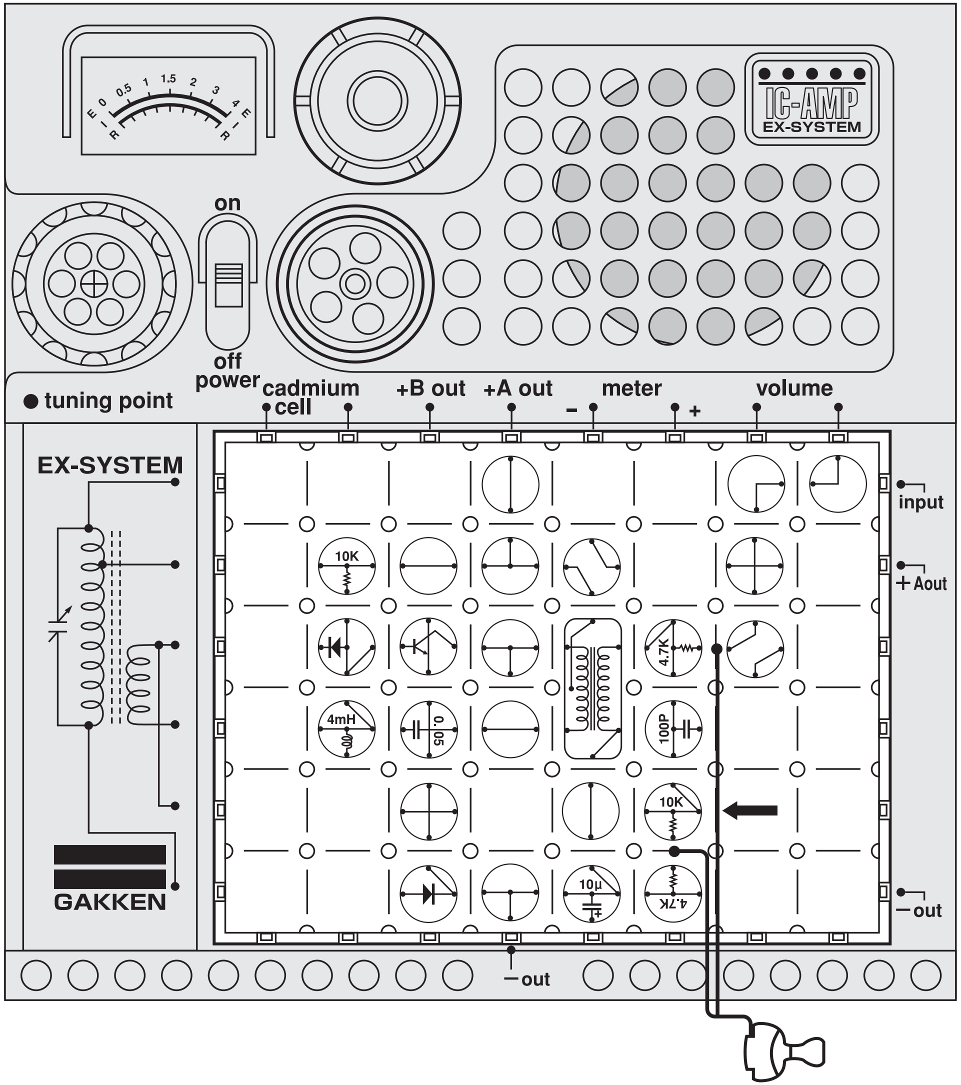
Circuit diagram for this experiment:



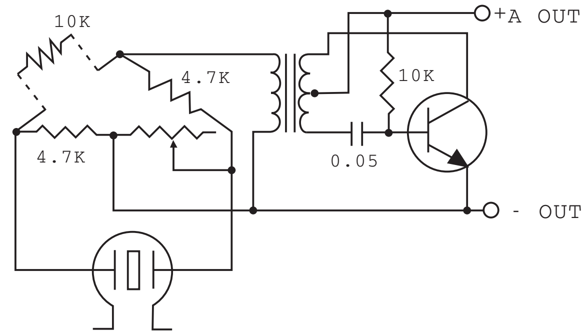
This device will change the sound of your voice. It uses the rectifying function of a diode to do so. The circuit, which is made up of a transistor and an IC amplifier, doubles the frequency of the incoming signal. Arrange the blocks as illustrated at left, attaching the earphone. Turn on the power switch and speak into the earphone. A voice which sounds different from yours will come out of the speaker.



No.61 AC Bridge (For Resistance)



Circuit diagram for this experiment:

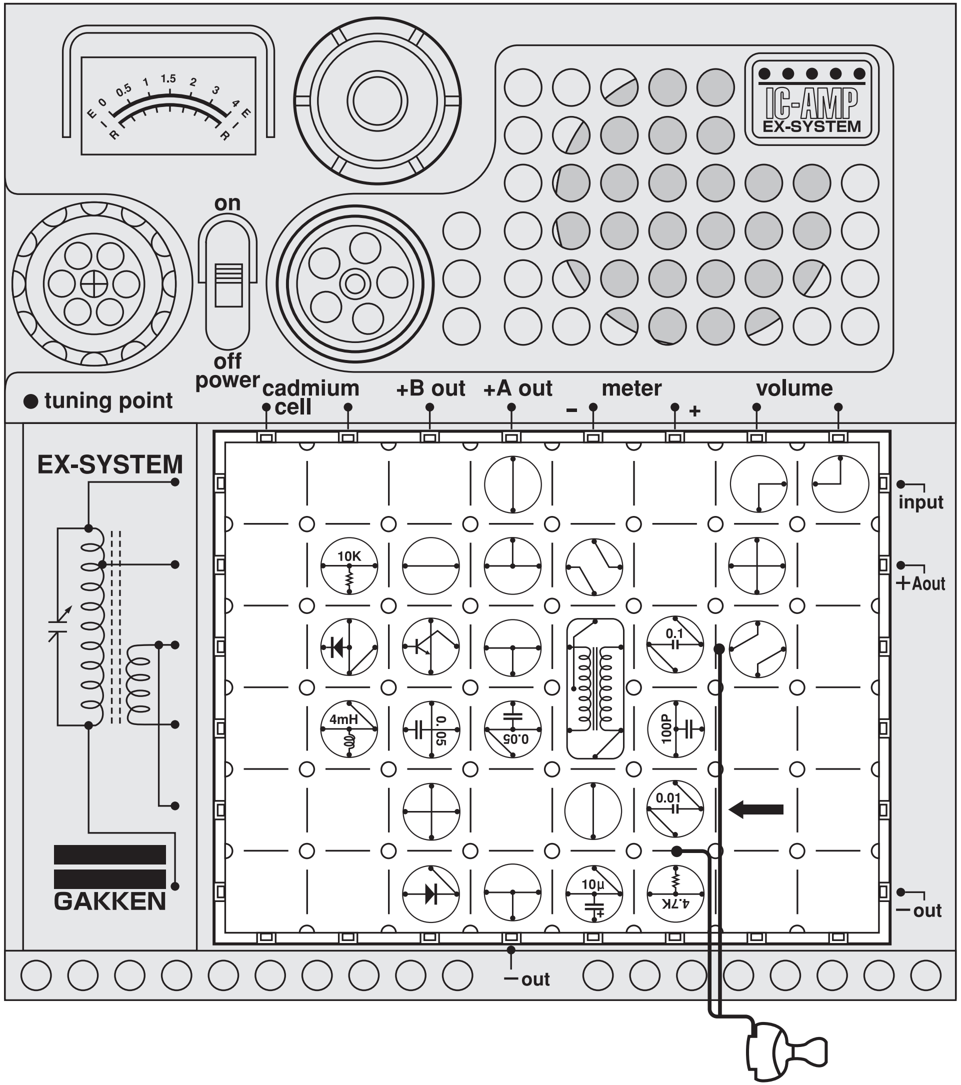


A tester is usually employed for measuring resistance, but resistance can also be measured by the intensity of sound. Now let's do an experiment with a circuit that uses sound. We will measure a resistance of 10KΩ, which is indicated by the arrow on the electronic board.

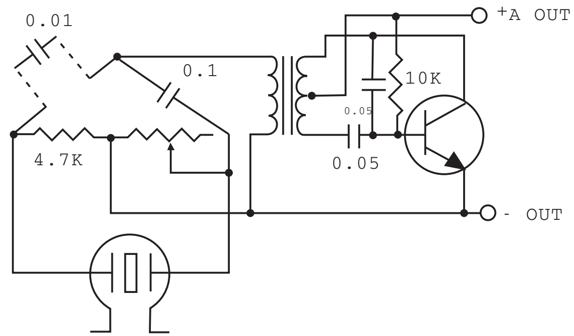
Arrange the electronic blocks and earphone as illustrated at left and turn on the power switch. Place the earphone in your ear. Listening to the sound, turn the volume control dial to the right and left, searching for the point where the sound is lowest; that is, where the resistance is about 10KΩ. Take a note of the position of the volume control dial. It will be helpful in measuring an unknown resistance whenever using this circuit.

< In case the sound comes from the amplifier when turning on the main switch>
1. Stay away from the main body as far as possible and put the earphone on the ear.
2. Change the volume little by little. Concentrate on the sound from the earphone.

No.62 AC Bridge (For Capacitor)

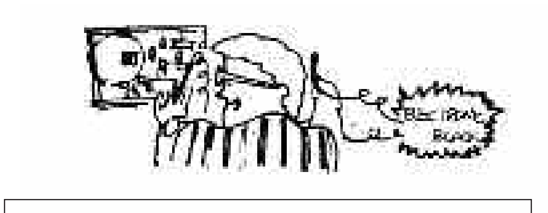


Circuit diagram for this experiment:



Were you successful with Experiment No.61? Now we will do a similar experiment for measuring capacitance.

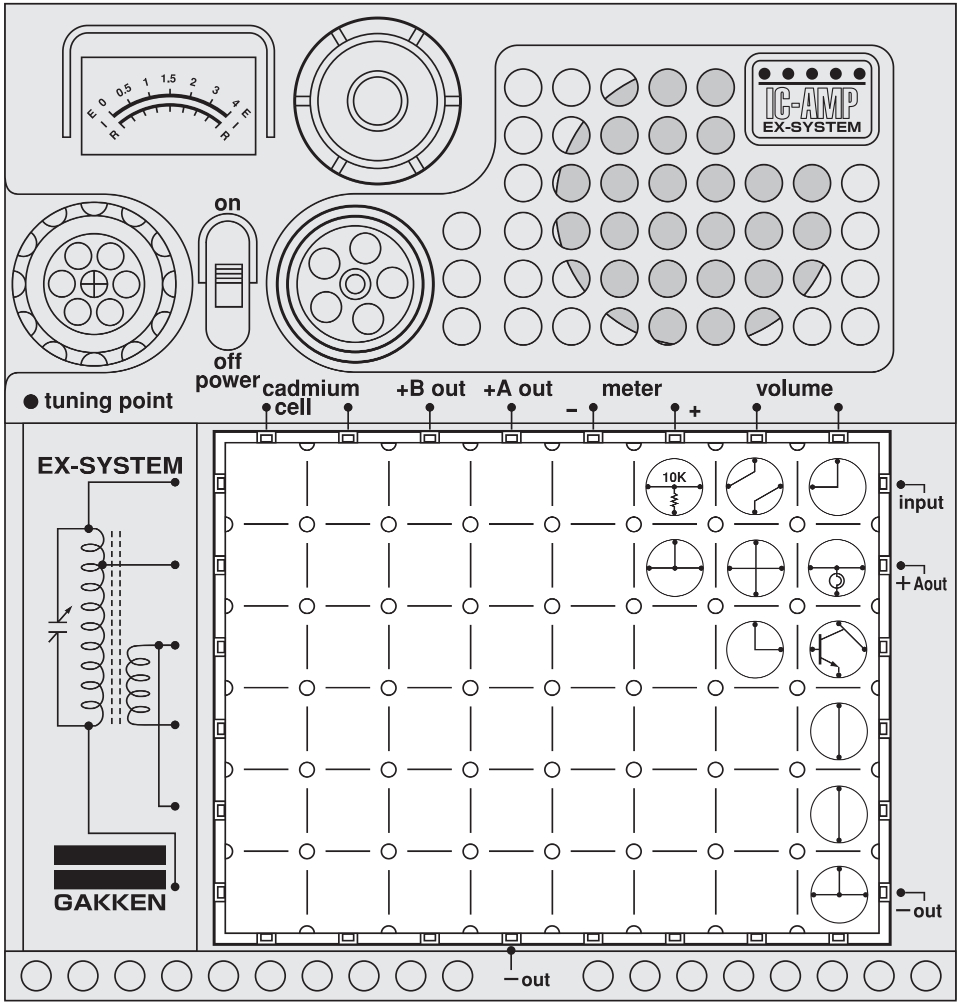
Arrange the blocks and earphone as illustrated at left. Place the earphone in your ear. As in the preceding experiment, turn the volume control dial while listening to the sound to find the point where the sound is lowest. A 0.01μ capacitor is inserted in this circuit, as indicated by the arrow.



< In case the sound comes from the amplifier when turning on the main switch>

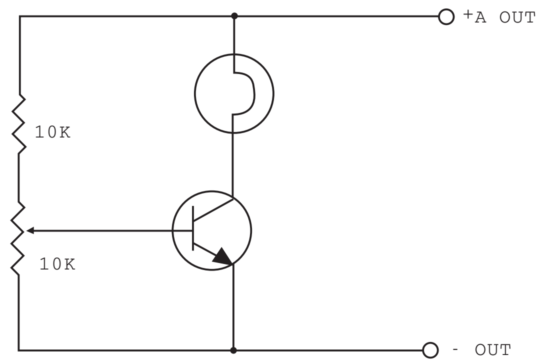
1. Stay away from the main body as far as possible and put the earphone on the ear.
2. Change the volume little by little. Concentrate on the sound from the earphone.

No.63 Light Control Circuit



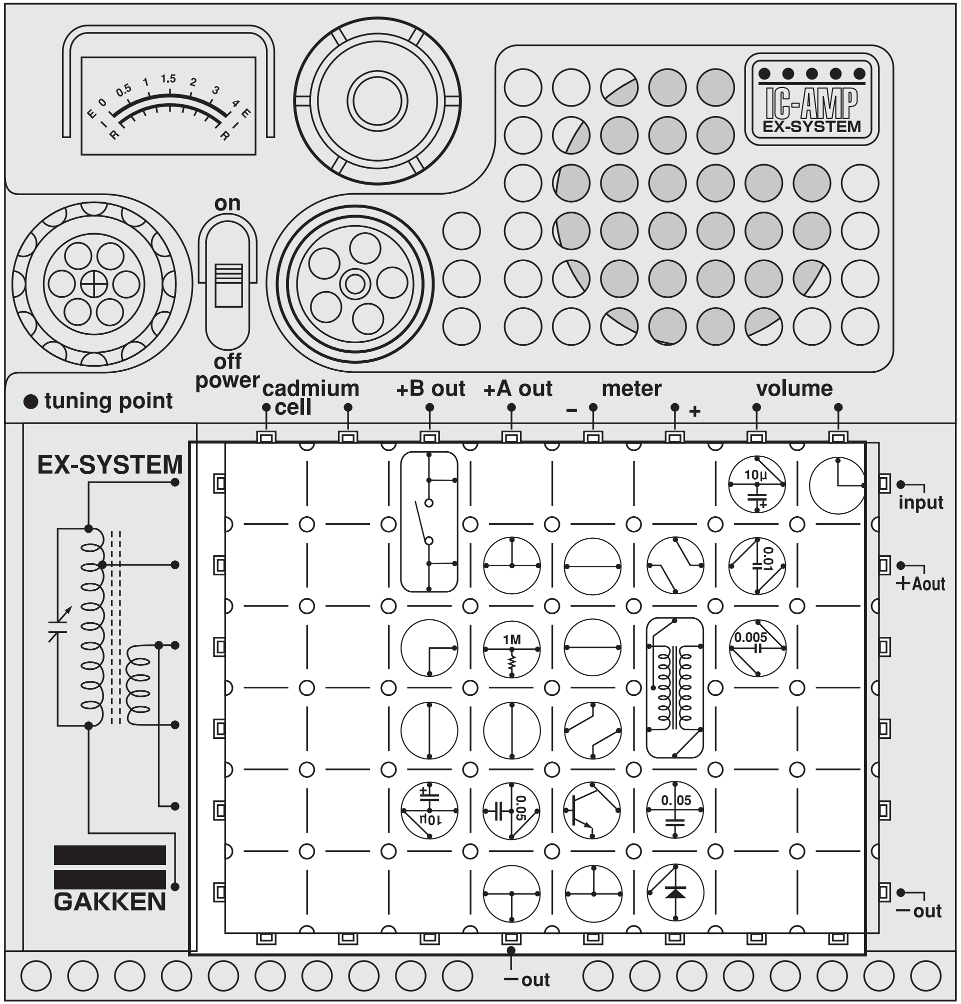
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

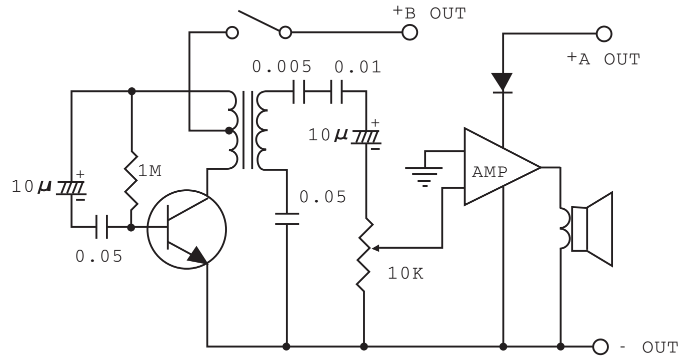


You must have been in movie theaters, where the lights are not abruptly switched off but gradually dimmed before a movie is shown on the screen. Now let's experiment with a circuit for controlling the intensity of light.
Arrange the blocks as illustrated at left and turn on the power switch. Then turn the volume control knob slowly to dim the light gradually.

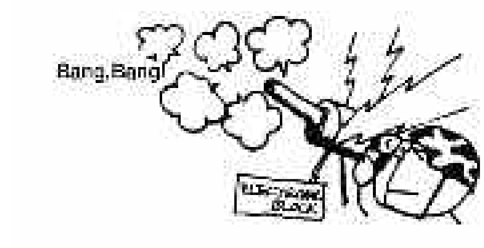
No.64 EIectronic Gun



Circuit diagram for this experiment:

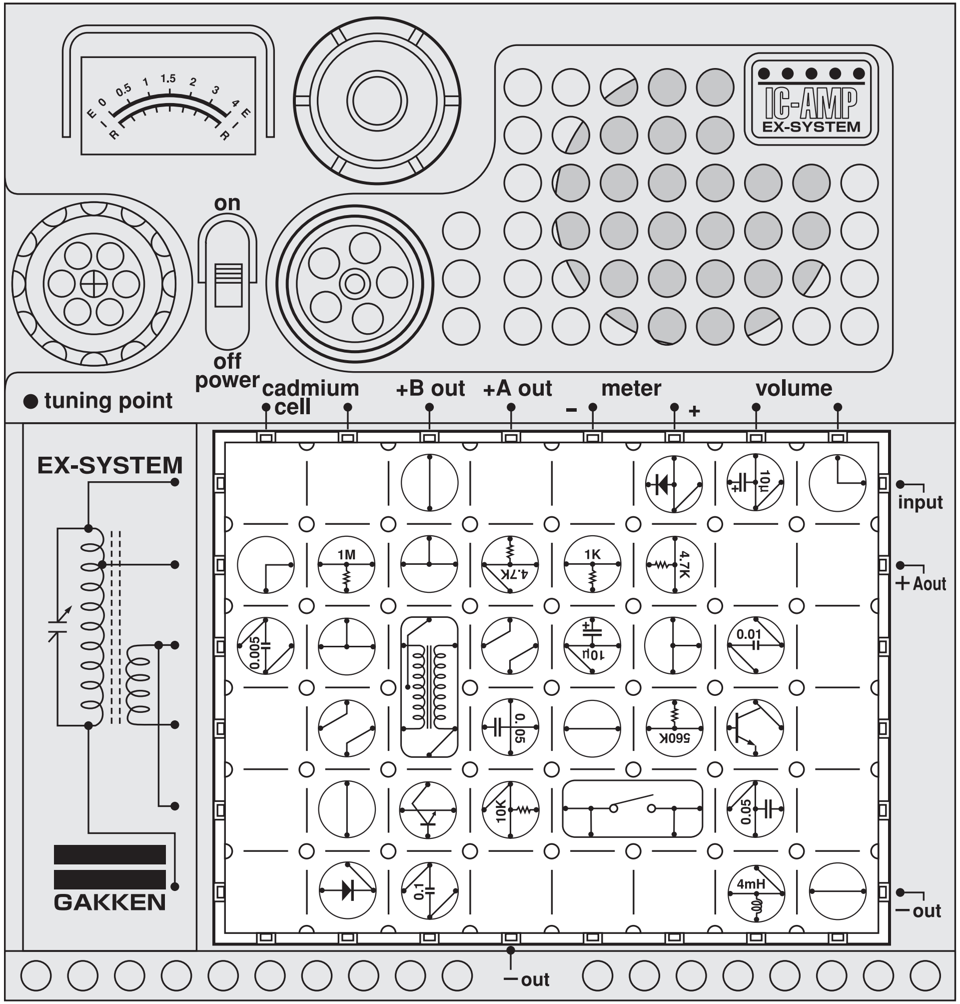


This is an experiment with a circuit that produces the imitation sound of a gun. Arrange the blocks as illustrated at left and turn on the power switch. You will hear the sound of a gun.



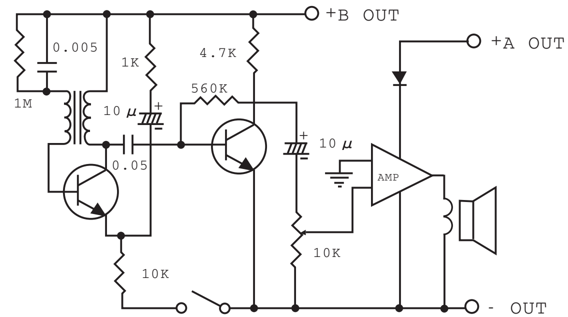
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

No.65 2-Transistor IC Electronic Siren

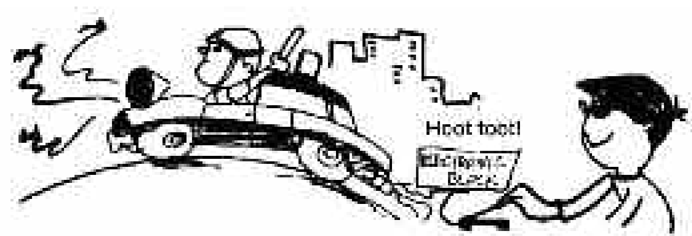


Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

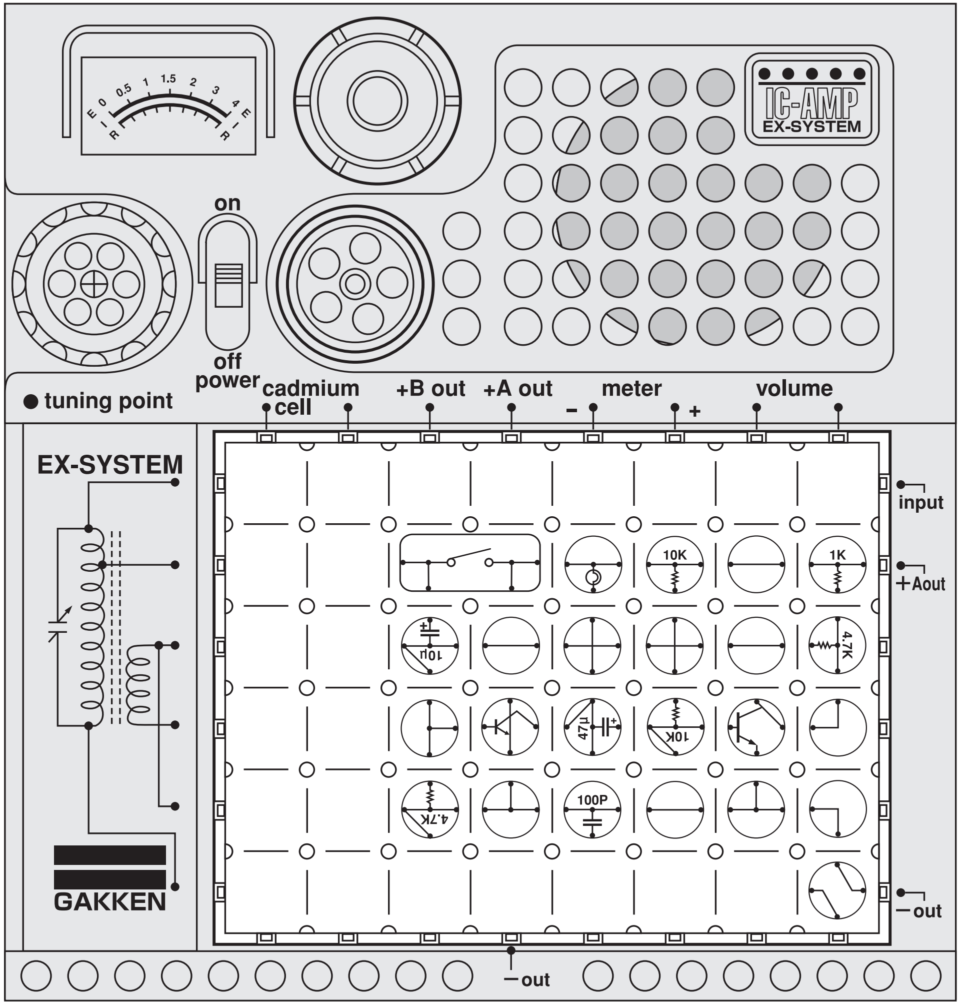


Let's make an electronic siren. This circuit is composed of two transistors and an IC amplifier. Arrange the blocks as illustrated at left and turn on the power switch. Do you hear the siren?



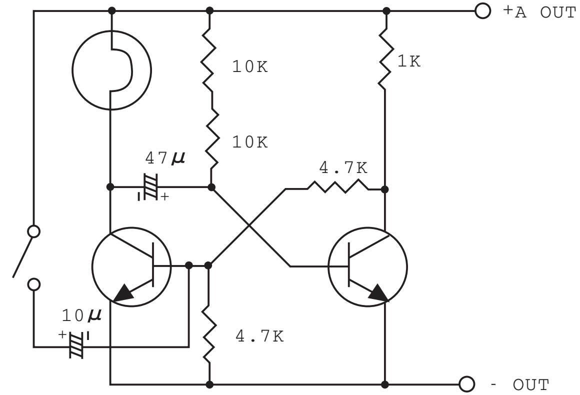
Note: Transistors and diodes are easily broken by over-current. Look at the circuit diagrams well to check if the placement is correct before turning on the switch.

No.66 Monostable Multiple Circuit

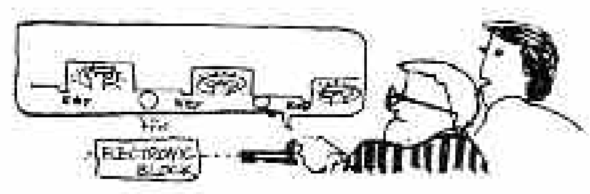


Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

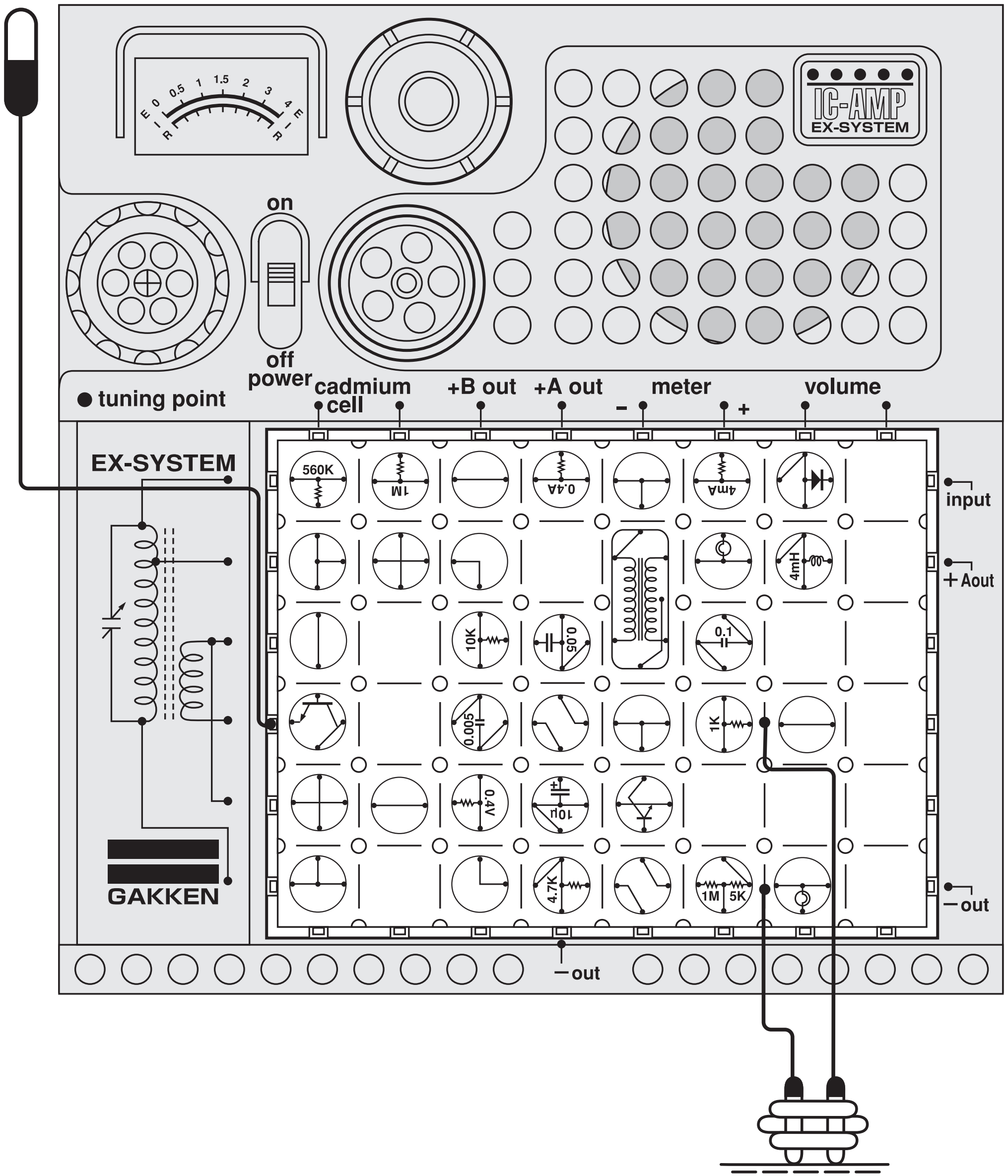


You have learned that whenever the key switch on the electronic board is pressed down, something is activated. In this circuit, when the key switch is pressed down for about 0.2 seconds, the lamp glows once and immediately goes off. This type of circuit is used for lighting a lamp on a bus and for various other purposes. Can you think of other interesting appli-cations for this circuit?

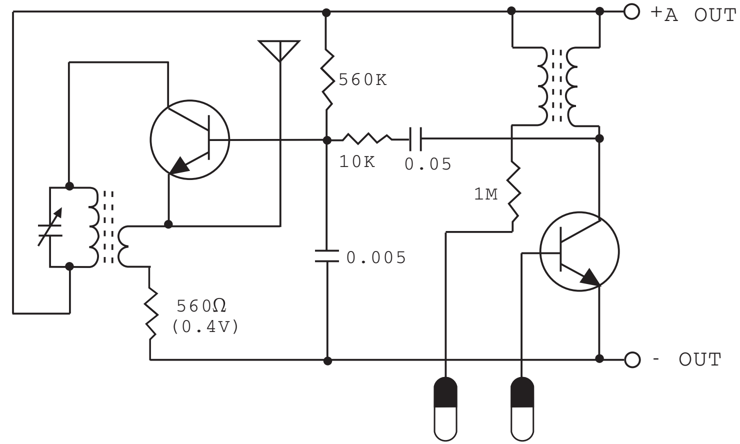


No.67 Wireless Water-Level Warning Device

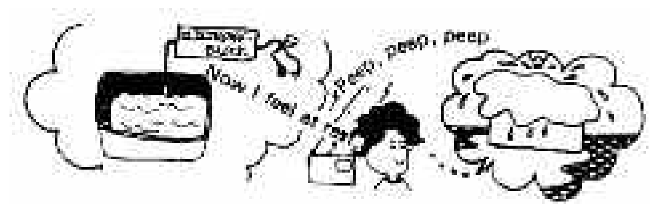
Antenna ●Dangerous! Do not insert antenna lead into an AC outlet.



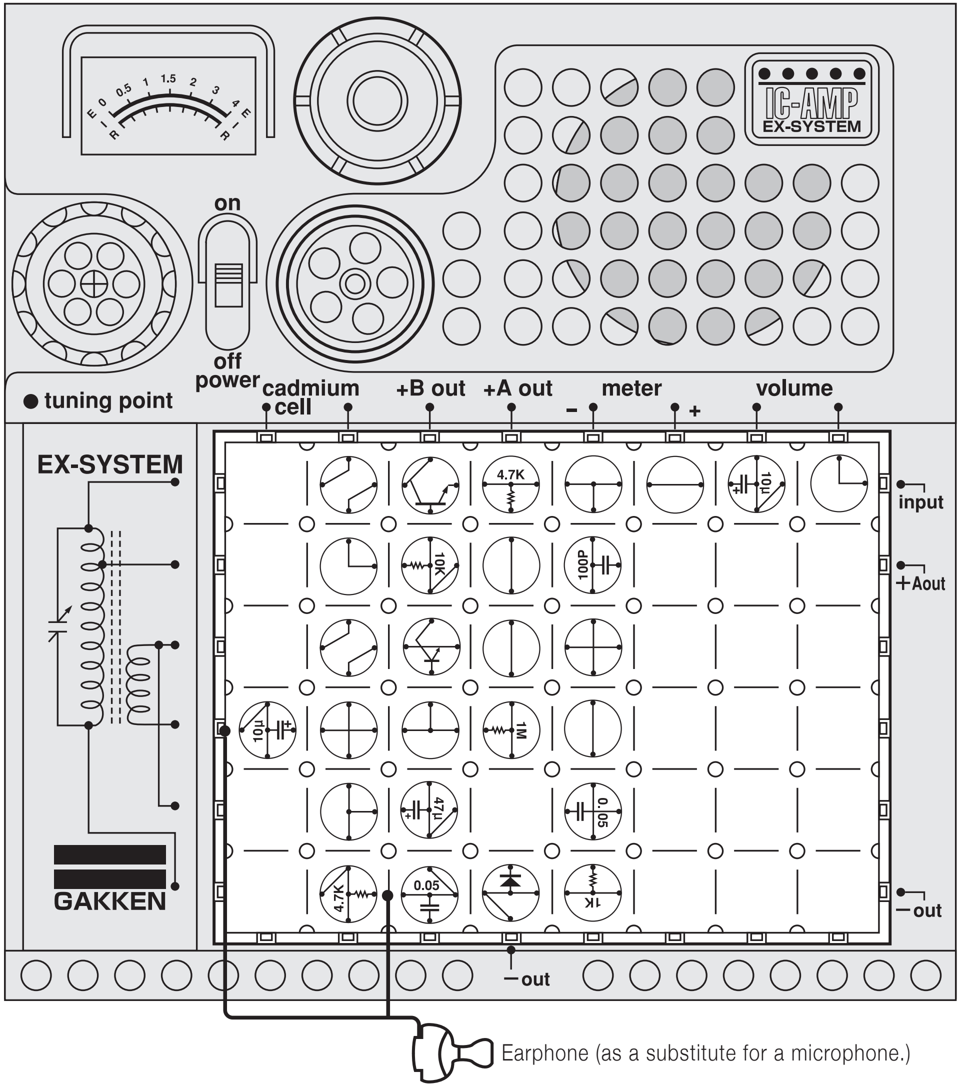
Circuit diagram for this experiment:



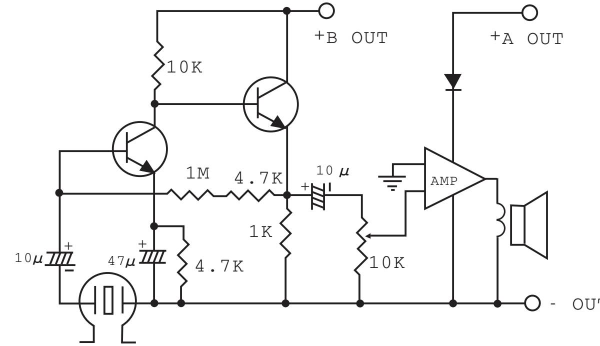
This circuit is another device that will tell you when your bathtub has been filled with water. Arrange the blocks, antenna, and 60cm cords as illustrated at left. Continue the experiment as No 27, but you will not require an earphone. When the water level rises to the cords (electrodes) and a current flows between them, a warning sound will come out of the radio. See No.10 to set up the radio.



No.68 2-Transistor + IC Amplifier (Direct-coupled Type



Circuit diagram for this experiment:

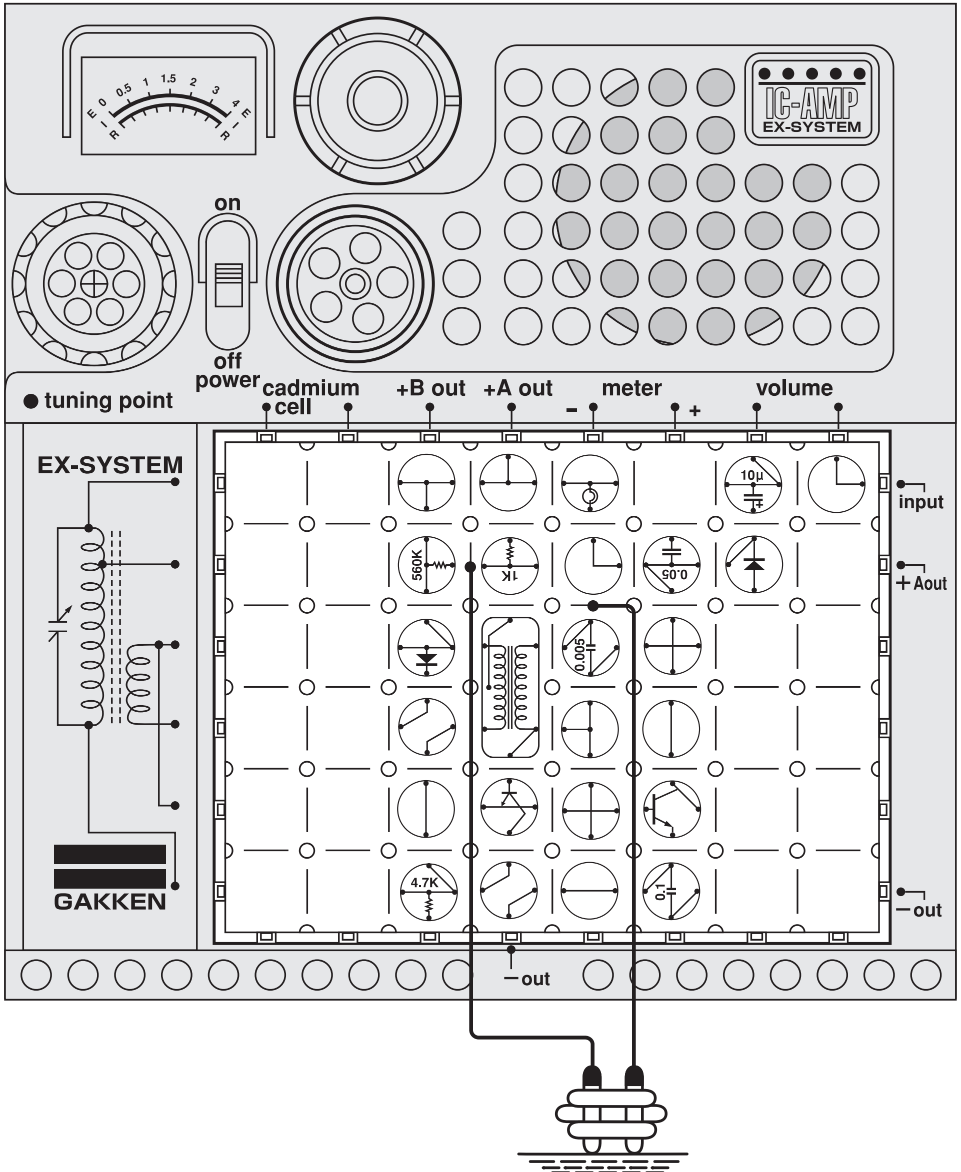


Now go back and review the amplifier circuits you have made. Then build the IC amplifier with transistors called for in this experiment.

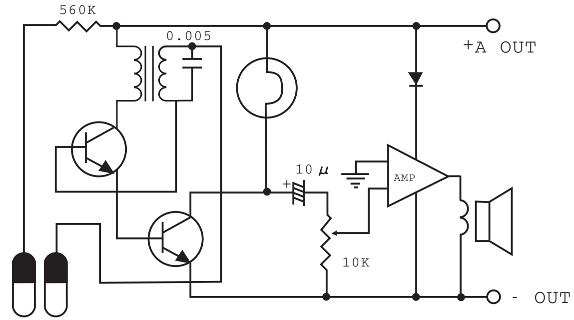
Arrange the blocks and earphone as illustrated at left. Speak to the earphone, you will hear your voice comes out of the speaker.

Of all the amplifiers you have built, which do you think has the highest sensitivity? Different components have been used to build their circuits. Take a good look at the components and try to understand the functions they perform.

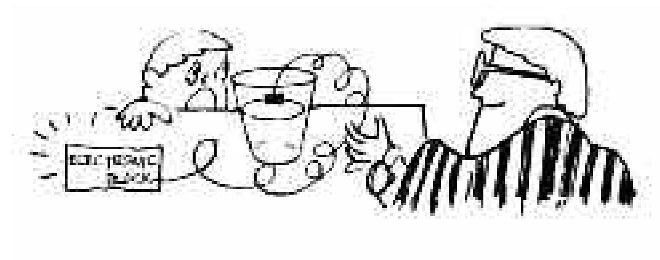
No.69 Light and Sound Water-LeveI Warning Device



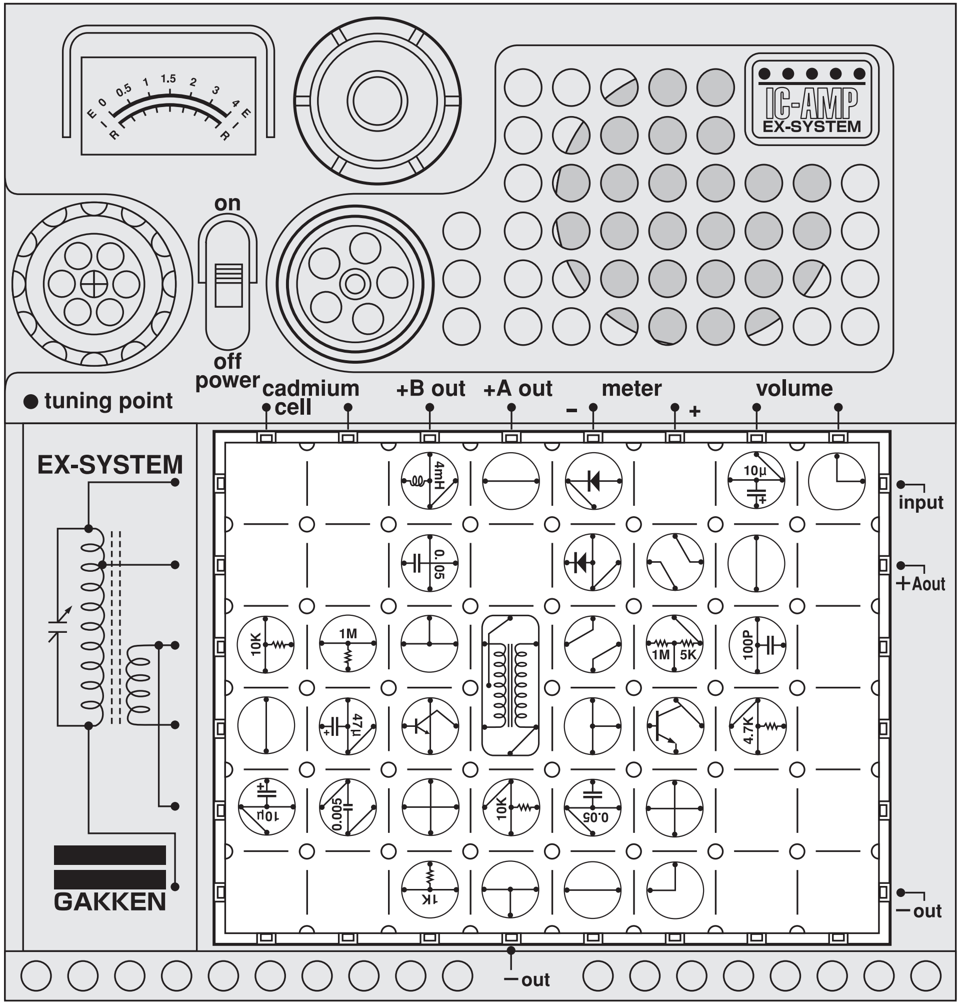
Circuit diagram for this experiment:



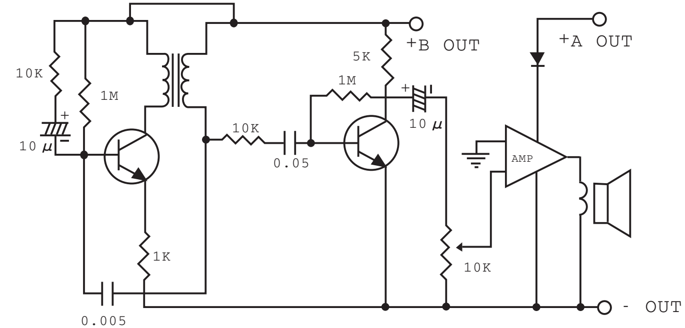
So far you have made various water-level warning circuits. In this experiment, you will make a water-level warning device using light and sound.
Arrange the blocks as illustrated at left, attaching the 60cm cords. Continue the experiment as No. 27, but you will not require the earphone, and you will test the water in a water glass rather than in a bathtub.
When the cords (electrodes) are immersed in the water, a sound comes from the speaker and the lamp glows at the same time. This circuit may be used as a rain warning device if cleverly arranged.



No.70 Electronic Bird (Speaker Type)



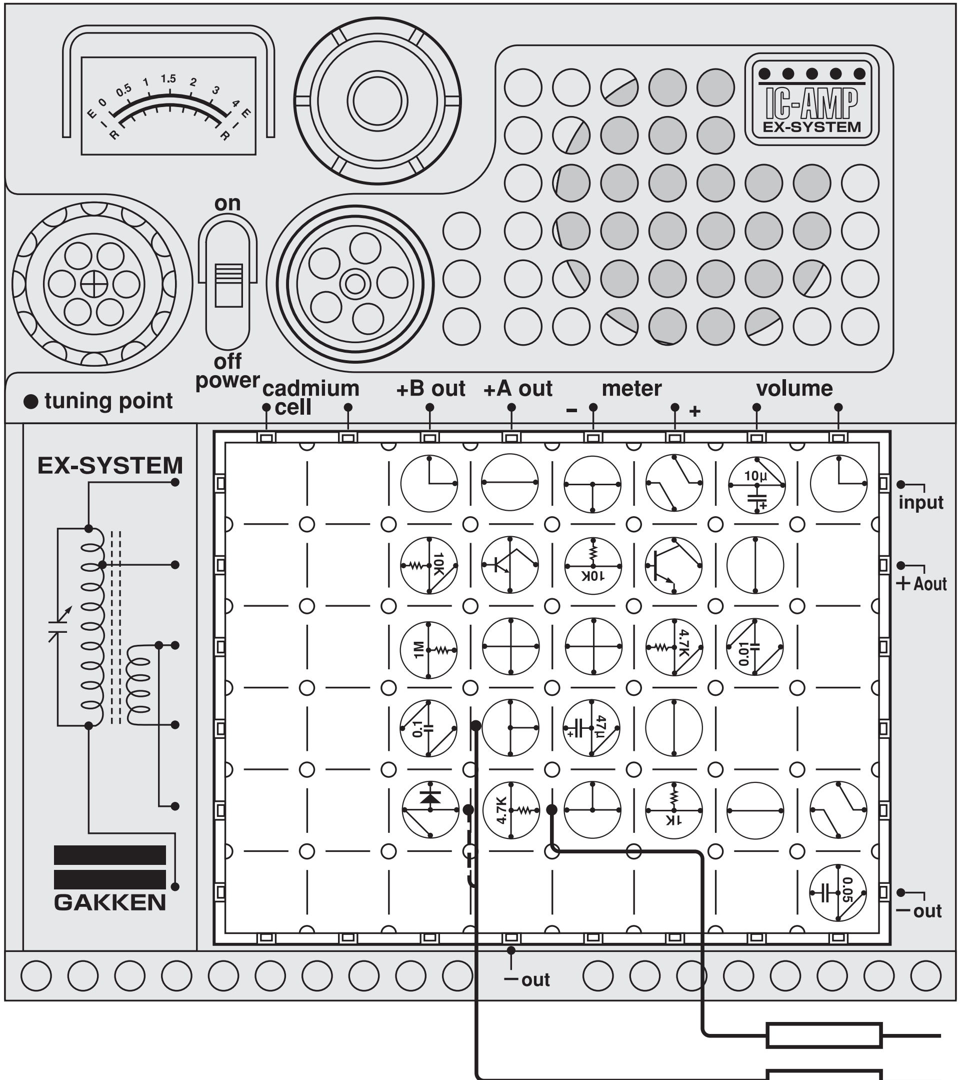
Circuit diagram for this experiment:



Now let's build a circuit using two transistors and an IC amplifier to electronically imitate the sound of a singing bird again. Arrange the blocks as illustrated at left and turn on the power switch.
In this circuit, the volume can be controlled.

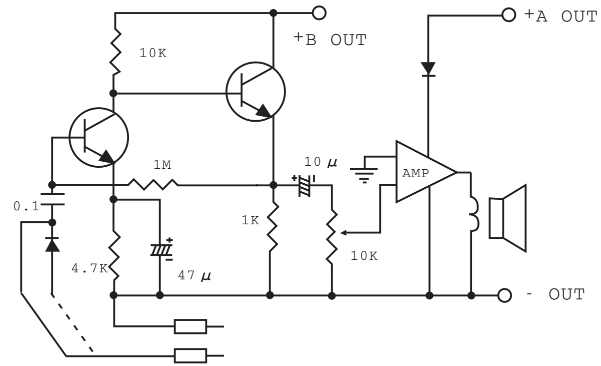
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

No.71 2-Transistor + IC Amplifier Signal Tracer



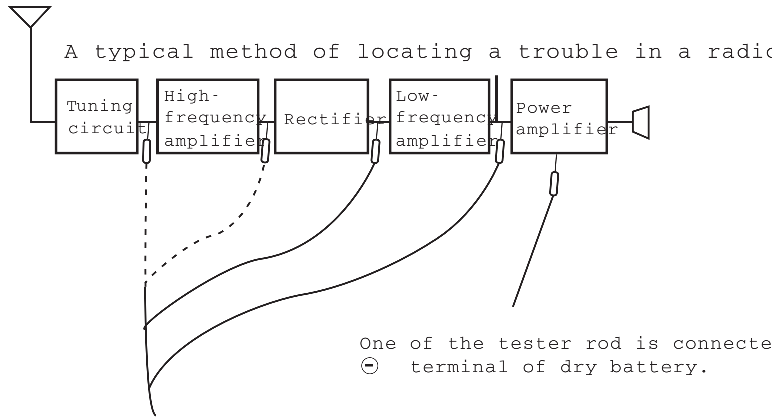
High-frequency
Low-frequency

Circuit diagram for this experiment:

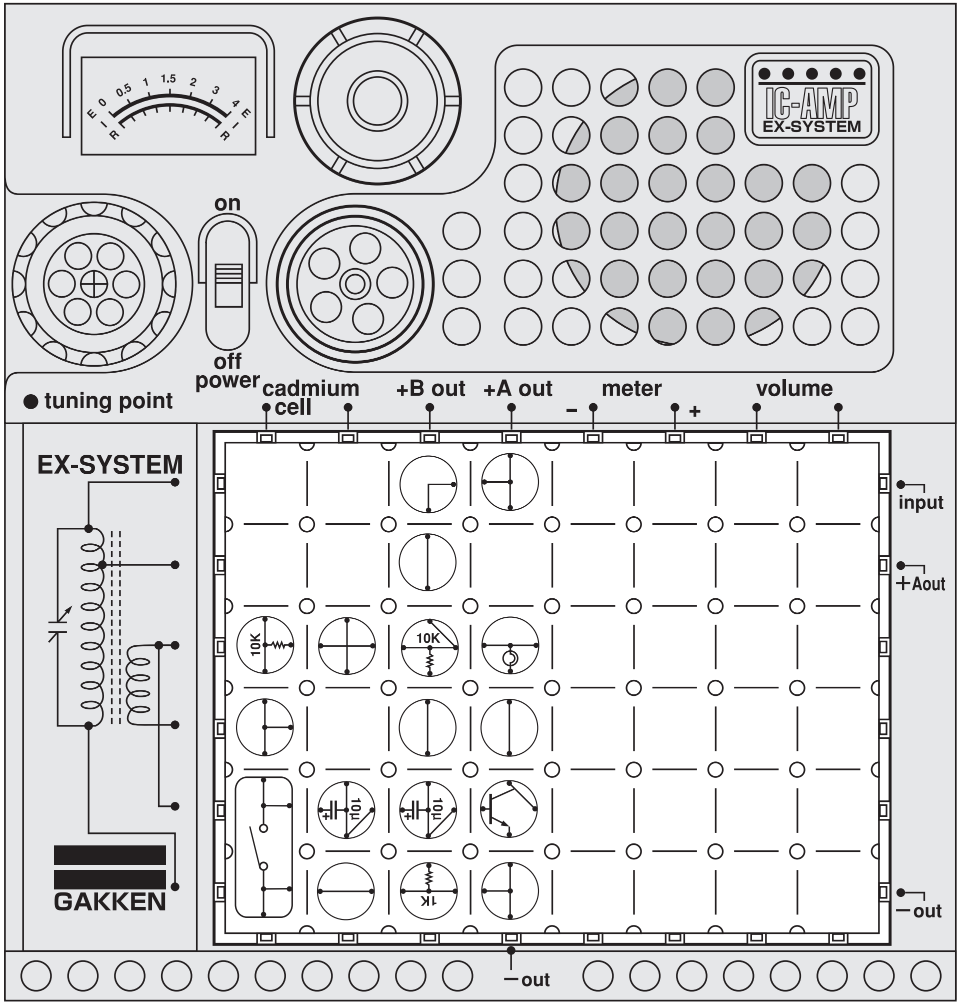


Use this 2-transistor and IC amplifier signal tracer to detect trouble in your radio receiver by checking the radio's components one after another as illstrated below.

Arrange the blocks as illustrated at left, attaching the red and black tester rods. Turn on power switch. Making sure that the radio is disconnected from the electrical socket, test it in the following manner:

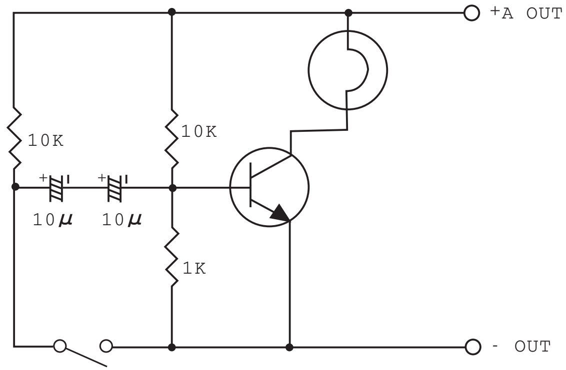


No.72 Physical Agility Tester



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

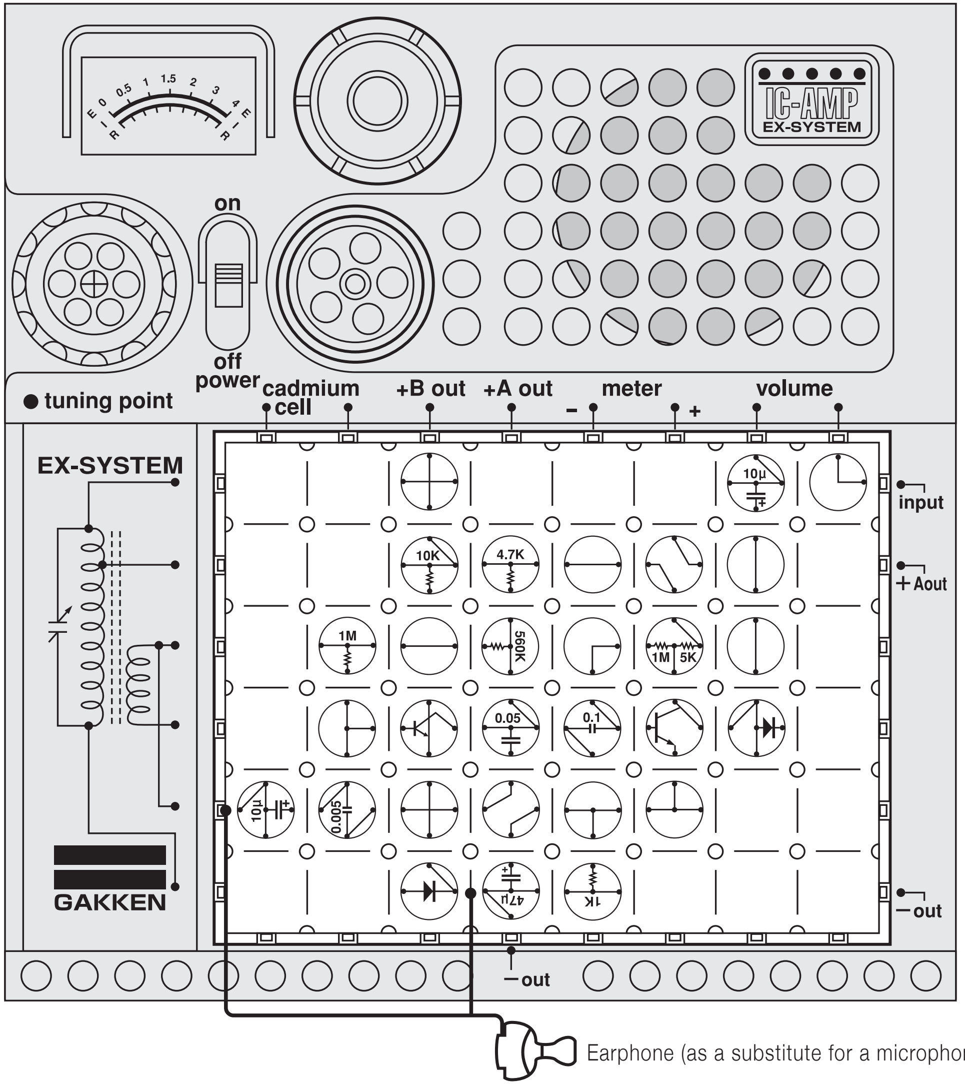
Circuit diagram for this experiment:



With this circuit, you can test your friends' agility by seeing who can make the lamp glow the brightest. It will glow only when someone quickly presses the key switch on and off. If he or she slows down the motion, the lamp will not light.

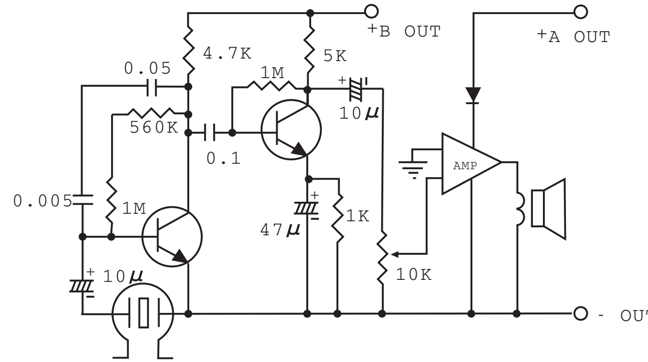
Arrange the blocks as illustrated at left and turn on the power switch. Then take turns pressing up and down on the key switch to see who is the most agile.

No.73 CR-Coupled 2-Transistor + IC Amplifier



Earphone (as a substitute for a microphone.)

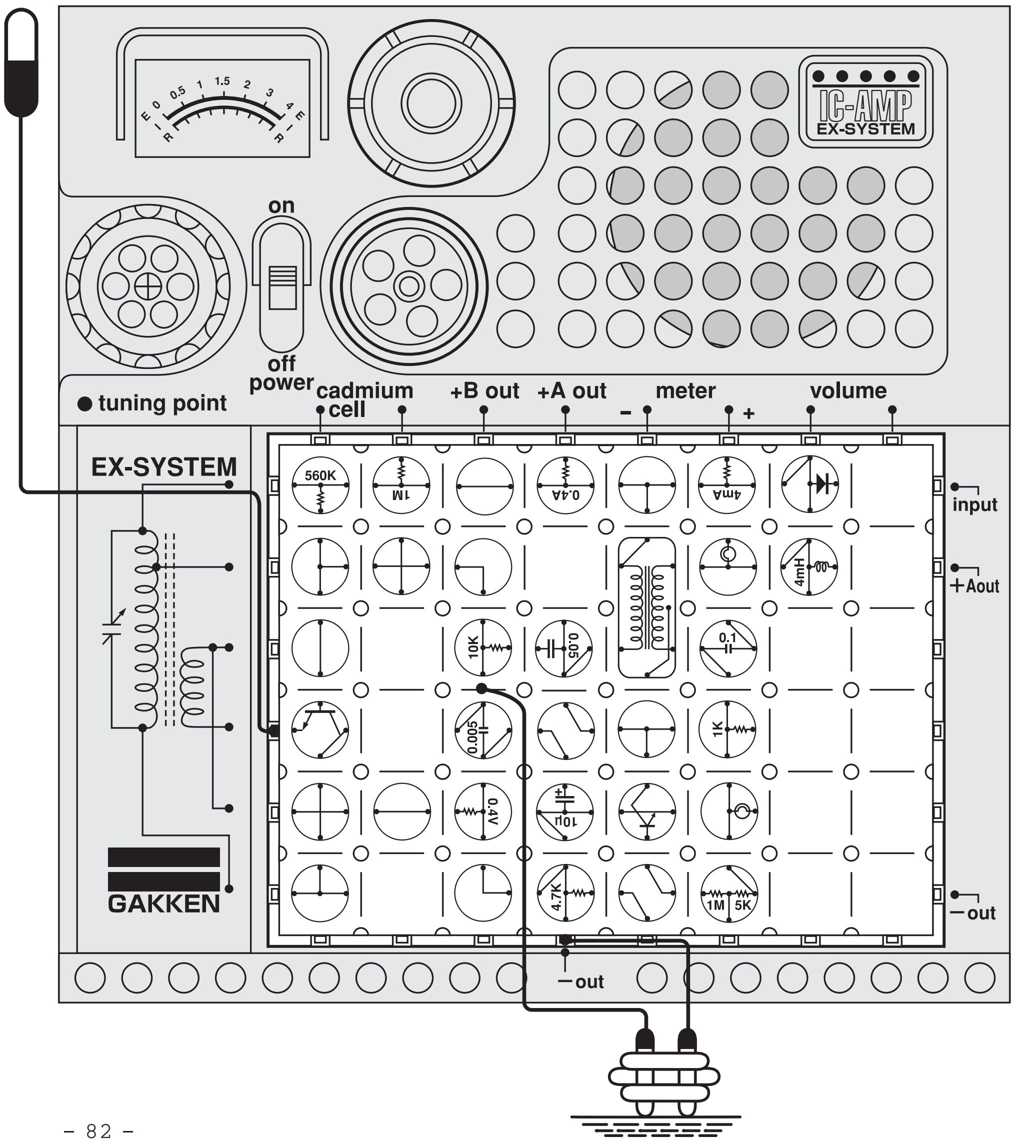
Circuit diagram for this experiment:



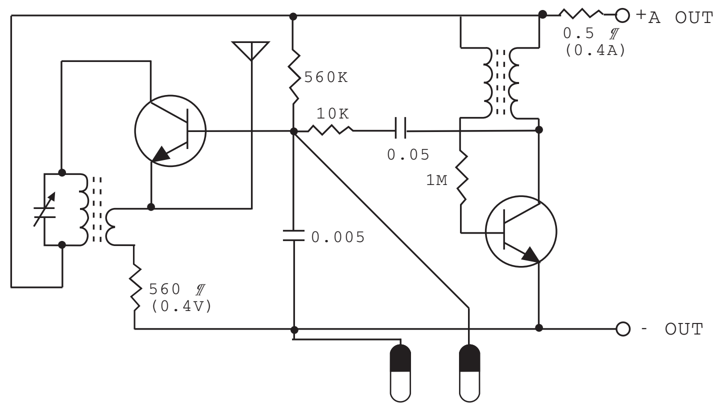
Now let's build a CR-coupled amplifier capacitor. R represents resistor; that is, this is an amplifier made up of a capacitor and a resistor. Arrange the blocks as illustrated at left, attaching the earphone. Turn on the power switch. For this experiment, you will use the earphone as a microphone.

No.74 Wireless Water Shortage Warning Device

Antenna ●Dangerous! Do not insert antenna lead into an AC outlet.



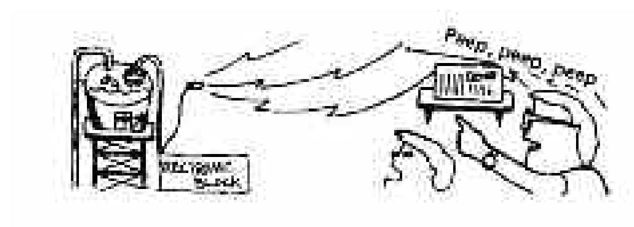
Circuit diagram for this experiment:



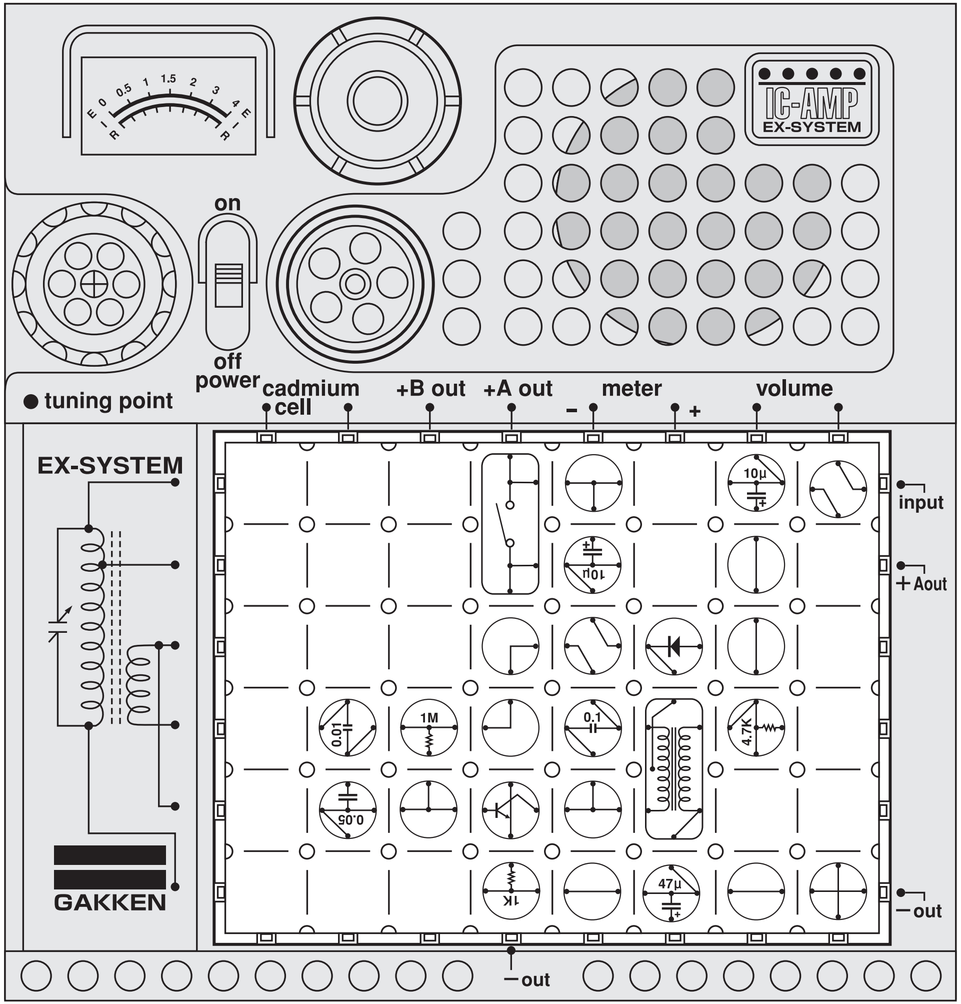
This is a wireless water shortage warning circuit that may be used in various ways, such as giving a warning when the water level has fallen too low in the bathtub or the soil in a flowerpot has become too dry. This device is constructed so that the oscillatory circuit will go into operation when the electrodes are out of water. Since this is a wireless mechanism, it must be tuned to a radio set.

Arrange the blocks as illustrated at left, attaching the antenna and 60cm cords fastened with a plastic clip.

Turn on the power switch and tune the kit to your radio set as in Experiment No.10. Place the cords (electrodes) in a container with water or a moist substance. When the water level goes down or water content evaporates, a warning will sound.

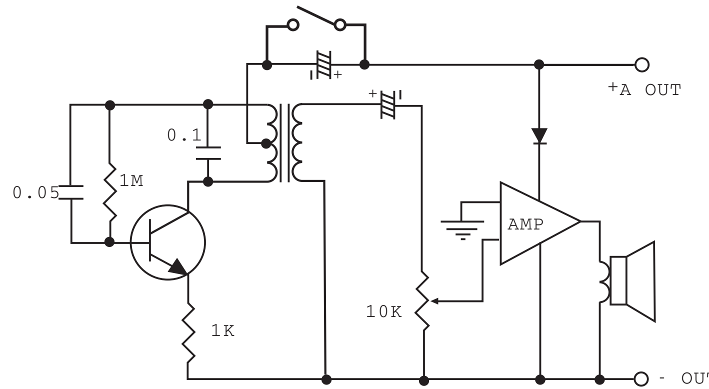


No.75 Electronic Horn



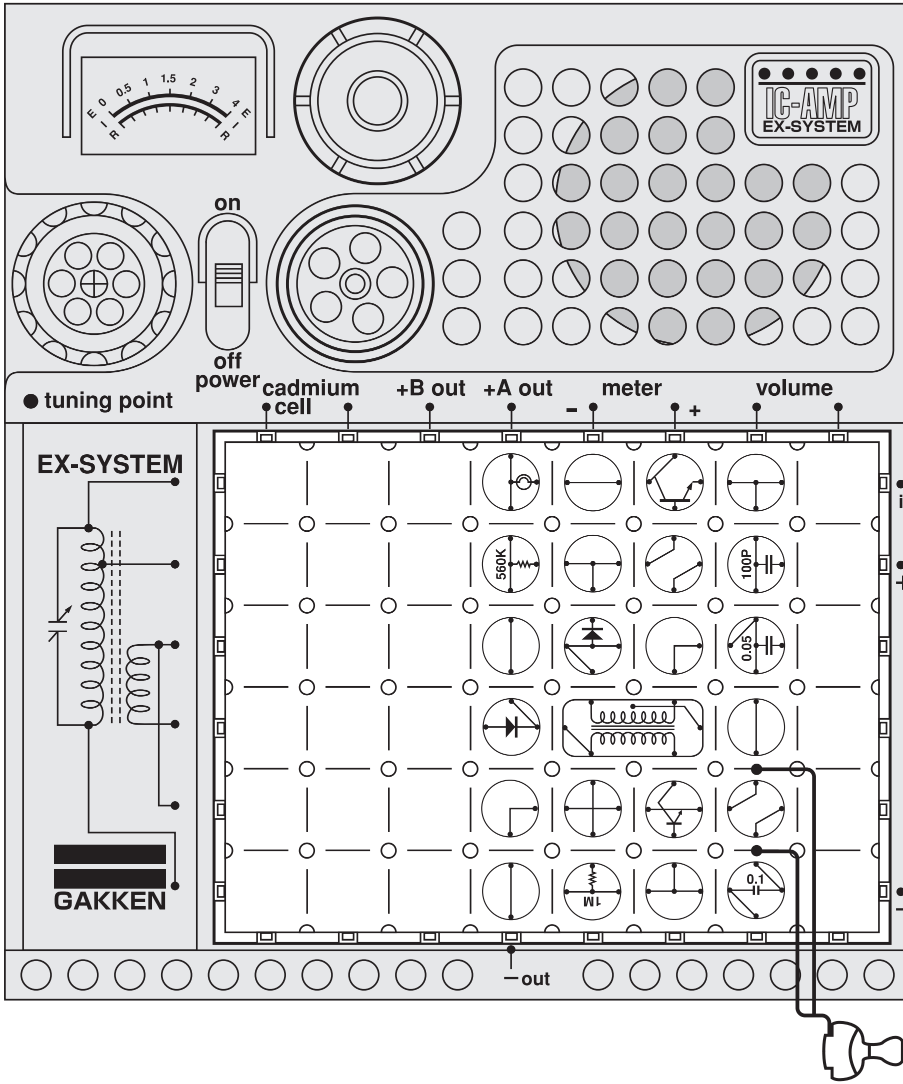
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:



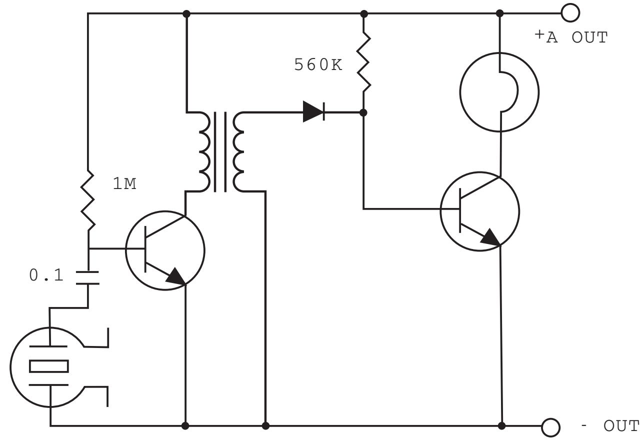
This experiment is an application of the unstable multivibrator. The circuit will produce the sound of a horn.
Arrange the blocks as illustrated at left and turn on the power switch. When the key switch is depressed, the circuit produces an oscillation sound, or the sound of the horn, which continues for a while after the switch is released.

No.76 Basic Circuit of Photophone



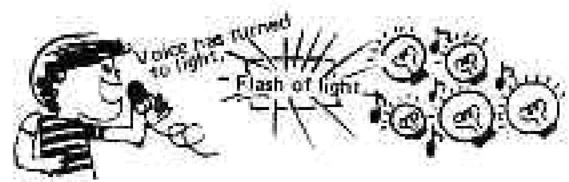
Earphone (as a substitute for a microphone.)

Circuit diagram for this experiment:

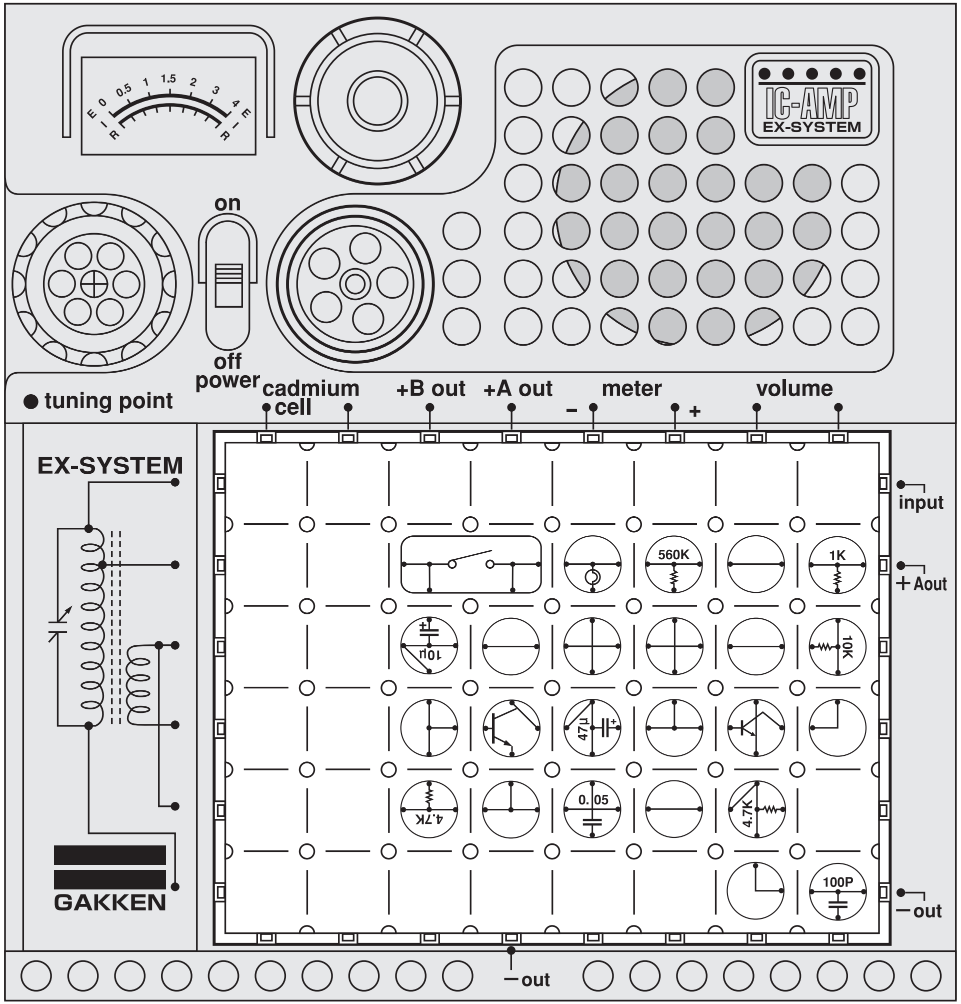


Have you ever seen a photophone? It is a telephone that uses light, instead of ordinary telephone cables, to transmit messages; that is, sound signals are turned to light signals (variations of light intensity) to travel through space. Then they are turned back to sound signals where they are received. In this experiment we will test the circuit for emitting the light signals.

Arrange the blocks and earphone as illustrated at left and turn on the power switch. Speak into the earphone and your voice will cause the lamp to flash.

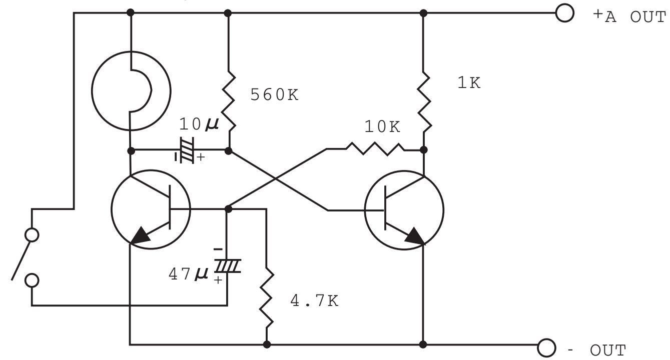


No.77 Basic Circuit of EIectronic Timer



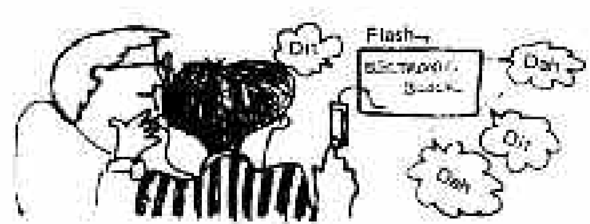
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

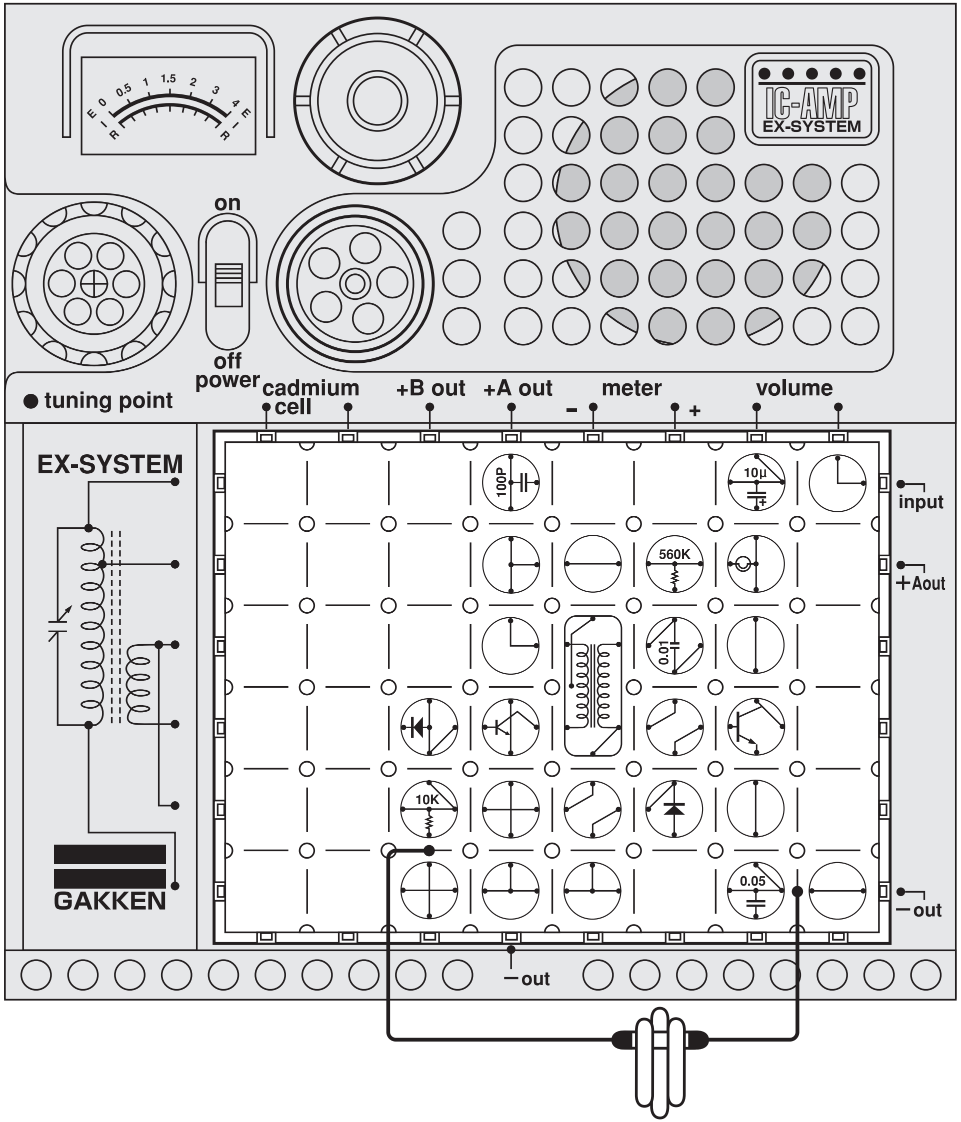


The electronic timer, coupled with a CdS photocell, is built into a camera to determine the correct shutter speed according to the available lighting. It also is used to assure the correct exposure time when developing and printing films in a darkroom. The electronic timer you are going to build now will work to make the lamp glow for 10 to 30 seconds.

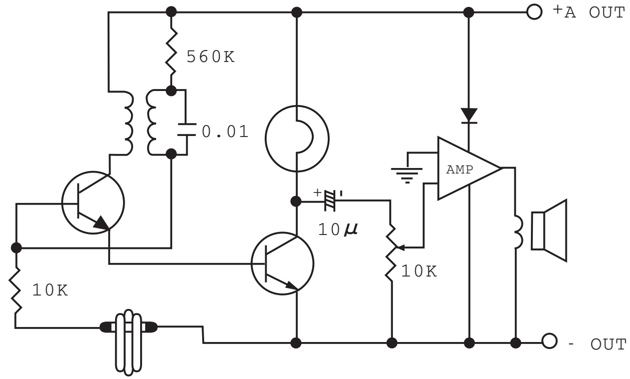
Arrange the blocks as illustrated at left and turn on the power switch. Press down on the key switch and the lamp will flash on as a timer.



No.78 Sound and Light Disconnected Circuit Warning

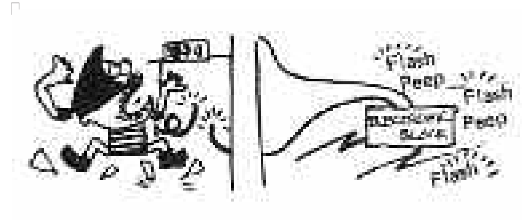


Circuit diagram for this experiment:

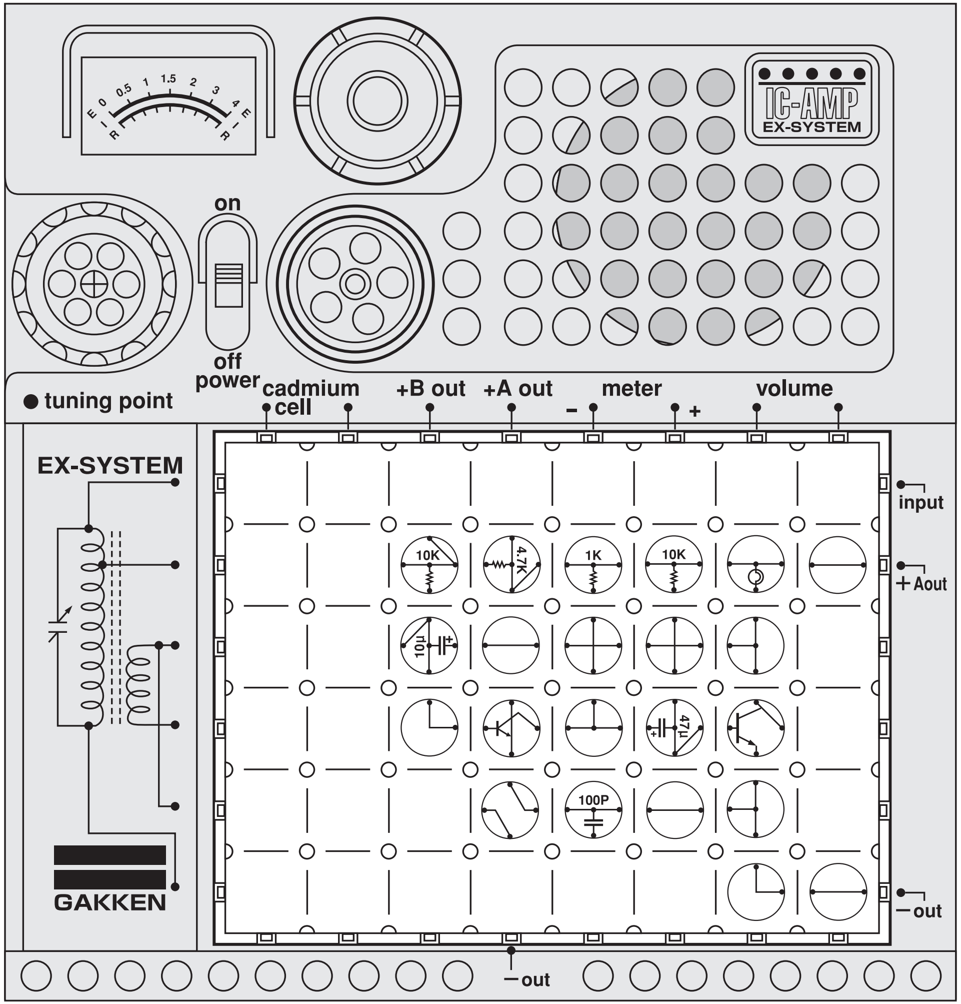


This circuit has the same function as that for other warning devices you have built; but the warning is signalled by both sound and light. When the sound volume is turned down to an inaudible level, light alone will flash the warning that the cords have been disconnected.

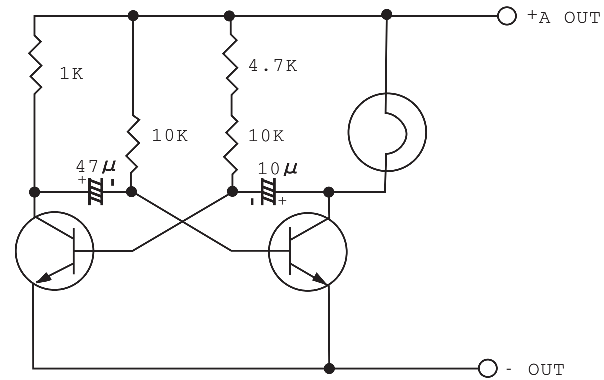
Arrange the blocks as illustrated at left. Continue as Experiment No.53. Then turn down the volume and see the light flash a warning by itself. Can you think of other interesting applications for this circuit?



No.79 Unstable Multiple Circuit



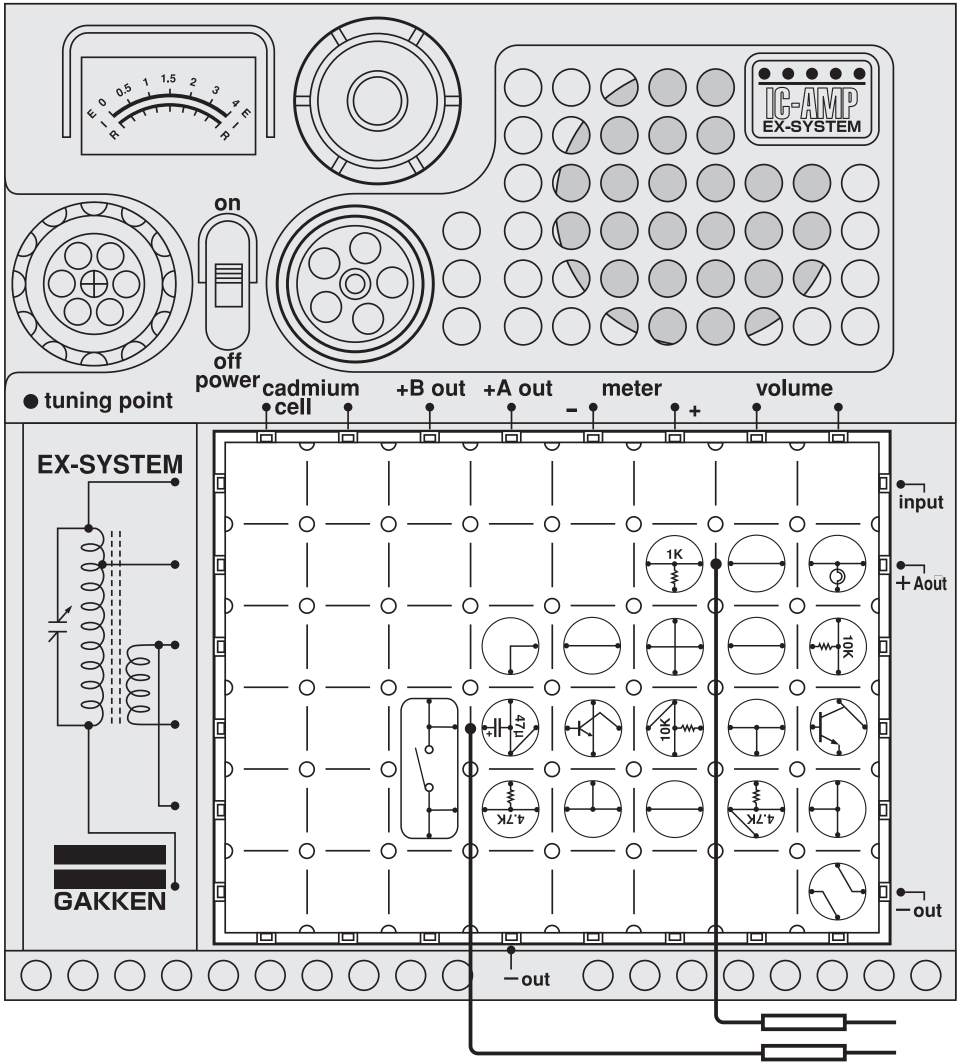
Circuit diagram for this experiment:



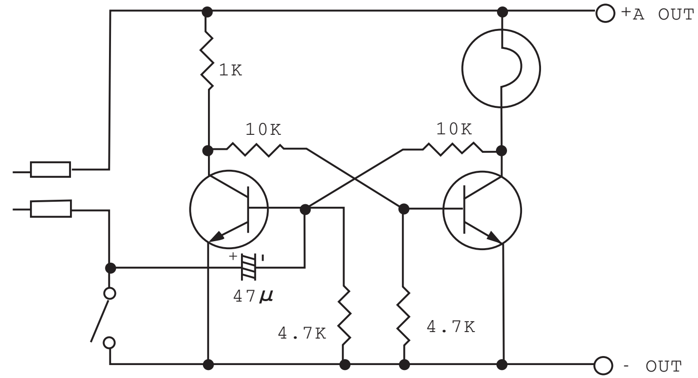
In a computer, the instructions and Information are processed at a definite speed, which is determined by the type of circuit featured in this experiment. Here, the circuit controls the speed at which the lamp goes on and off.

Arrange the blocks as illustrated at left and turn on the power switch. Then watch the lamp to see how it is programmed.

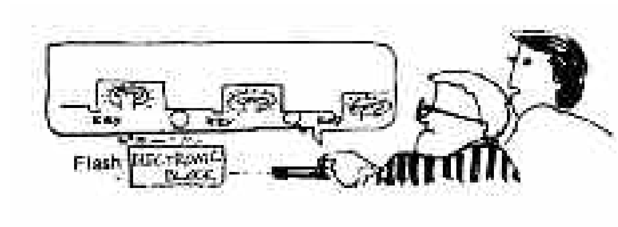
No.80 FIip-Flop Multiple Circuit



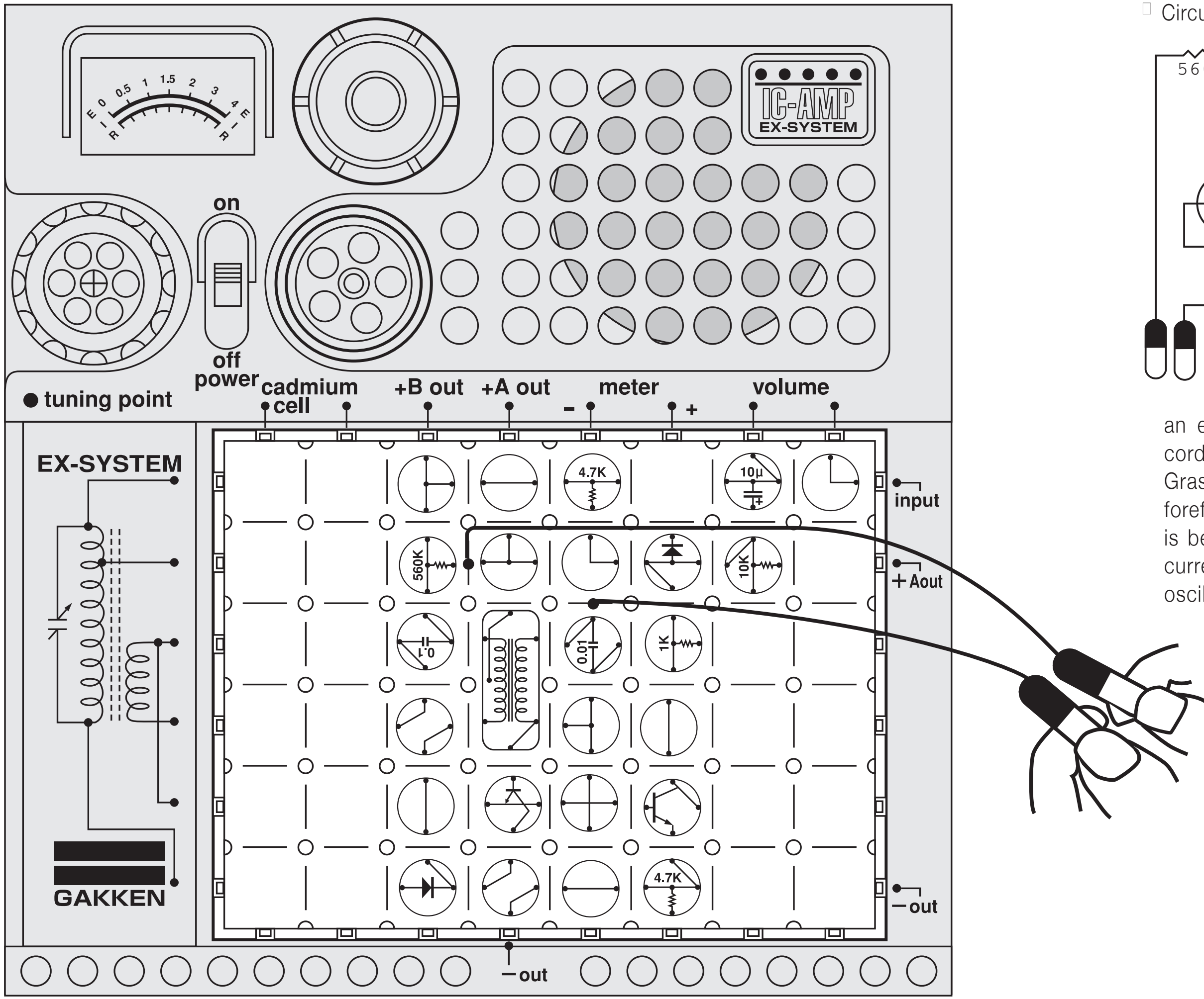
Circuit diagram for this experiment:



This is also one of the circuits used in a computer. Arrange the blocks and tester rods as illustrated at left. Then turn on the power switch. Press down on the key switch and the lamp will go on. It will remain on even when the key switch is released. Touch the two tester rods together. The lamp will go off and remain off when the tester rods are separated and set aside. You have just seen that this circuit performs the function of memorizing that the key switch was depressed (instruction A) and that the tester rods were touched together (instruction B).

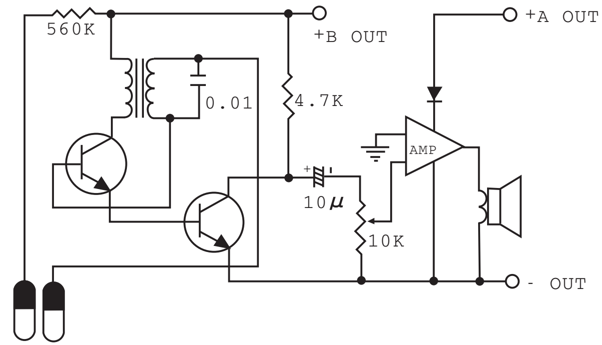


No.81 Touch Buzzer



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

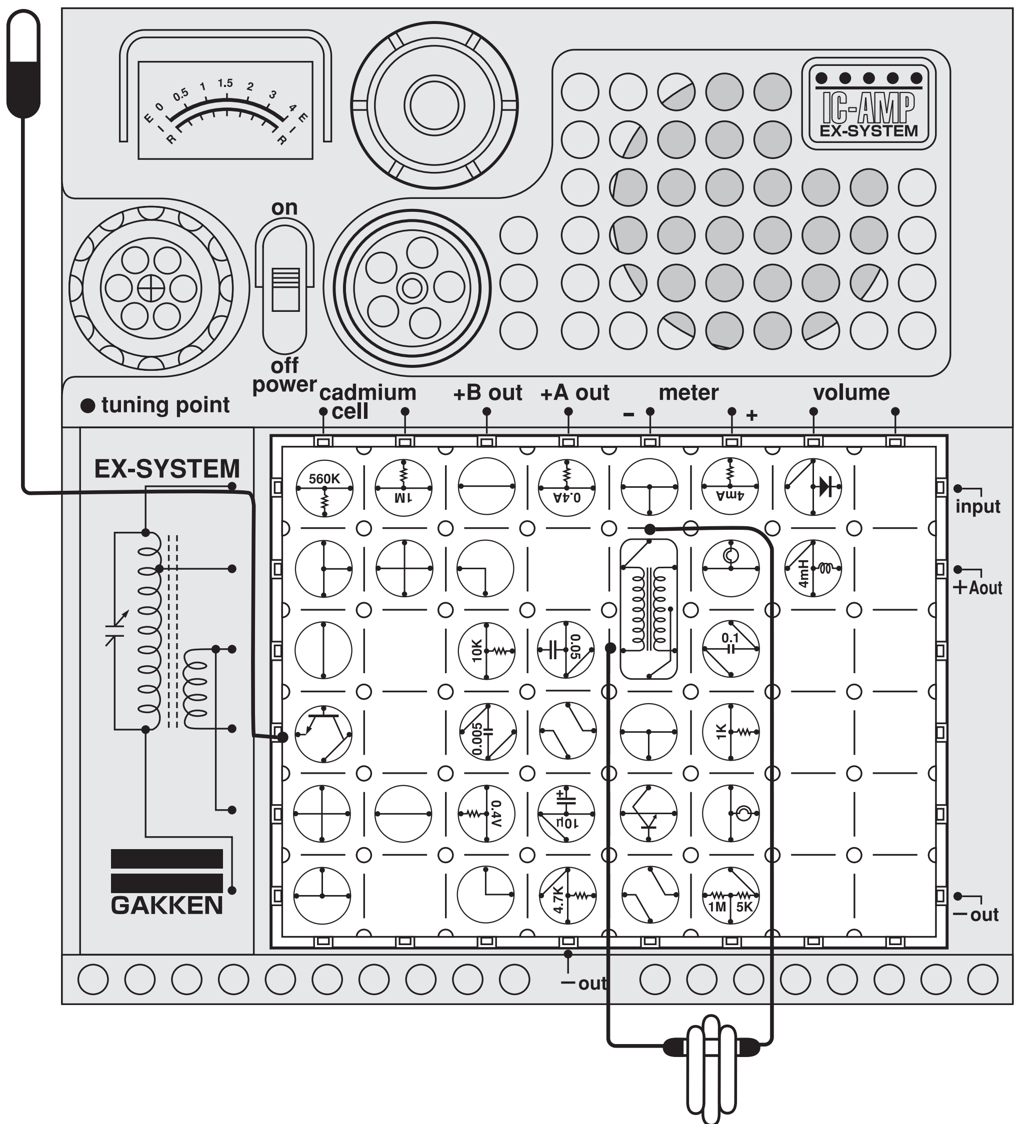
Circuit diagram for this experiment:



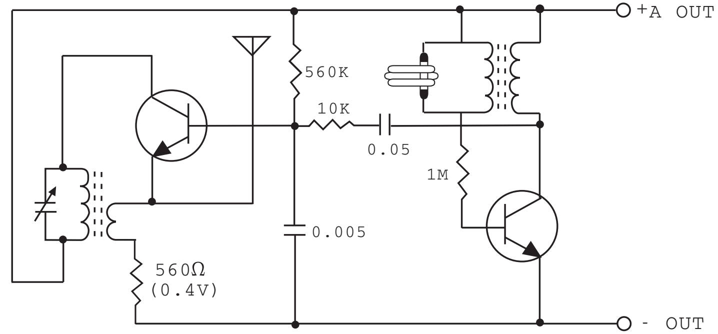
Let's do an experiment to see if the human body is an electrical conductor. Arrange the blocks and 60cm cords as illustrated at left and turn on the power switch. Grasp the ends of the cords lightly in the thumb and forefinger of each hand, and the buzzer will sound. This is because when you hold the electrodes in this way, a current flows between them through your skin to put the oscillatory circuit into operation and sound the buzzer.

No.82 Wireless Disconnected Circuit Warning Device

Antenna ●Dangerous! Do not insert antenna lead into an AC outlet.

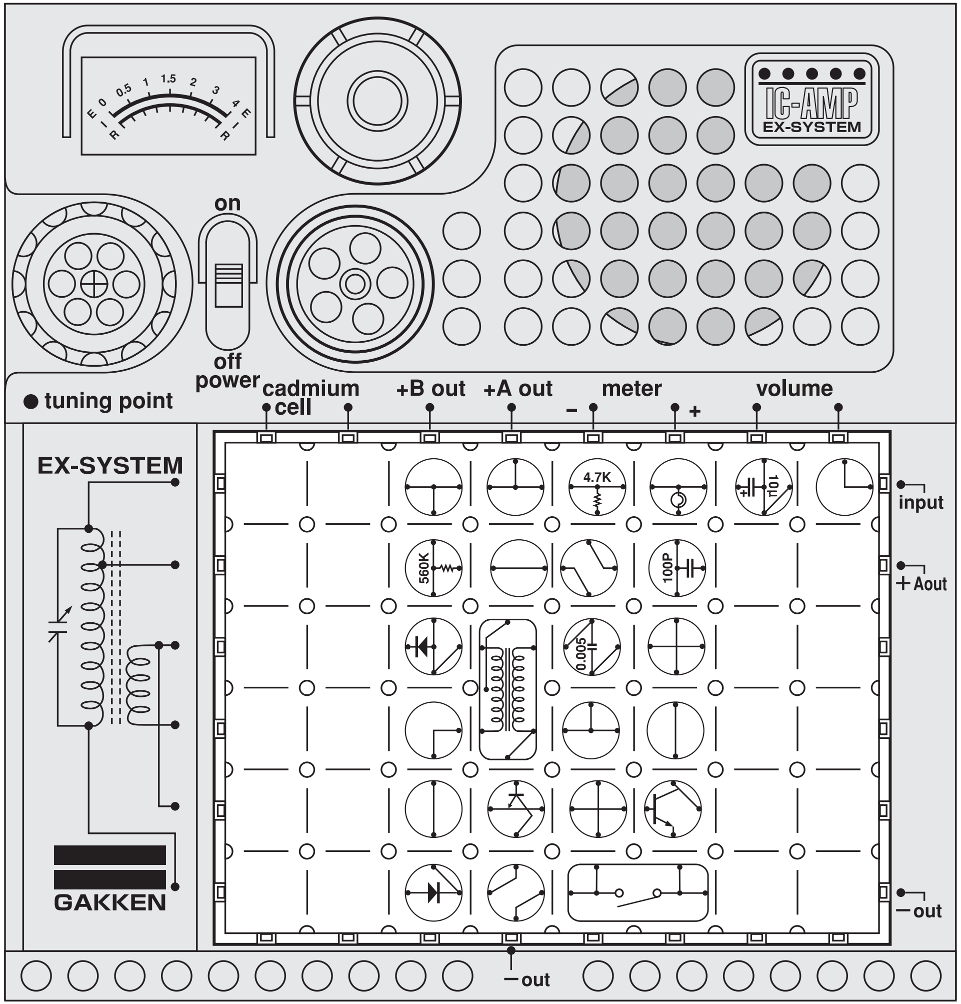


Circuit diagram for this experiment:



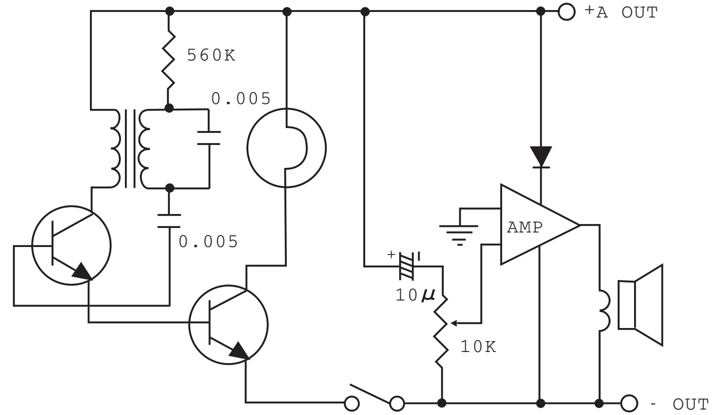
Now let's experiment with another wireless disconnected circuit warning device. Arrange the blocks, antenna, and 60cm cords as illustrated at left. You need an extra radio with AM frequency.
Turn on the main switch, disconnect the water level clip.
Tuning the extra radio until you hear a high-pitch tone comes out of the radio.
If you connect the water level clip, the high-pitch tone will disappear.

No.83 Sound and Light Morse Code Practice Circuit



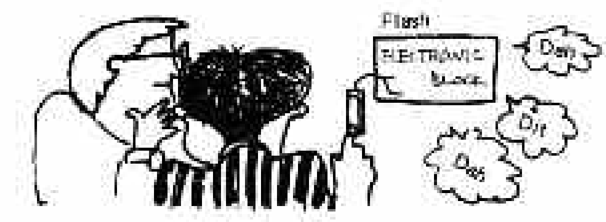
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:



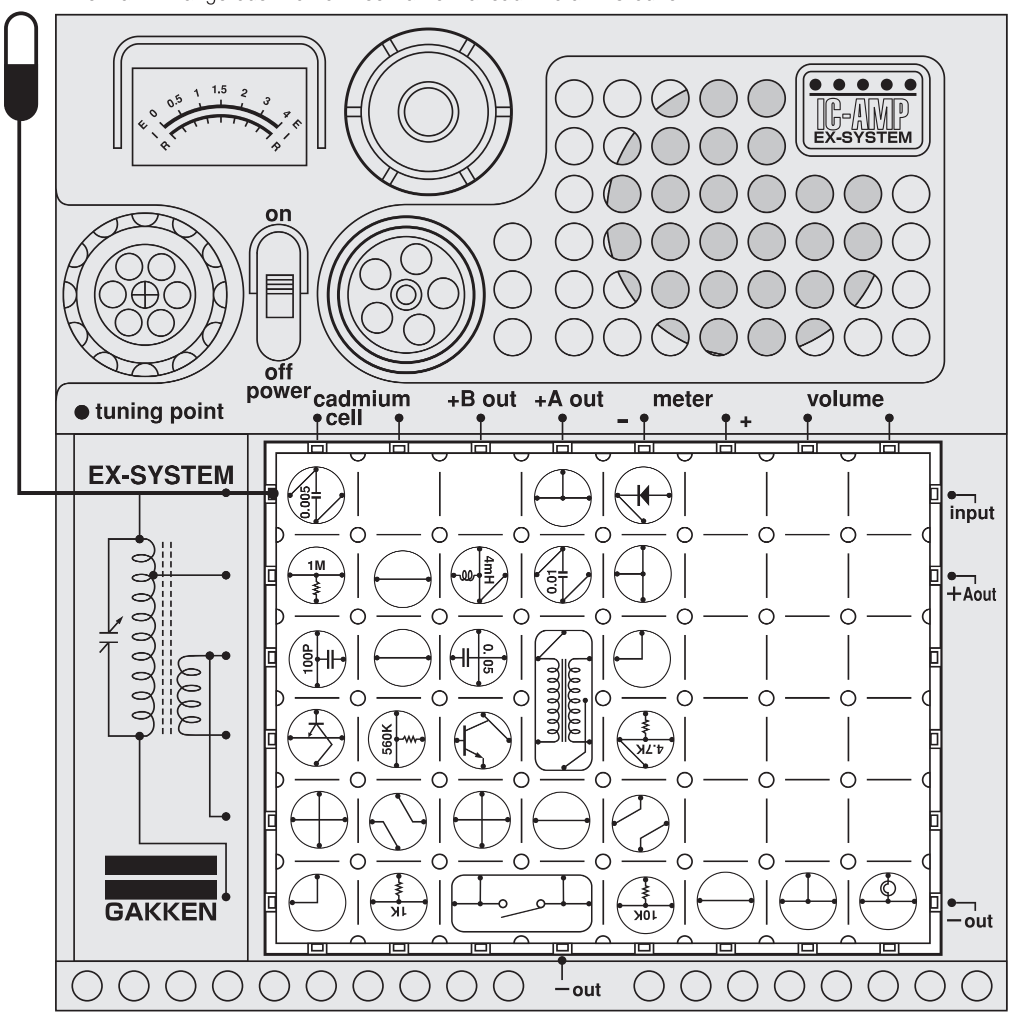
Have you trained yourself to send Morse code signals yet? This time, let's build another Morse code practice circuit using both sound and light. Refer to Experiment No. 24 to review the Morse code signals if necessary.

Arrange the blocks as illustrated at left and turn on the power switch. If you wish, turn the volume down. You may now send signals by light alone.



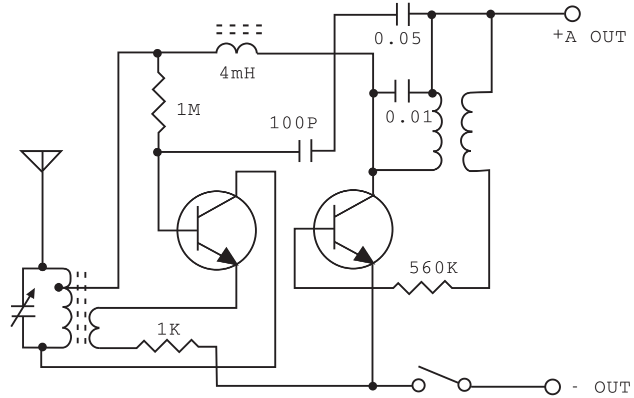
No.84 Wireless Morse Telegraph

Antenna ●Dangerous! Do not insert antenna lead into an AC outlet.



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

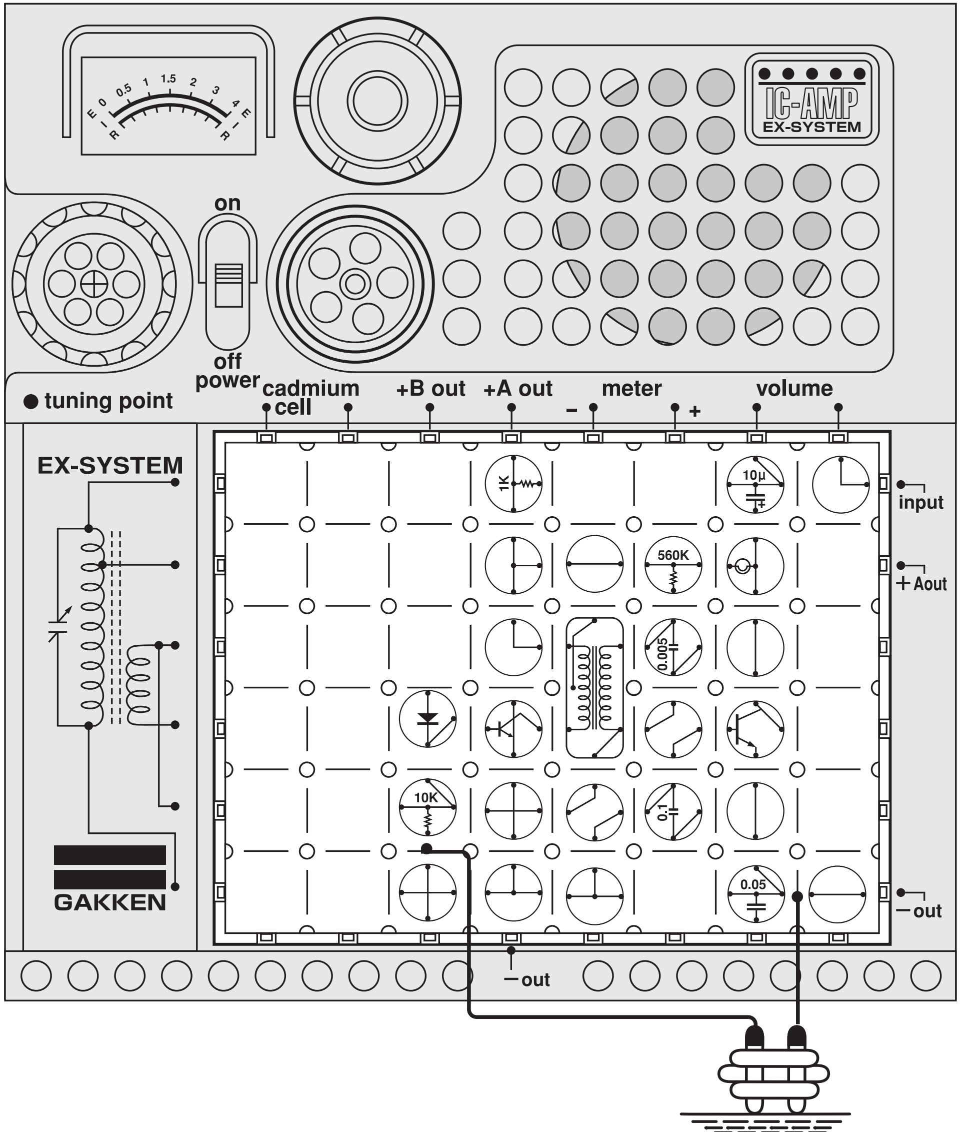


Nowadays there are many uses for radio waves in our home, such as TV and radio sets, and microwave ovens. Radio waves will be employed even more to serve our daily needs in the future.

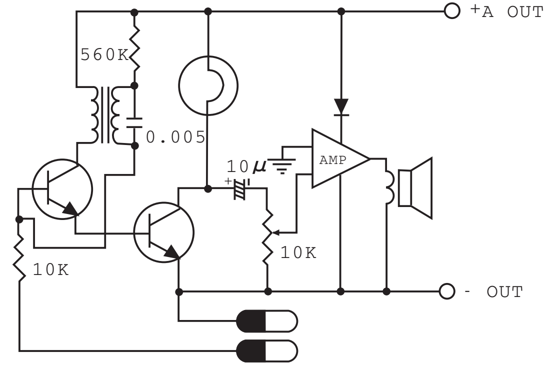
In this experiment, we will build a wireless telegraph that uses radio waves. After assembling the blocks and antenna as illustrated at left, turn on the power switch and tune the telegraphic circuit to your radio set as you did in Experiment No.10. Now you can experiment again with wireless Morse code communication. Use the Morse code signals shown in Experiment No. 24.

The waveform used is the A2 wave.

No.85 Sound and Light Water Shortage Warning Device



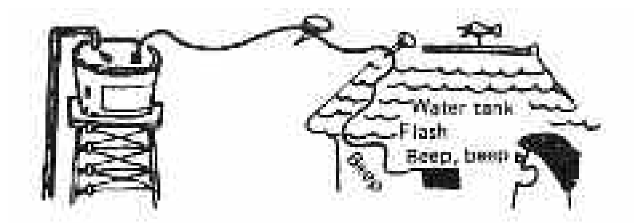
Circuit diagram for this experiment:



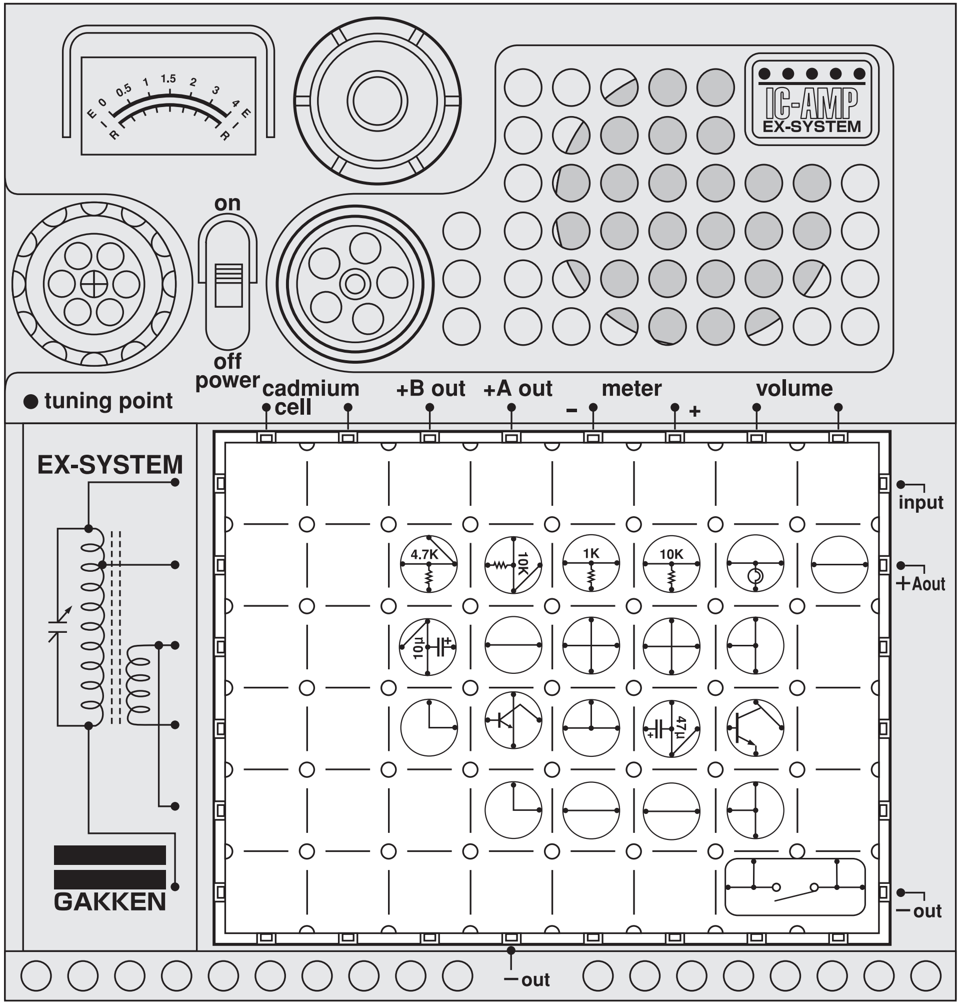
Did you find any interesting applications for the water shortage warning circuits in previous experiments? Here we will make a water shortage warning circuit using both sound and light.

Arrange the blocks as illustrated at left and attach the 60cm cords. Fasten the cords with a plastic clip. They will function as electrodes.

Dip the electrodes into water and turn on the power switch. Then lift the electrodes out of the water and listen to the sound that is made by the circuit. Now turn the volume down and dip the electrodes again. The lamp will flash a warning. Since this circuit produces both sound and light, it can be used even at night. Try to find several interesting applications for tihs device.

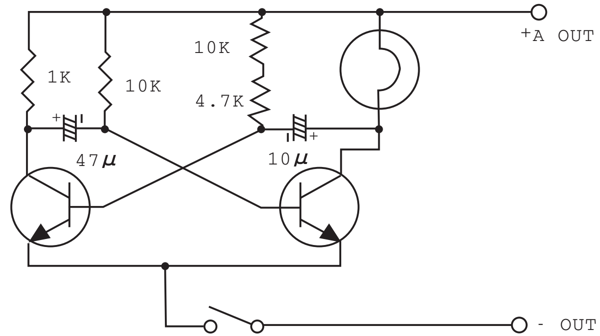


No.86 Automatic Lamp Flashing Circuit



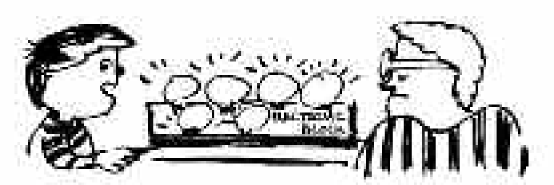
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

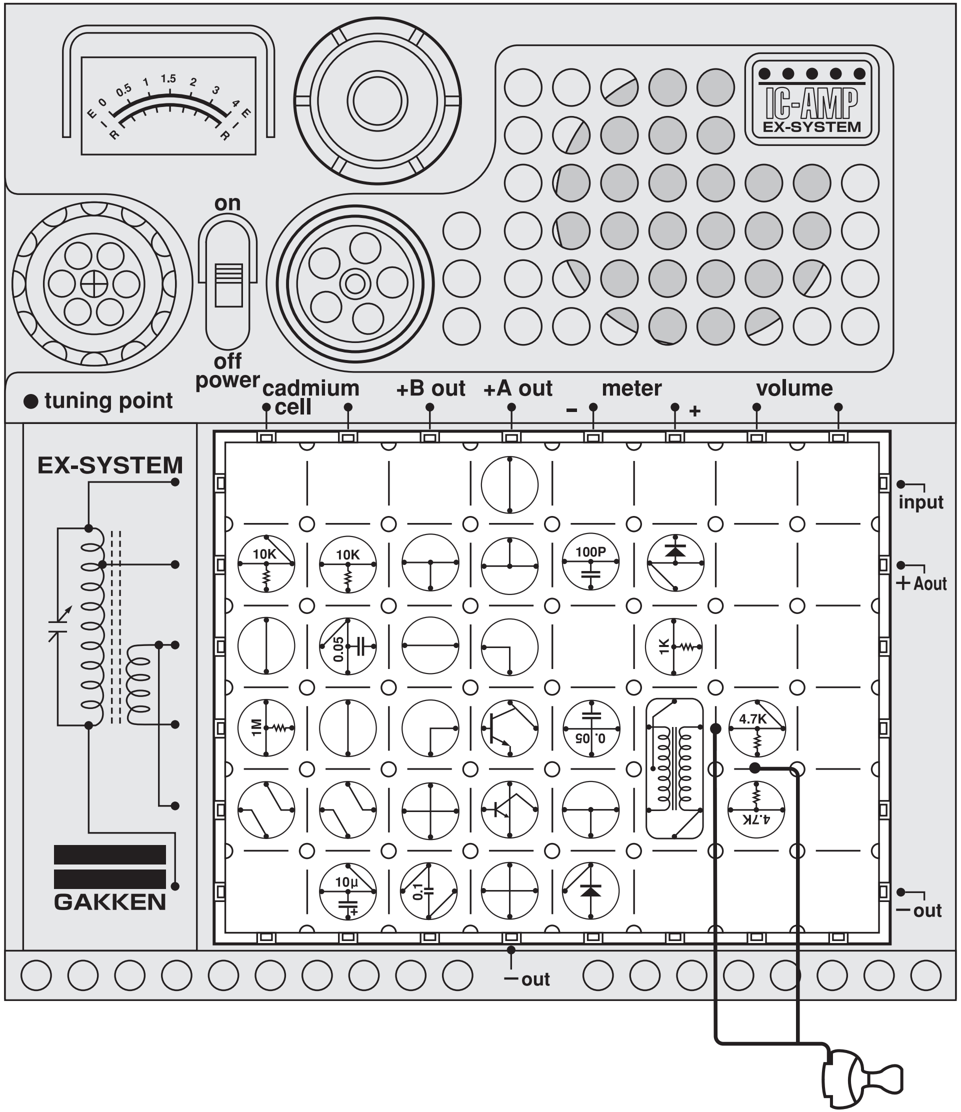


A circuit for automatically turning a lamp on and off has many applications. It is used in the flashing light signals for electric trains and automobiles. You will now build one of these circuits.

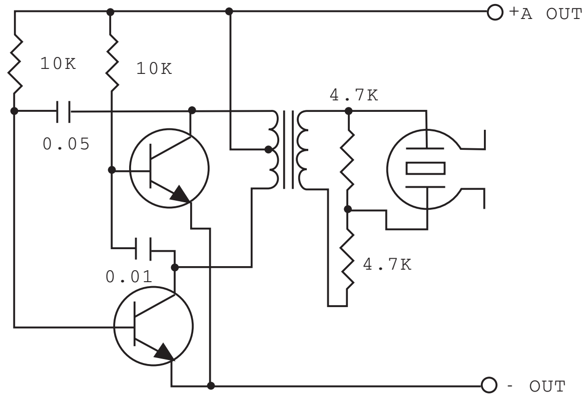
Arrange the blocks as illustrated at left and turn on the power switch. Press the key switch and see the lamp flash on and off.



No.87 Alternating Current Generator



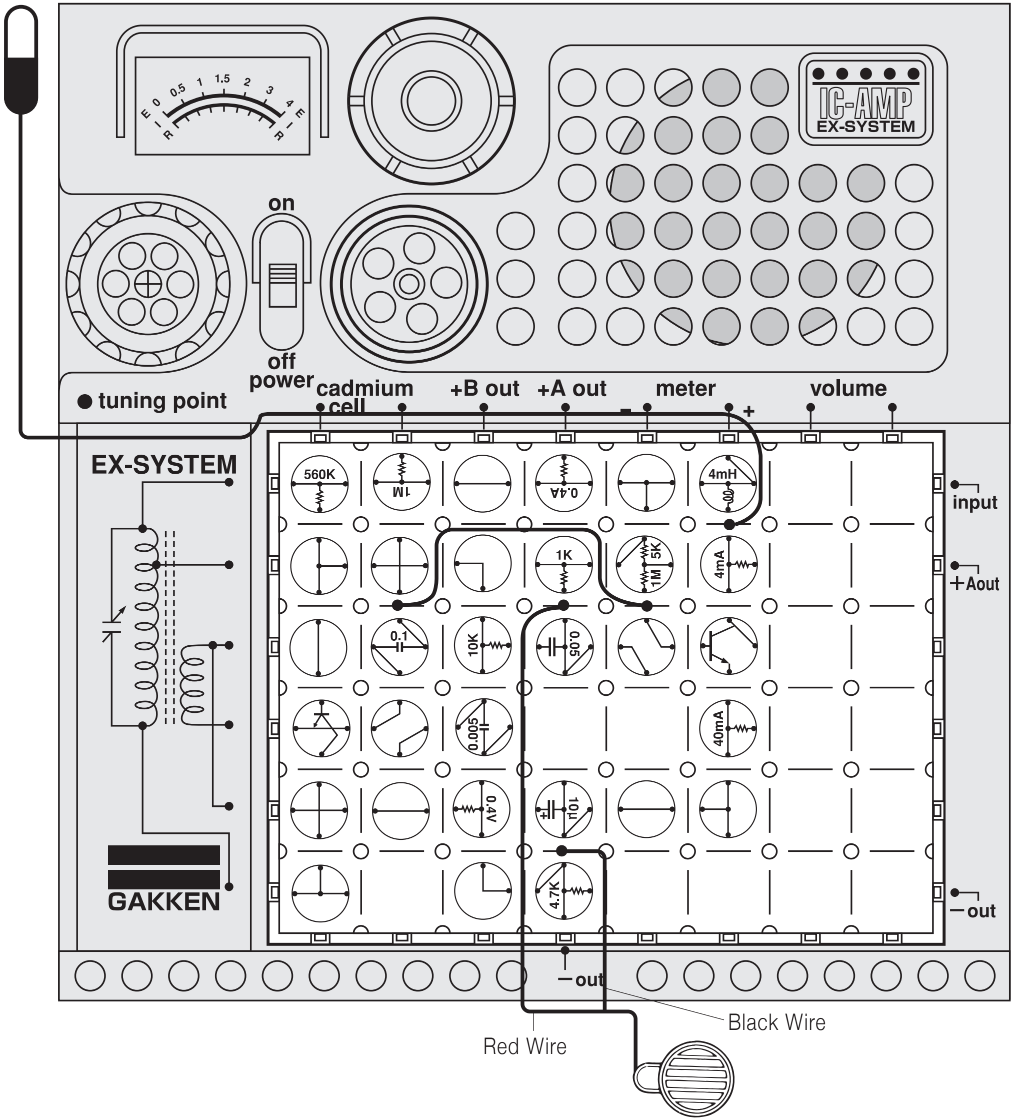
Circuit diagram for this experiment:



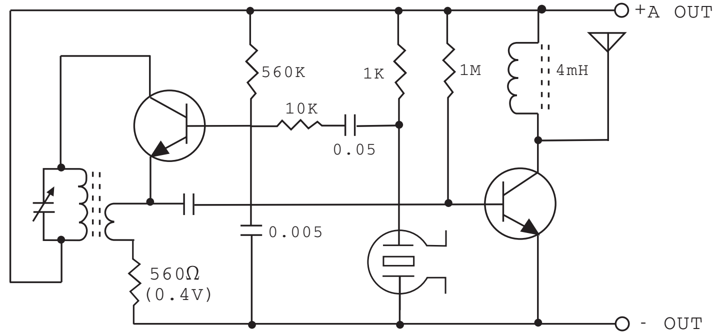
This is an application of the multivibrator. In this circuit we use a transformer connected to the collectors of two transistors to generate an alternating current from the direct current derived from the 6V dry battery. This principle is used to provide a power supply for TV sets and fluorescent lamps in cars in which only dc current is available. In this experimental circuit, the oscillation frequency is so lowered that the sound of oscillation is audible to the ear. Use earphone to hear the sound of the alternating current. The alternating voltage varies according to the ratio of the number of turns in the primary and the secondary windings of the transformer. It is about 10V to 20V in this circuit.

No.88 2-Transistor Wireless Microphone

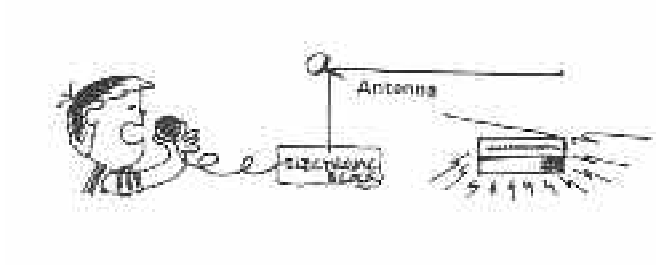
Antenna ●Dangerous! Do not insert antenna lead into an AC outlet.



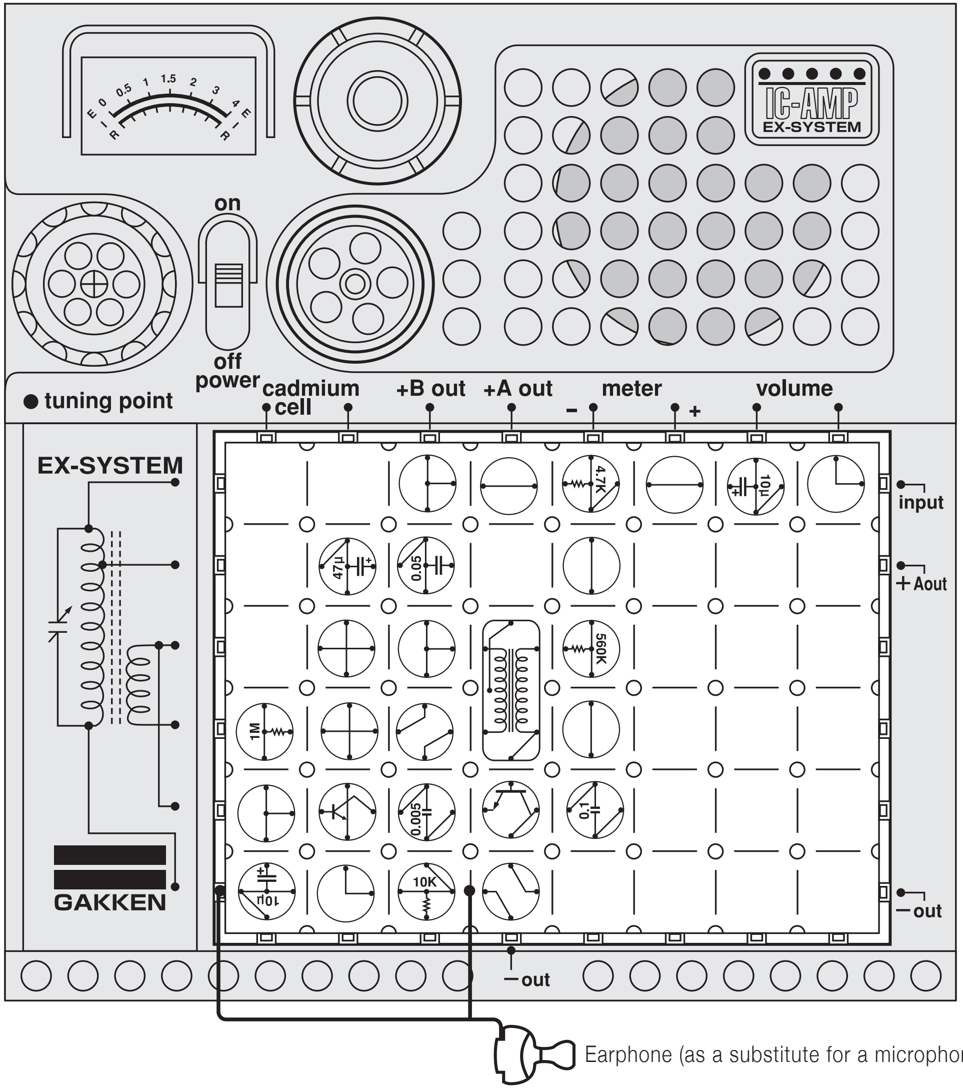
Circuit diagram for this experiment:



Now let's build a wireless microphone circuit with two transistors. Arrange the blocks, antenna, and microphone as illustrated at left and turn on the power switch. Tune the kit to a radio as in Experiment No. 10. Now speak into the microphone.

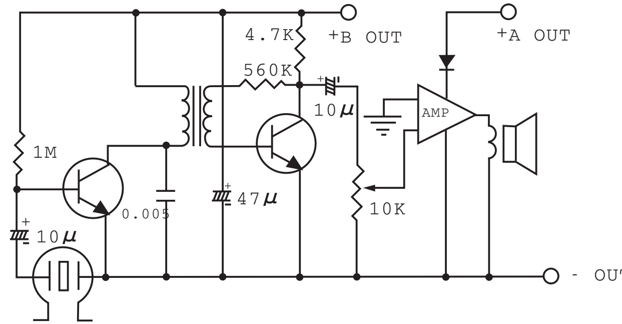


No.89 Transformer-coupled 2-Transistor + IC Amplifier

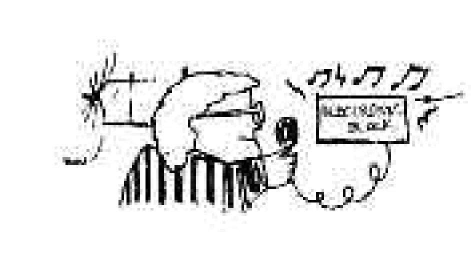


Earphone (as a substitute for a microphone.)

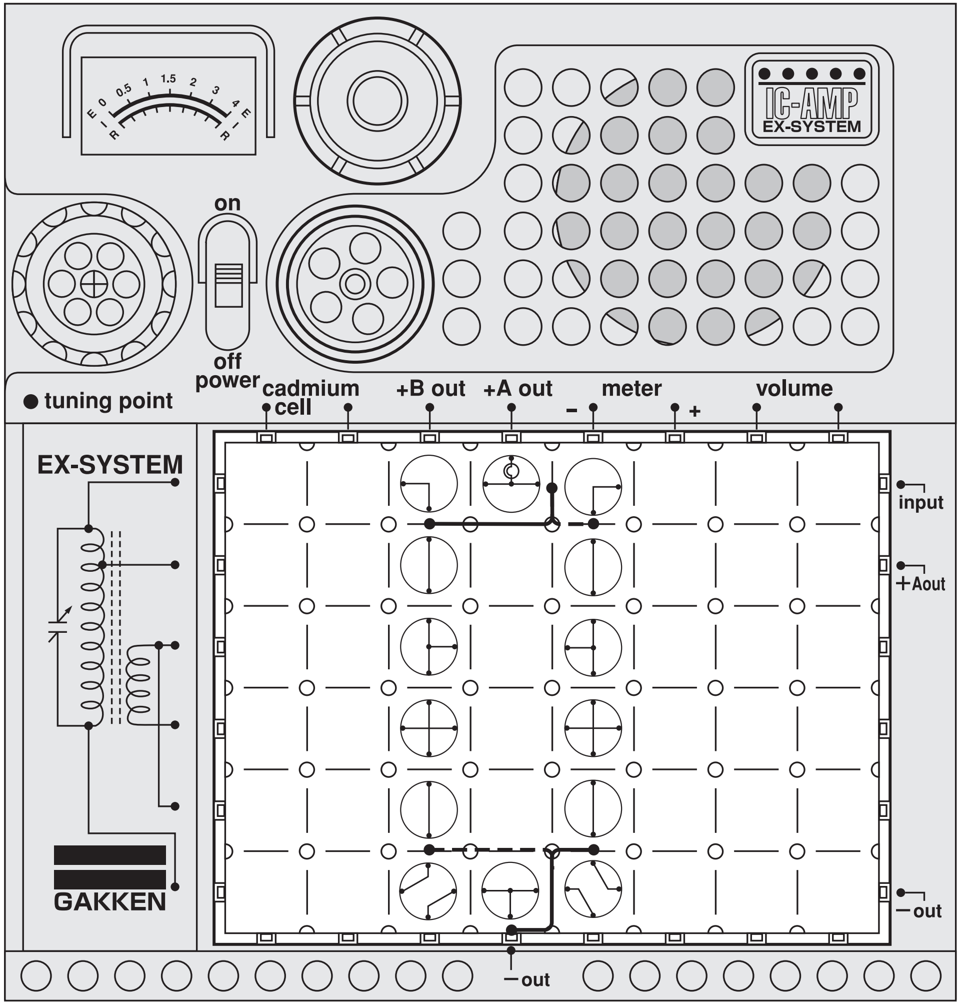
Circuit diagram for this experiment:



This is an Experiment with a transformer-coupled 2-transistor amplifier. Arrange the blocks and earphone as illustrated at left and turn on the power switch.
Can you think of various uses for this amplifier?

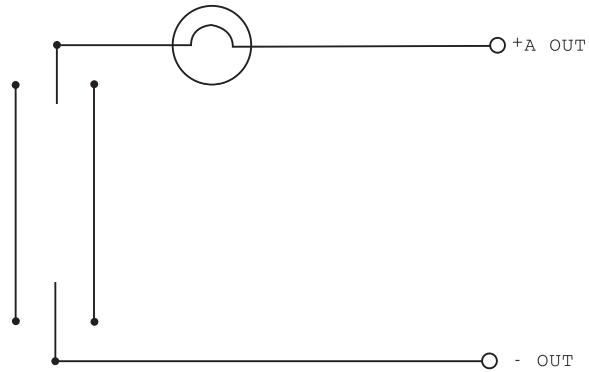


No.90 Turning a Lamp On and Off by Two Switches



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

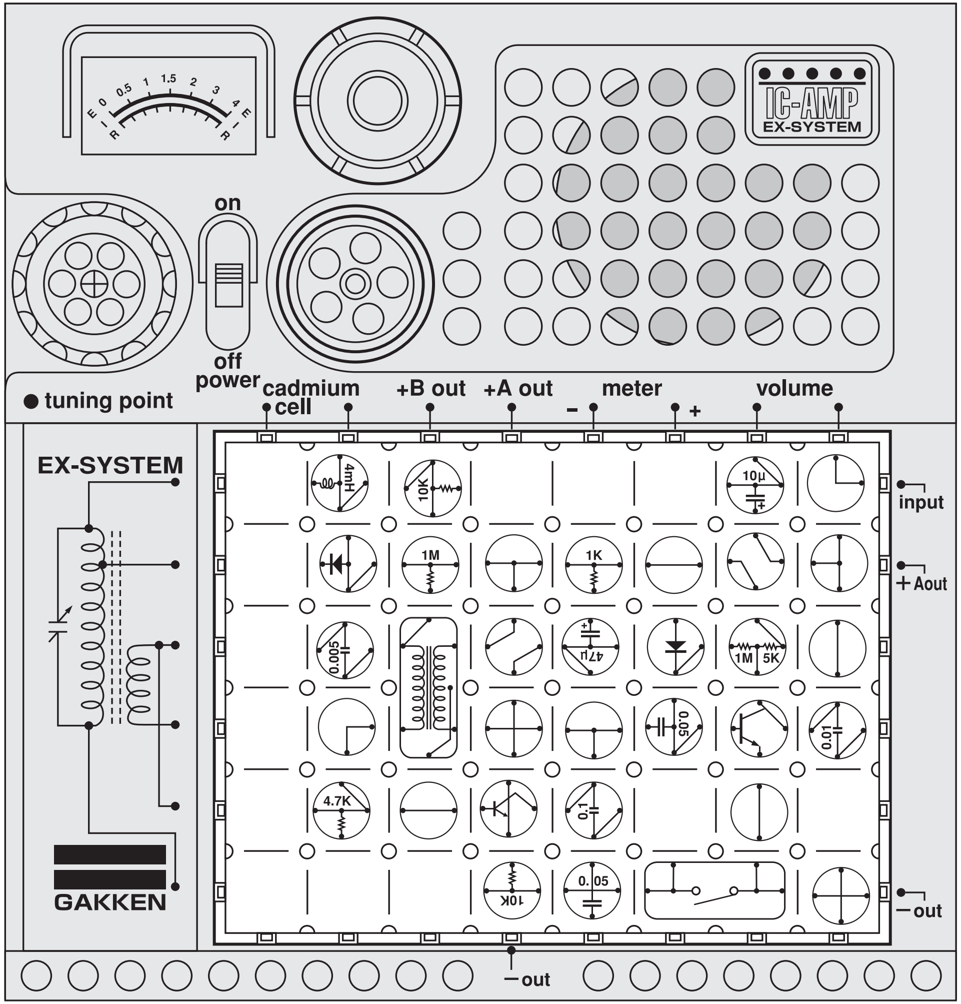
Circuit diagram for this experiment:



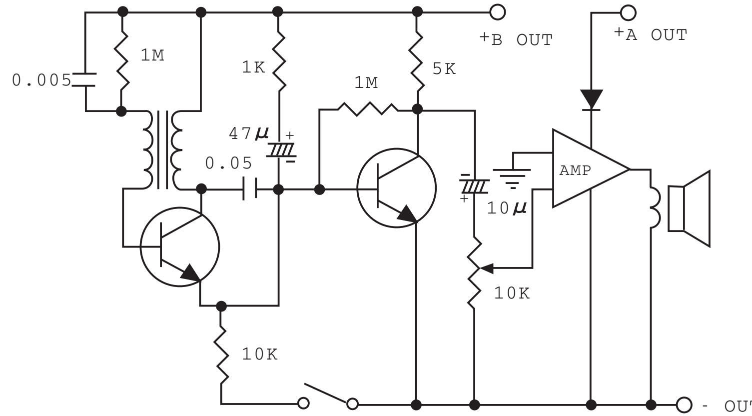
Frequently you will find stairways that have a light switch at the top and bottom of the stairs. You can turn the light on and off with either switch, and you can turn it on with one swicth and off with the other. Now you will build this convenient circuit.

Arrange the blocks as illustrated at left. Connect the 60cm cords as indicated by solid lines and turn on the power switch. Now the lamp is off, but it will go on when either of the cords is connected, as indicated by the broken lines.

No.91 Buzzer Sounding for a Definite Time



Circuit diagram for this experiment:



This is another appilcation of the osclilatory circuit. With this circuit, the buzzer will sound for only a fixed amount of time. It would be fun to use this circuit to see how much you can accomplish while the buzzer is ringing.

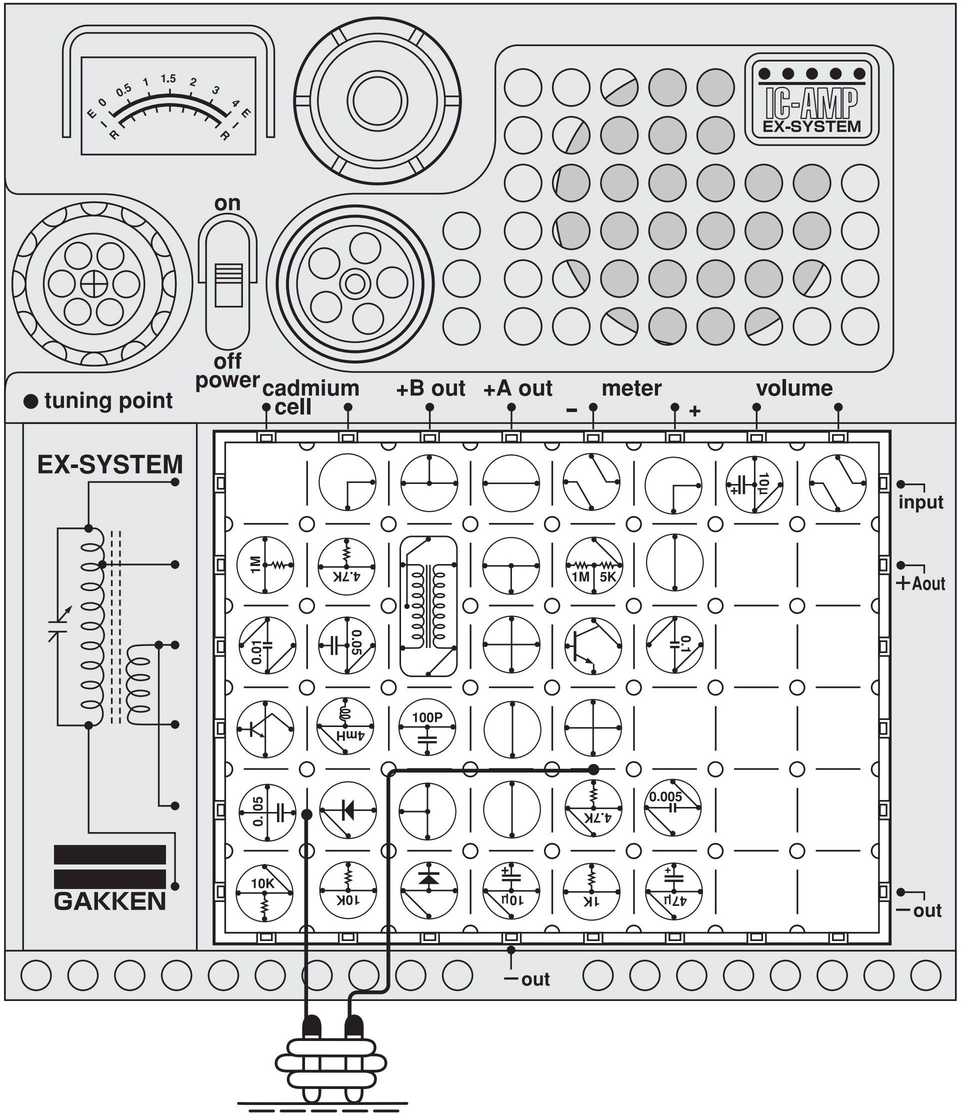
Arrange the blocks as illustrated at left and turn on the power switch. Press the key switch and the buzzing will begin.

< In case the buzzer sounds before the key switch is turned on when turning on the main switch>
Turn off the main switch once and adjust the volume as follows.

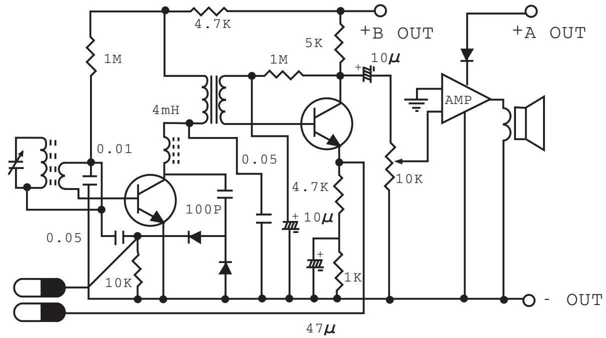
1. Turn on the main switch.
2. Turn down the volume little by little.
3. When the buzzer becomes too small to hear, push the key switch.

Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

No.92 Radio with Water-LeveI Warning Device

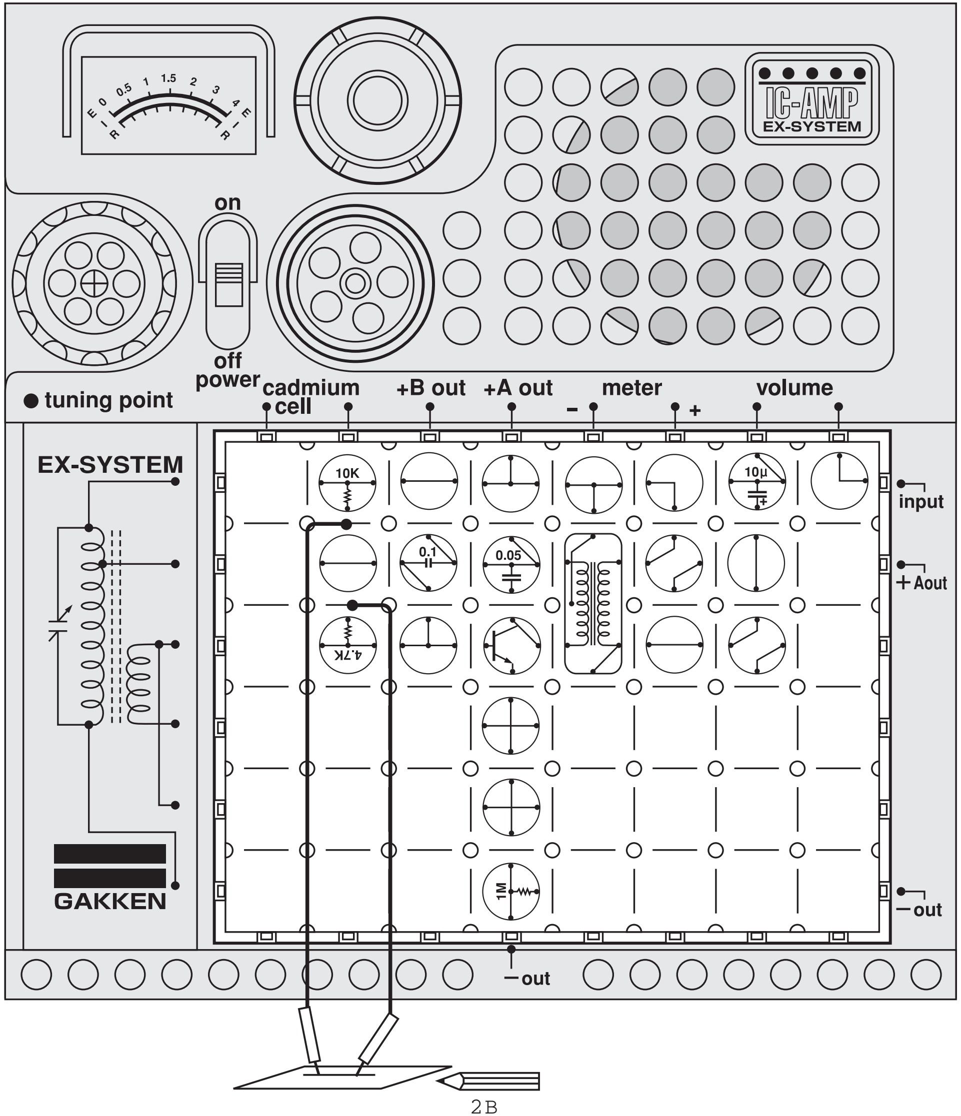


Circuit diagram for this experiment:

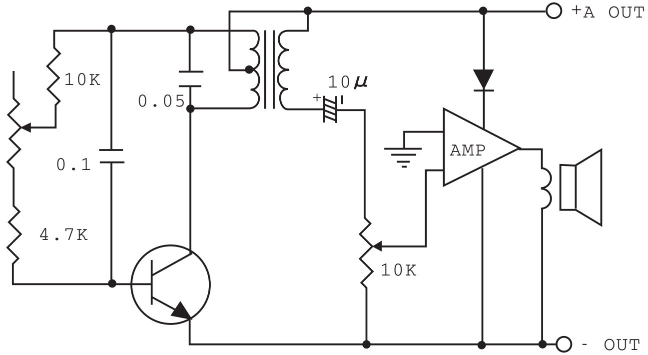


With this circuit, the radio in your kit will warn you when water rises to a predetermined level in the bathtub. Arrange the blocks and 60cm cords as illustrated at left. Attach the cords with a plastic clip, place them at a desired height in the bathtub, and turn on the power switch. The radio will produce a warning sound. "beep, beep, beep," when the water rises to the ends of the cords. This circuit can also be used as a rain warning device.

No.93 Electronic Organ



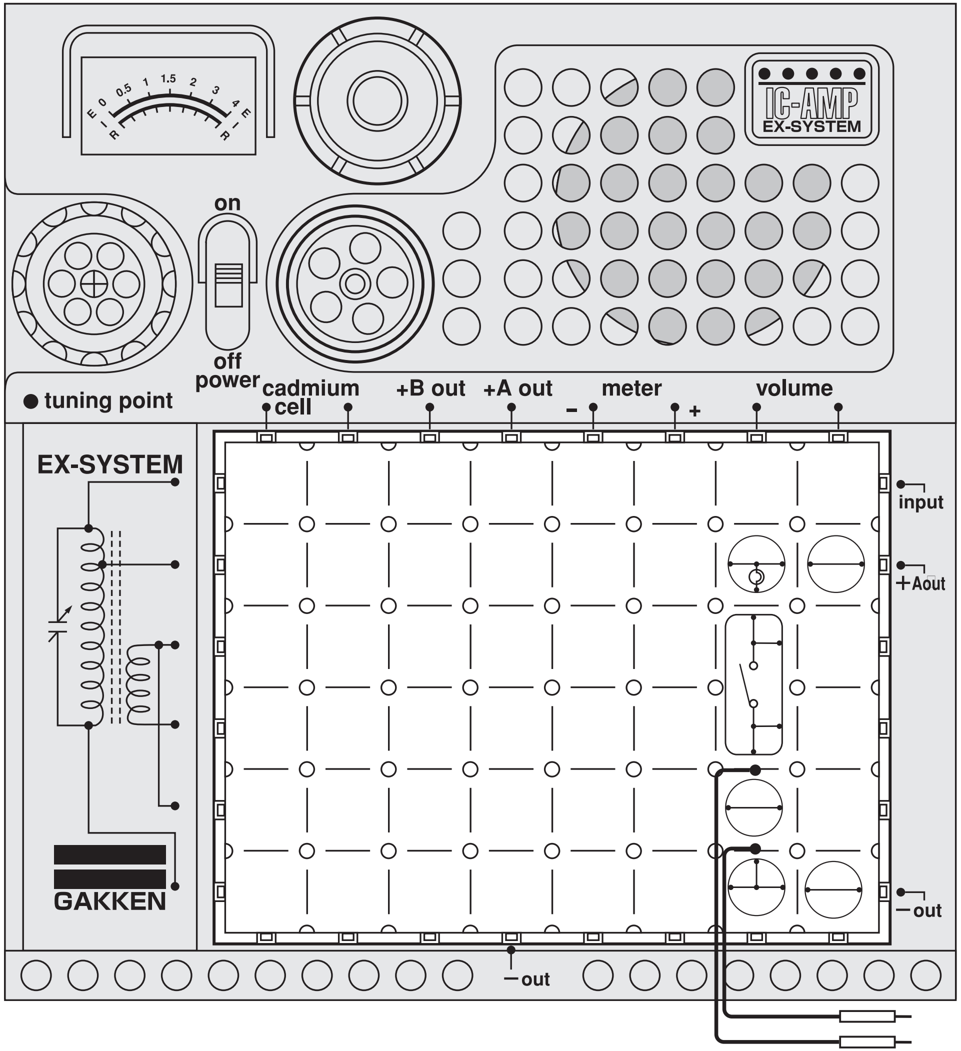
Circuit diagram for this experiment:



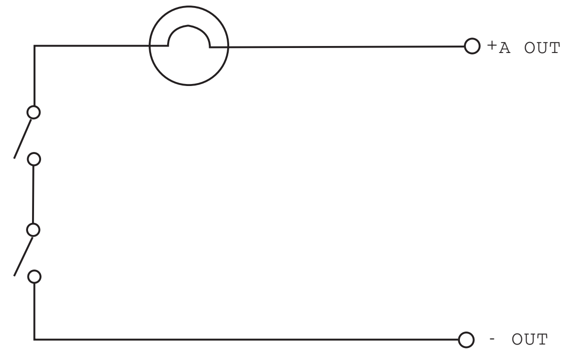
In Experiment No.16, we showed that the lead of a pencil will conduct an electrical current. Now let's experiment with an electronic organ, using a pencil-drawn stripe on a piece of paper as resistance.

Arrange the blocks and connect the tester rods as illustrated at left. Draw a stripe about 5mm wide in pencil on a piece of thick paper. Turn on the power switch. With one of the tester rods left in contact with one end of the stripe, slide the other tester rod along the stripe to produce the notes of the musical scale: do, re, mi, fa, so, la, ti, do. Writing down where the notes are produced will help in playing this electronic organ.

No.94 Basic Theory of AND Circuit



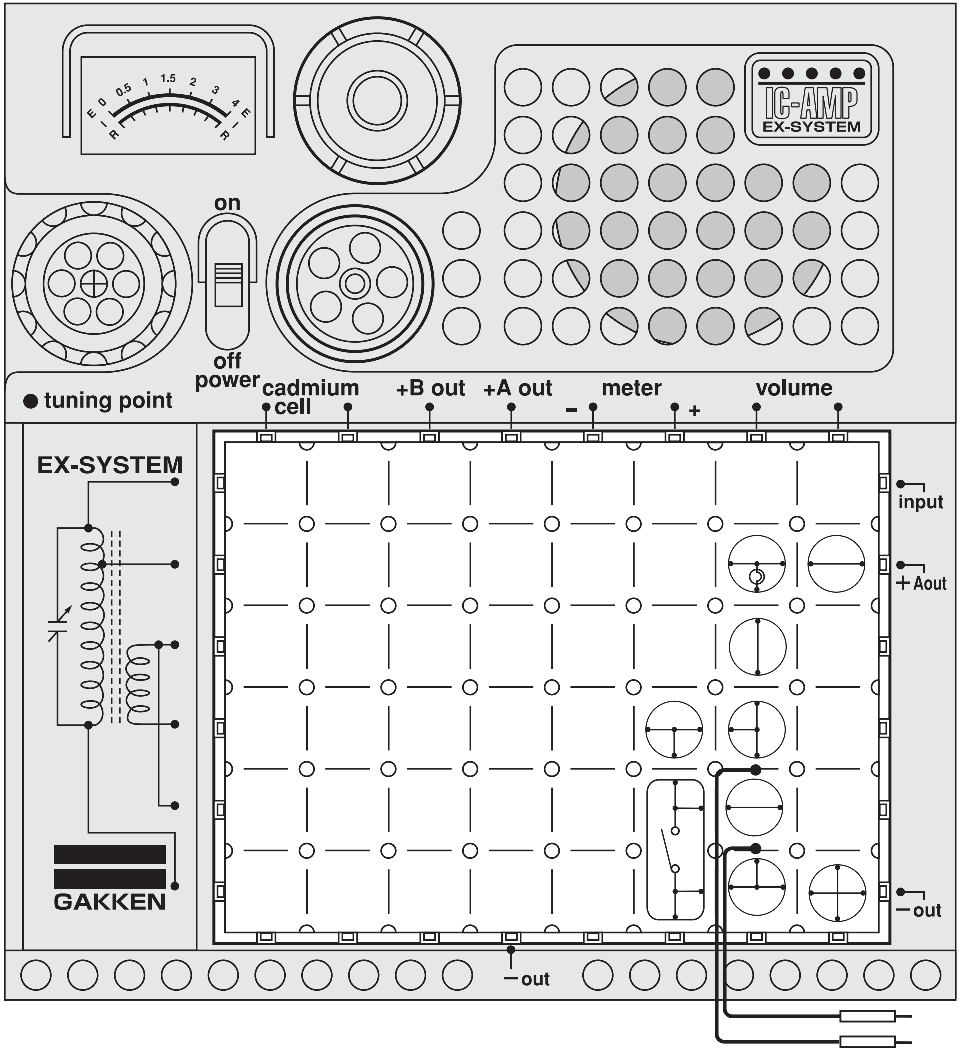
Circuit diagram for this experiment:



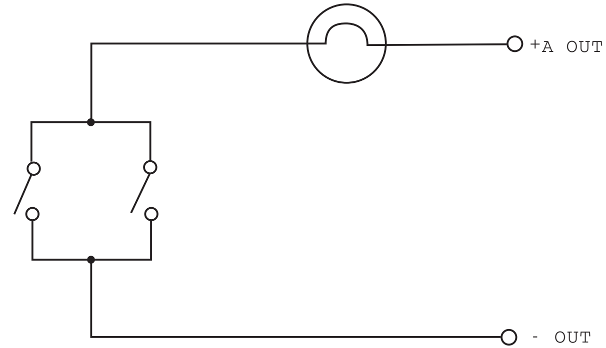
A circuit that produces an output only when two instructions (A) and (B) coincide with each other is called the AND circuit, element, or gate.

Arrange the blocks and tester rods as illustrated at left. Turn on the power switch. Now (A) depress the key switch; the lamp remains off. With the key switch depressed, (B) touch the ends of the tester rods, and this time the lamp will glow. This is because the AND circuit has been given two coincident input signals.

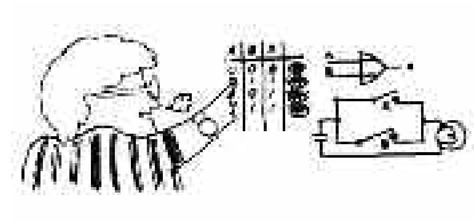
No.95 Basic Theory of OR Circuit



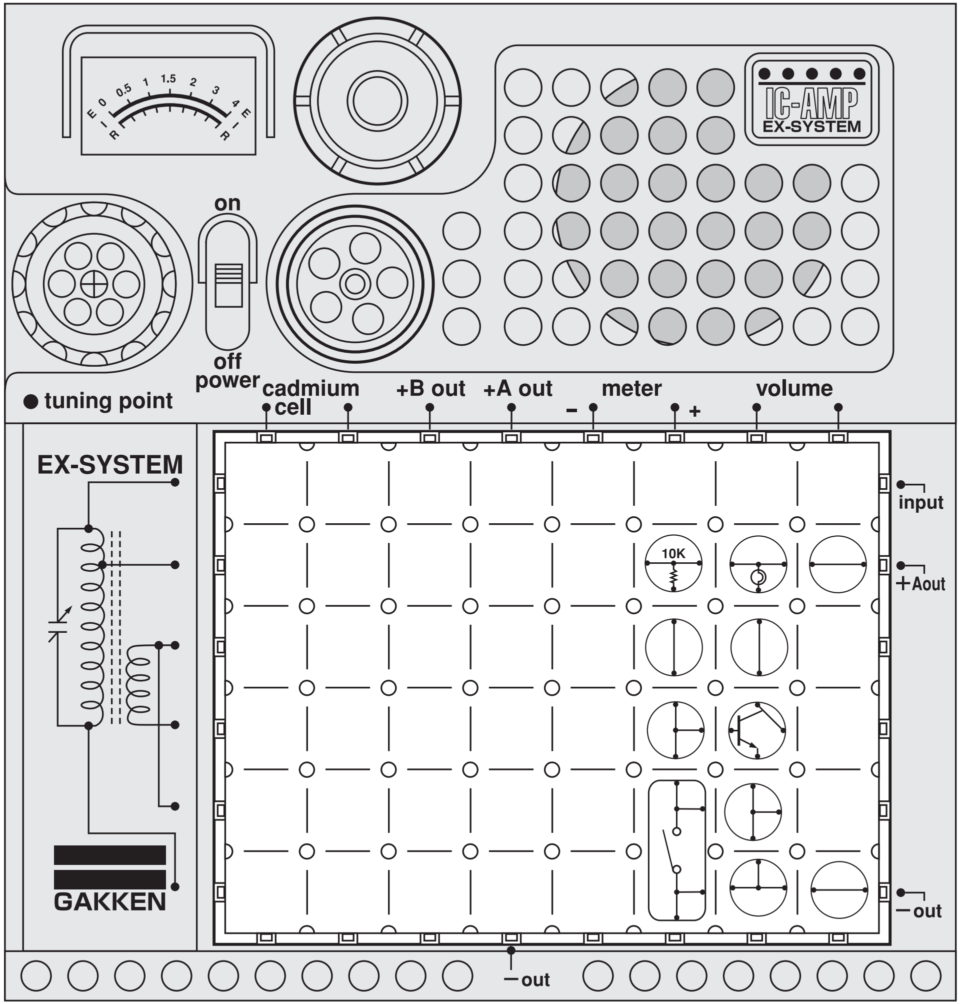
Circuit diagram for this experiment:



The OR circuit operates when either one of two instructions, (A) or (B), is given. Arrange the blocks and tester rods as illustrated at left. The lamp will go on either when (A) the key switch is depressed or when(B) the tester rods are touched.

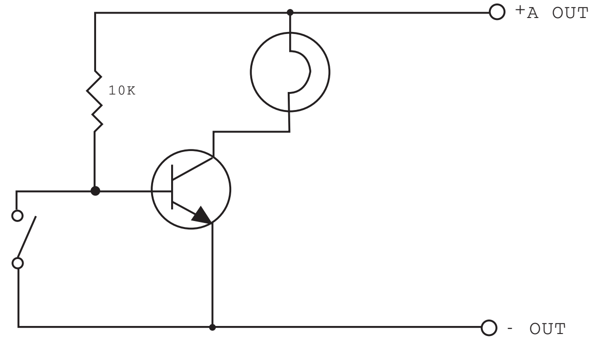


No.96 Basic Theory of NOT Circuit

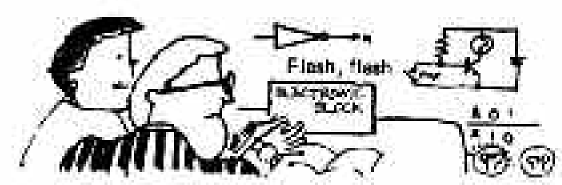


Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

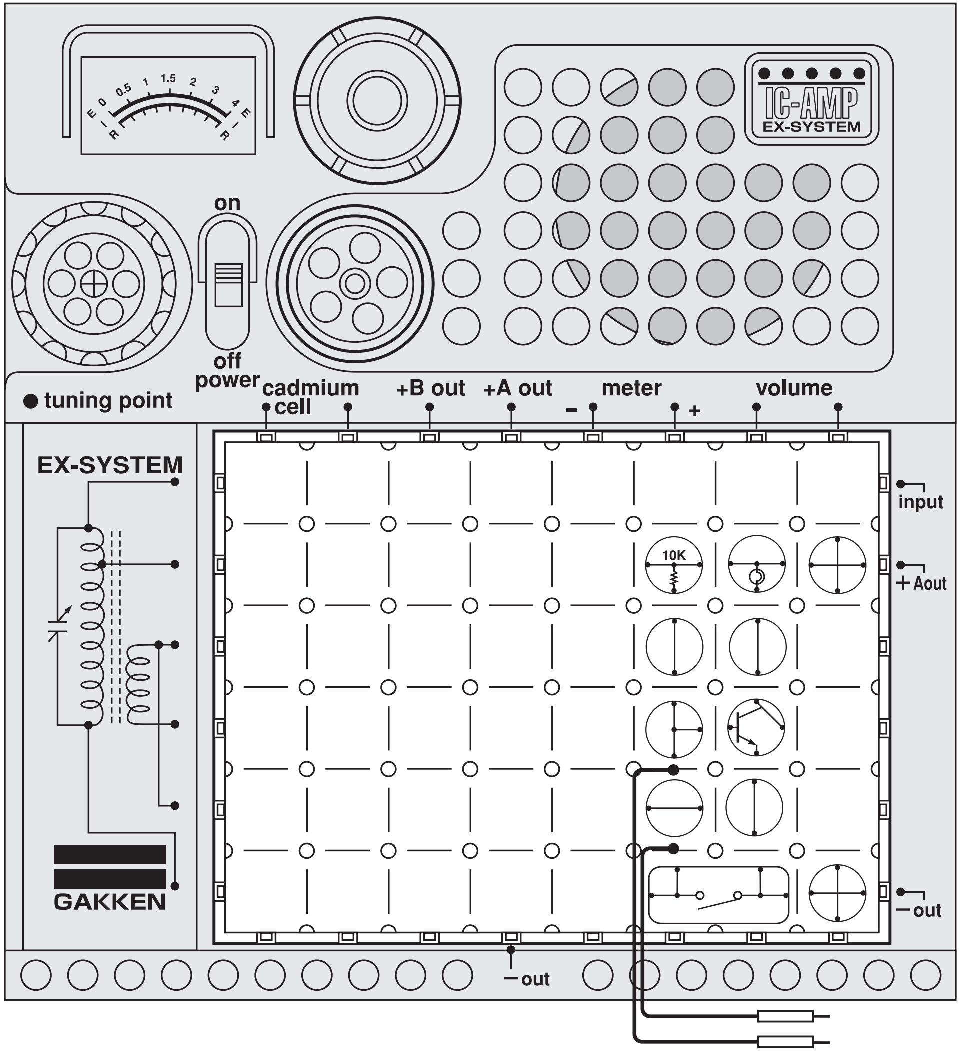
Circuit diagram for this experiment:



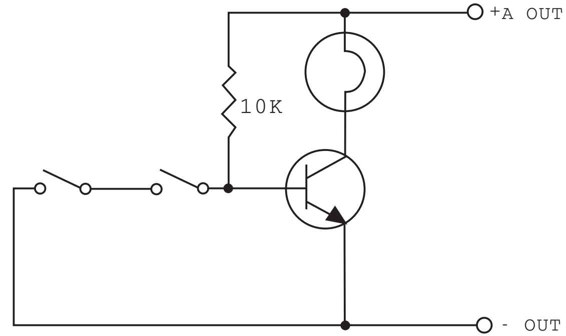
A computer does calculations and processes data by translating 0 or 1 and yes or no on electrical signals, that is, there is a voltage or there is no voltage. There are gates in the information transmission circuits to let in and out the data to be handled. According to the various instructions, these gates open and close at a definite speed to store information, take information from the memory, and to do calculations. We have so far experimented with the basic principles of such circuits. Now let's build up a NOT circuit, which is used to reverse a sequence of instructions that have been received. Arrange the blocks as illustrated at left and turn on the power switch. Depress the key switch, and the lamp,which has been on, will go off.



No.97 Basic Theory of NAND Circuit



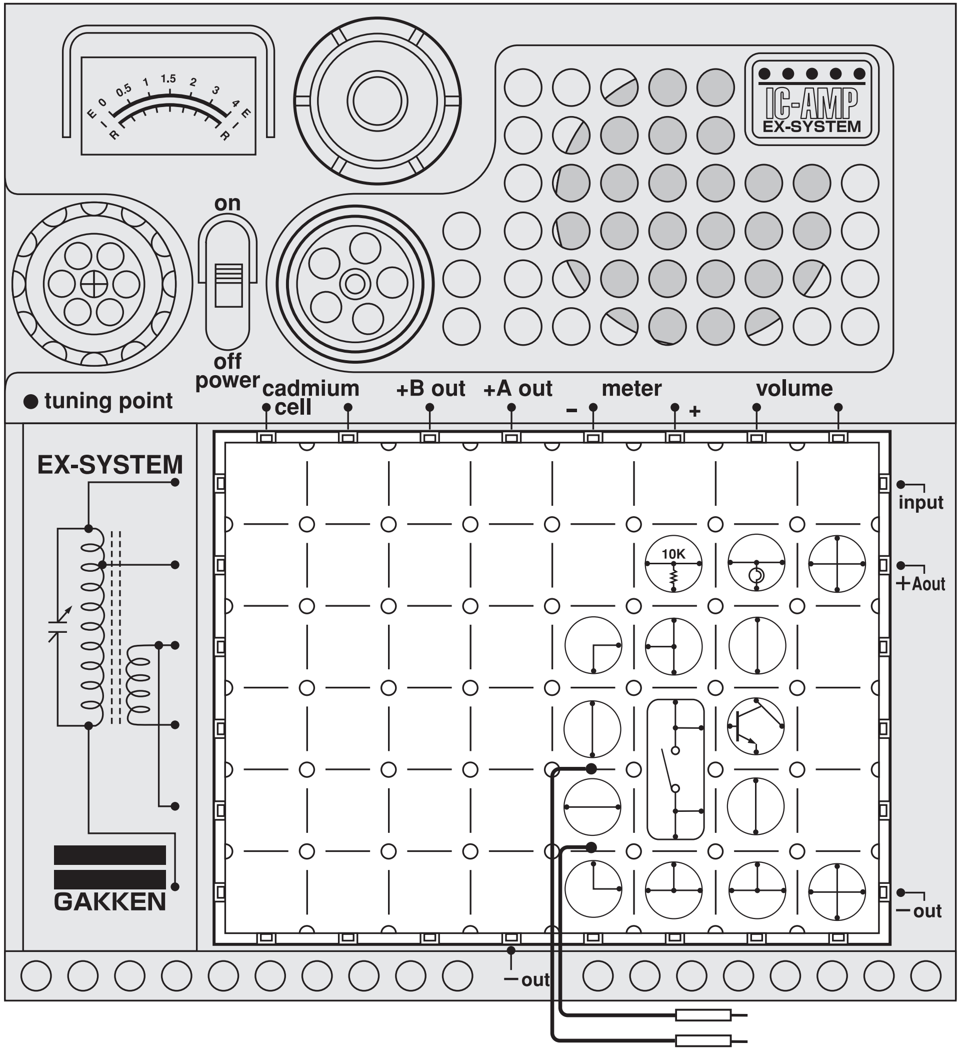
Circuit diagram for this experiment:



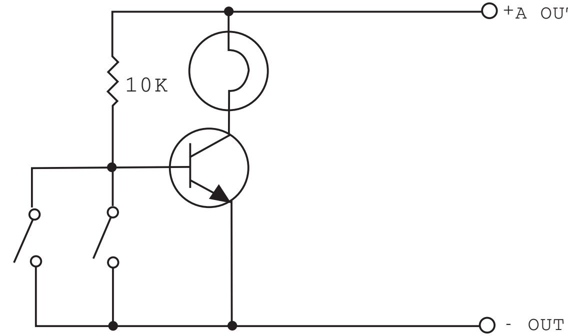
This is also an experiment with a computer circuit. When two coincident instructions are put in, the NAND circuit reveres the instructions. A gate that performs such a function is called the NAND gate. It is a combination of the AND gate and the NOT gate.

Arrange the blocks and tester rods as illustrated at left. Turn on the power switch and (A) depress the key switch and the lamp will go on. Now (B) touch the tester rods together. The lamp goes out; that is, when the two instructions were given at the same time, they reversed each other.

No.98 Basic Theory of NOR Circuit

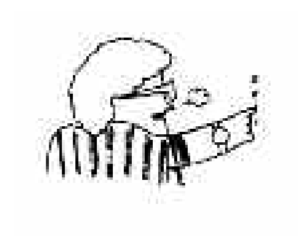


Circuit diagram for this experiment:

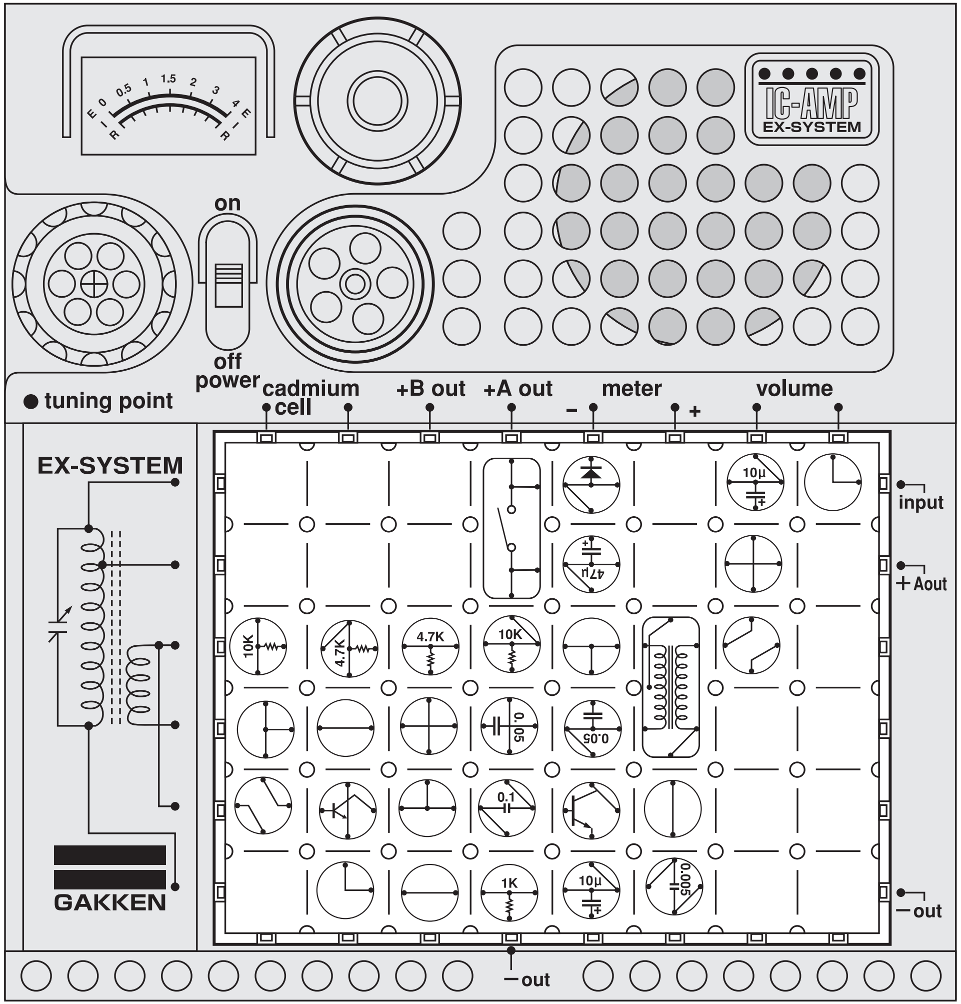


The NAND gate reverses two coincident instructions. The NOR gate, or circuit, reverses either of two instructions, (A) or (B).

Arrange the blocks and tester rods as illustrated at left and turn on the power switch. Now the lamp goes on. (A) Depress the key switch and the lamp remains off. Next, (B) touch the tester rods together and the lamp will go off. That is, the NOR gate has reversed the two instructions (A) and (B). The NOR gate is a combination of the OR gate and the NOT gate.

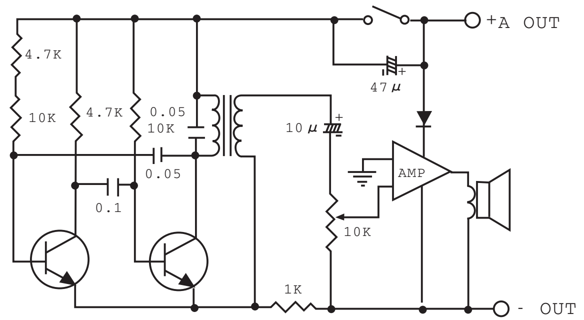


No.99 EIectronic Horn



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

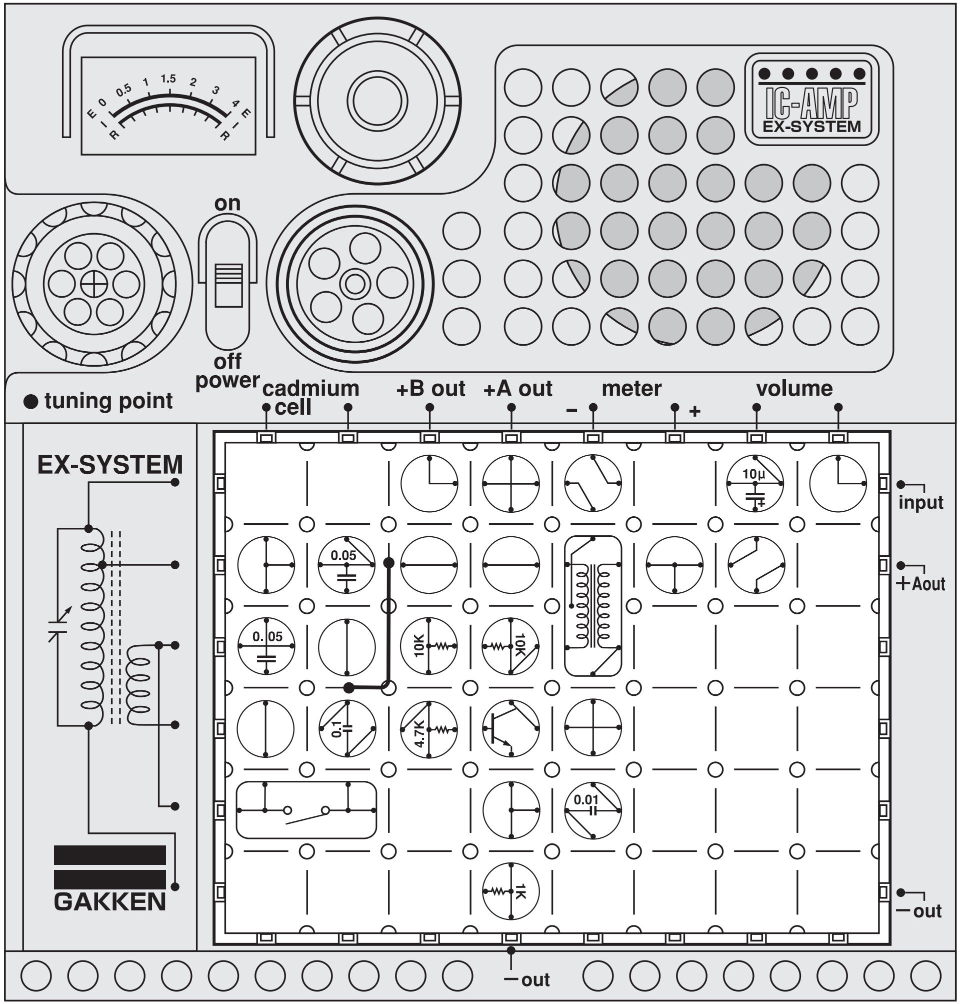
Circuit diagram for this experiment:



This circuit makes a sound like the horn of a car, truck, or bus when the key switch is depressed. The sound will continue for a while after the switch is released. This is because the discharging of a 47 capacitor is utilized.

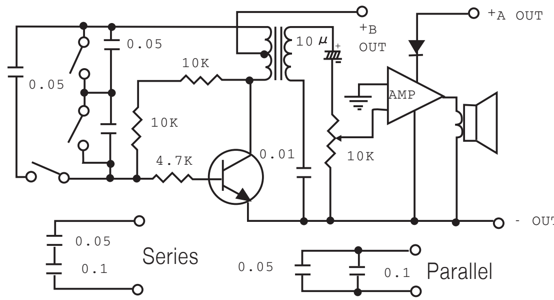
Arrange the blocks as illustrated at left, turn on the power switch, and press down on the key switch to produce the sound of the horn. Pressing down in different ways will bring forth different tones from the horn.

No.100 Series and ParaIIeI Connections of Capacitors



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

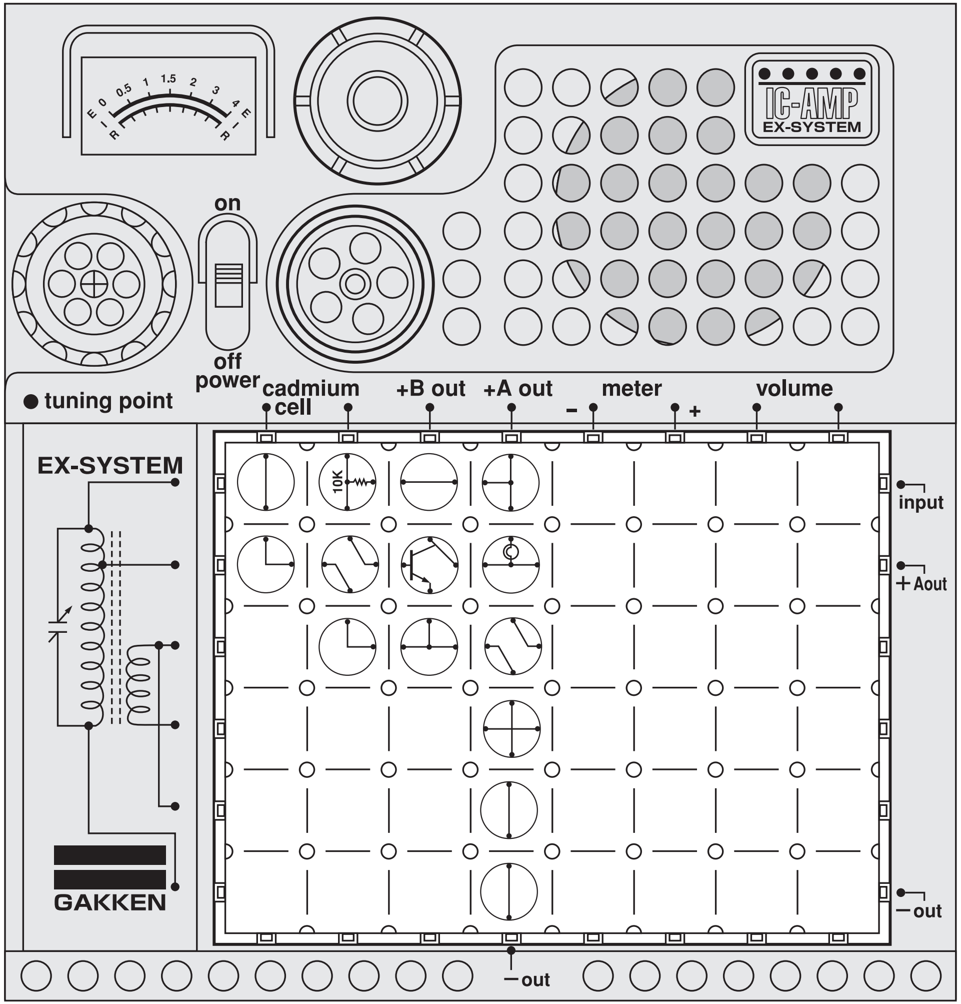


Let's do an experiment with capacitors to see how their capacitance changes when they are connected either in series or in parallel. Arrange the blocks and connect a 60cm cord as indicated by the solid line in the illustration at left. Turn on the power switch and listen to the sound coming from the speaker. It is the sound of oscillation by the 0.1 . Disconnect the cord and the pitch will become higher. This is because the 0.05 capacitor is now connected in series with the 0.1 capacitor. Connect the cord as indicated by the solid line and listen to the sound when the key switch is depressed. It wilt become lower in pitch. This is because the 0.1 capacitor has been connected in parallel with the 0.05 capacitor. The test results may be summarized as follows:

Capacitors connected in series = Capacitance becomes smaller

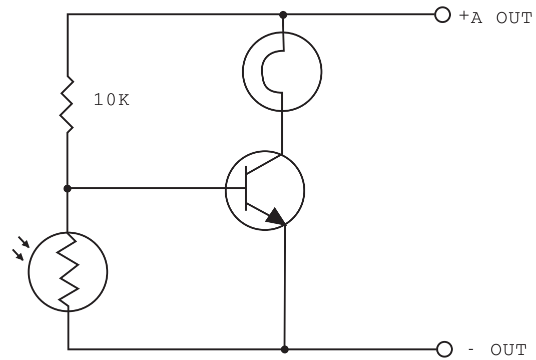
Capacitors connected in parallel = Capacltance becomes larger

No.101 Switching Function of CdS Cell



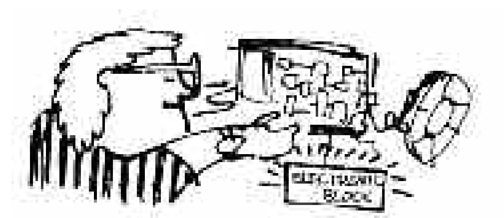
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

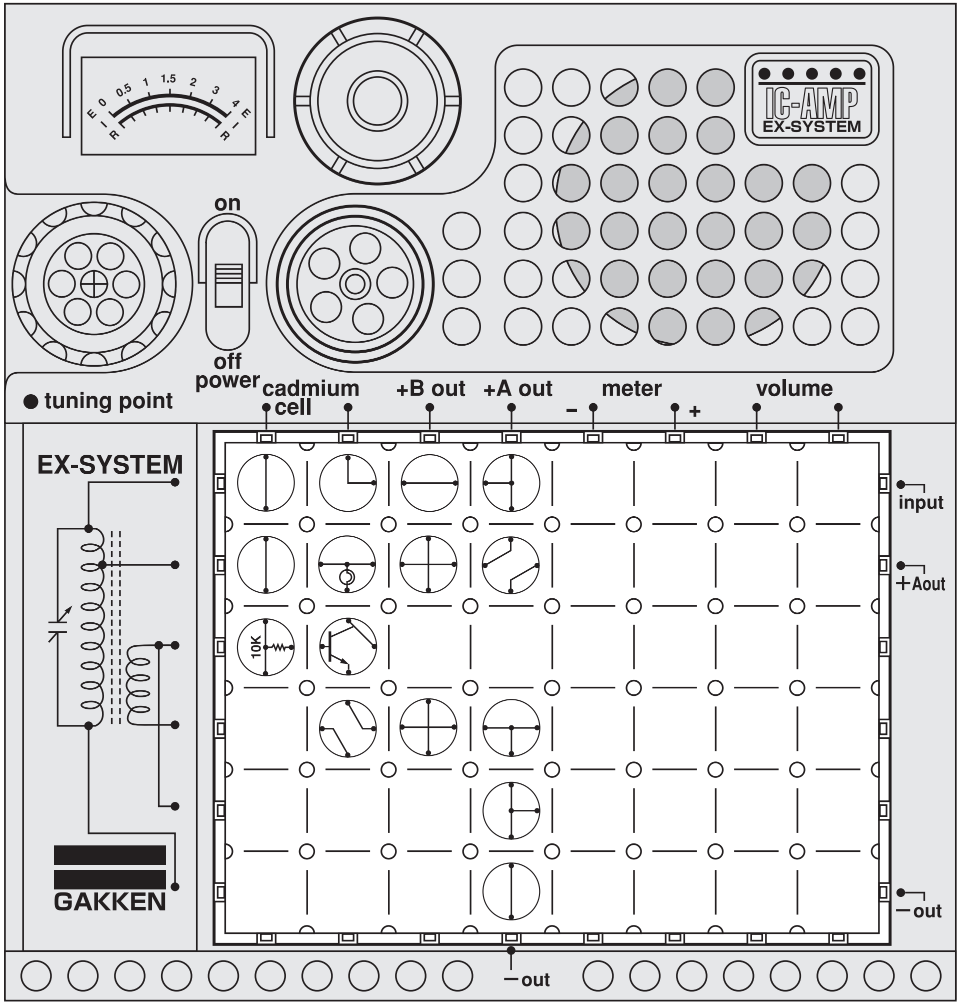


A CdS cell has the properties of becoming lower in resistance when exposed to light and higher in resistance when no light shines on it. Now let's experiment with these properties of the CdS cell.

Arrange the blocks as illustrated at left and turn on the power switch. Shine a strong light on the CdS cell and the lamp remains off. Next, shade the CdS cell from the light and the lamp will go on. Using the CdS cell, it is possible to turn the lamp on and off simply through the presence or absence of light. That is, the CdS cell can perform a "switching operation".

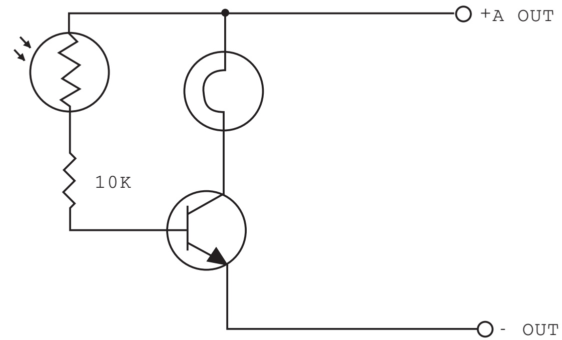


No.102 Basic Circuit of Light Warning Device(1)



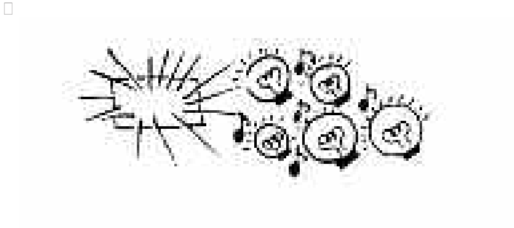
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

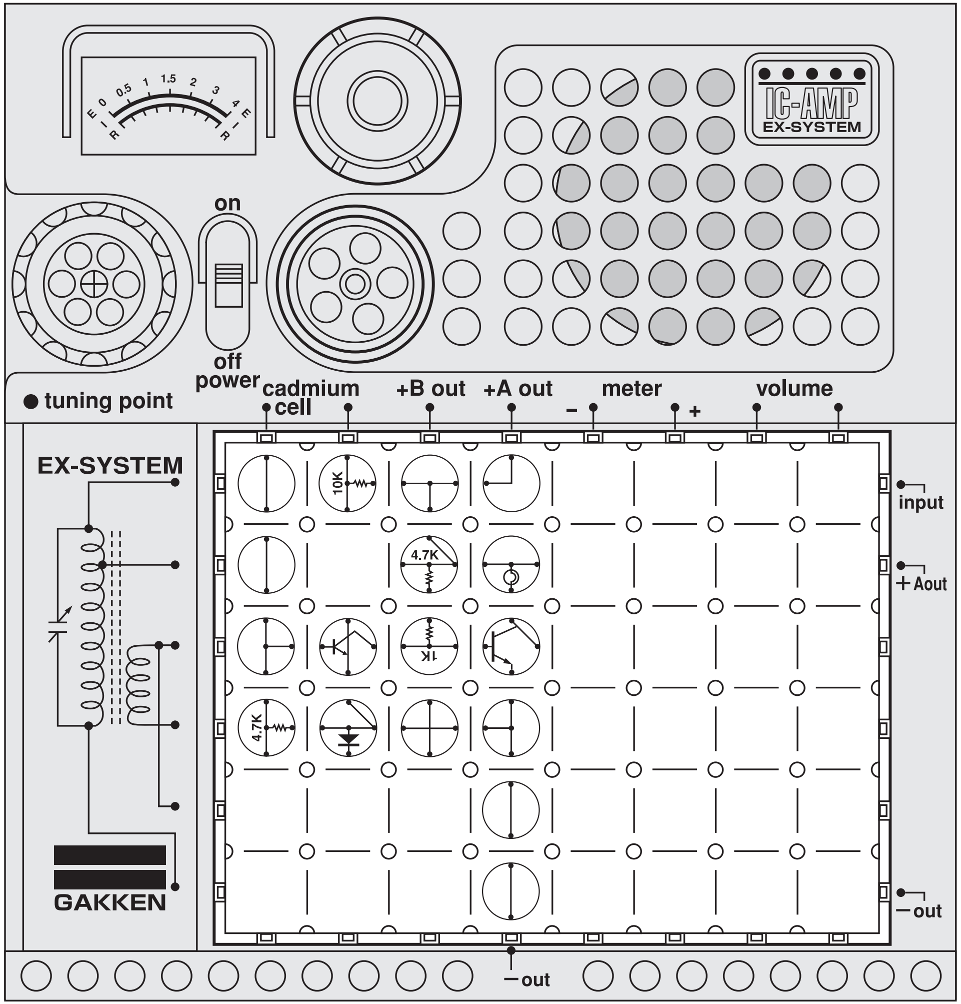


The circuit for a light warning device using the CdS photocell is simple in principle and very interesting. It can also be applied to various uses other than warning devices.

As we studied on the preceding page, the CdS cell changes its electrical resistance according to the intensity of light that strikes the cell. Here we will also do an experiment with this property of the CdS cell. With the circuit you will now build, however, you can use a light weaker than that which you used in the previous experiment. Arrange the blocks as illustrated at left and turn on the power switch. With the CdS cell shielded with one hand, direct it toward a source of bright light, then remove the hand so that the cell is exposed to the light. Now the lamp will go on.

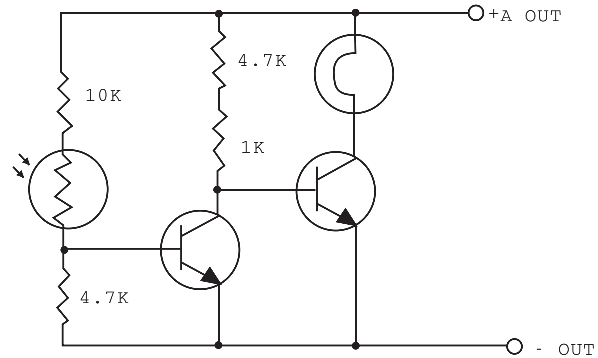


No.103 Basic Circuit of Light Warning Device (2)

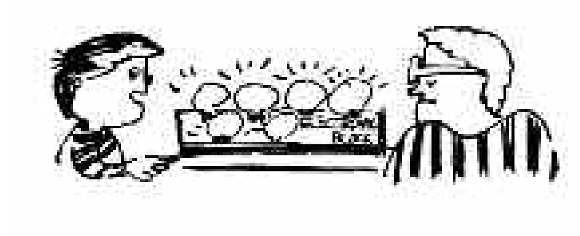


Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

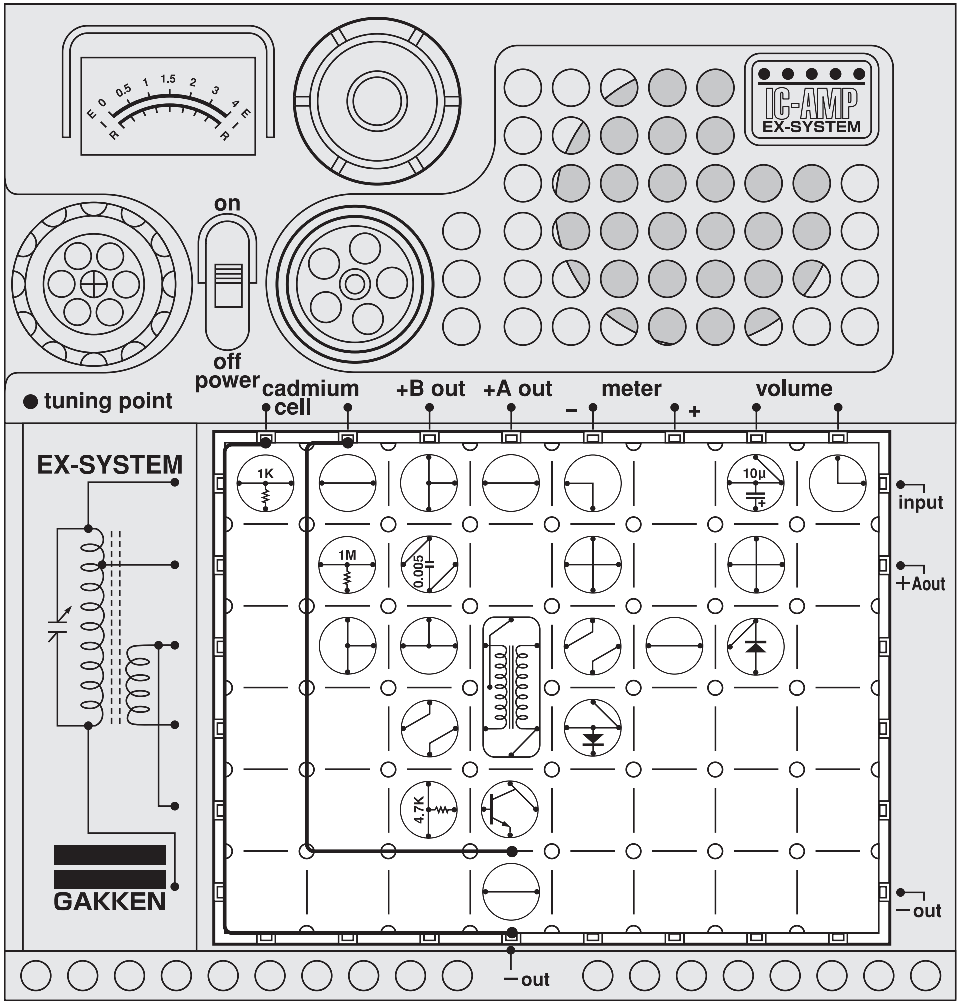
Circuit diagram for this experiment:



This experiment uses an interesting circit that causes a lamp to glow when it is shielded from light. The circuit is useful because it can warn you when you have insufficent reading light, and it can also act as a "receptionist" by sounding a warning when someone has opened a door to your house.
After arranging the blocks as illustrated at left and turning on the power switch, shine strong light on the CdS cell. Then shade the cell from the light with one hand. Now the lamp will glow.
Can you think of other uses for this circuit?

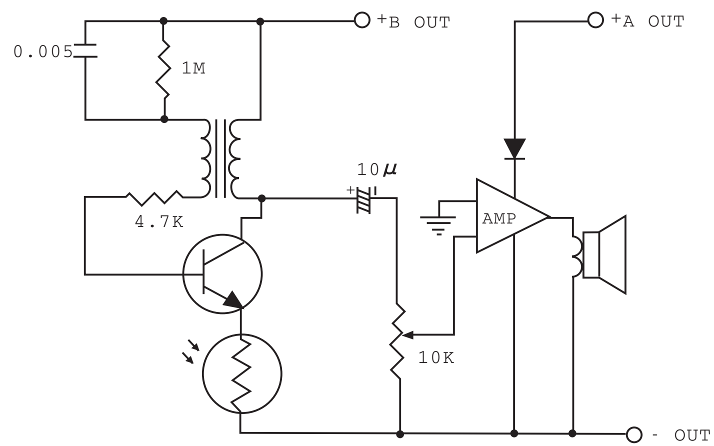


No.104 Circuit That Buzzes When Struck by Light

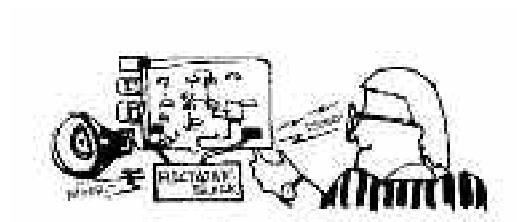


Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

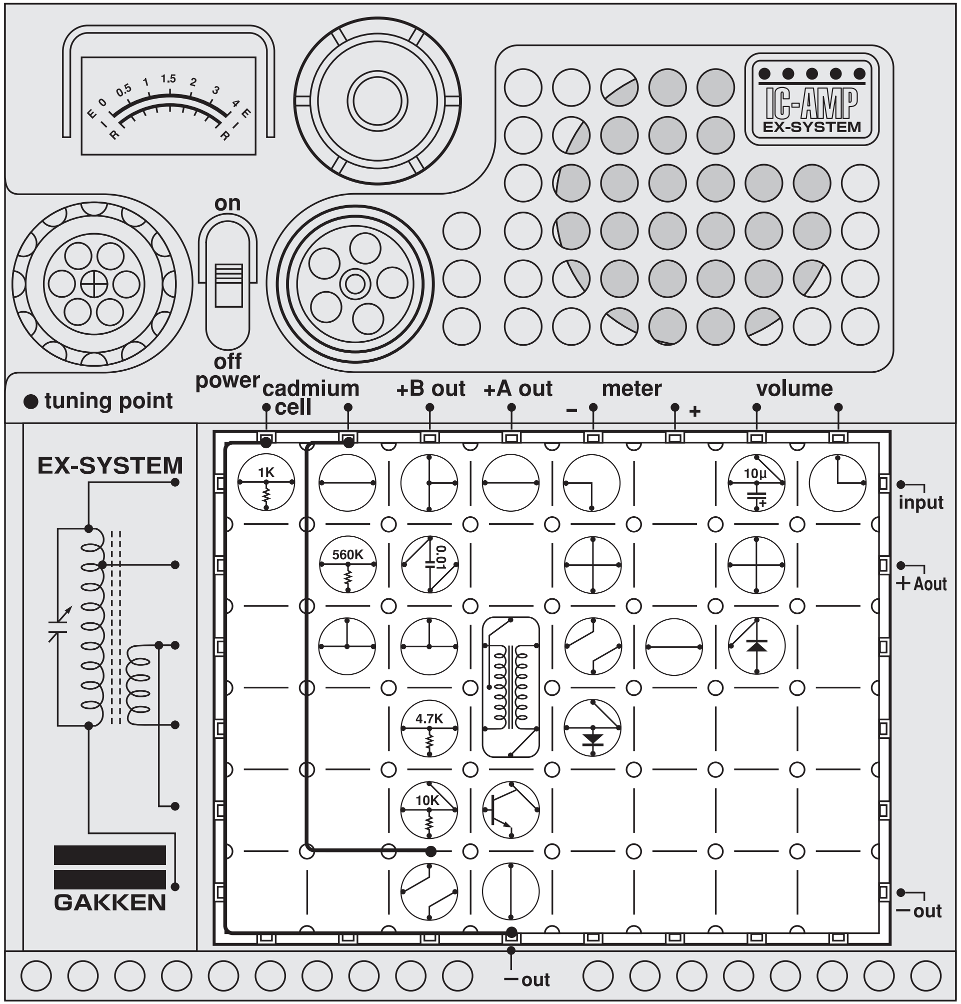


You have learned to build various kinds of warning circuits. Now let's experiment with one that produces a buzzing sound when exposed to light.
Arrange the blocks and connect the 60cm cords as illustrated at left. Turn on the power switch and shine a light on the CdS cell. A buzzing sound will come out of the speaker.



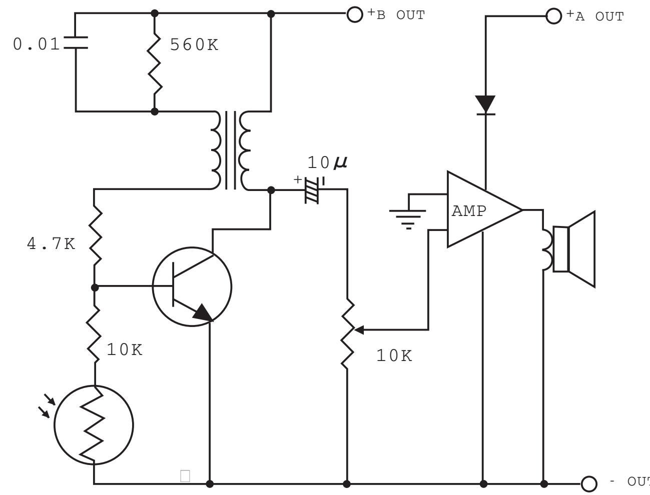
Note: When casting a light, it has to be strong.
If it is feeble, the buzzer may not sound.

No.105 Circuit That Buzzes When Shaded from Light



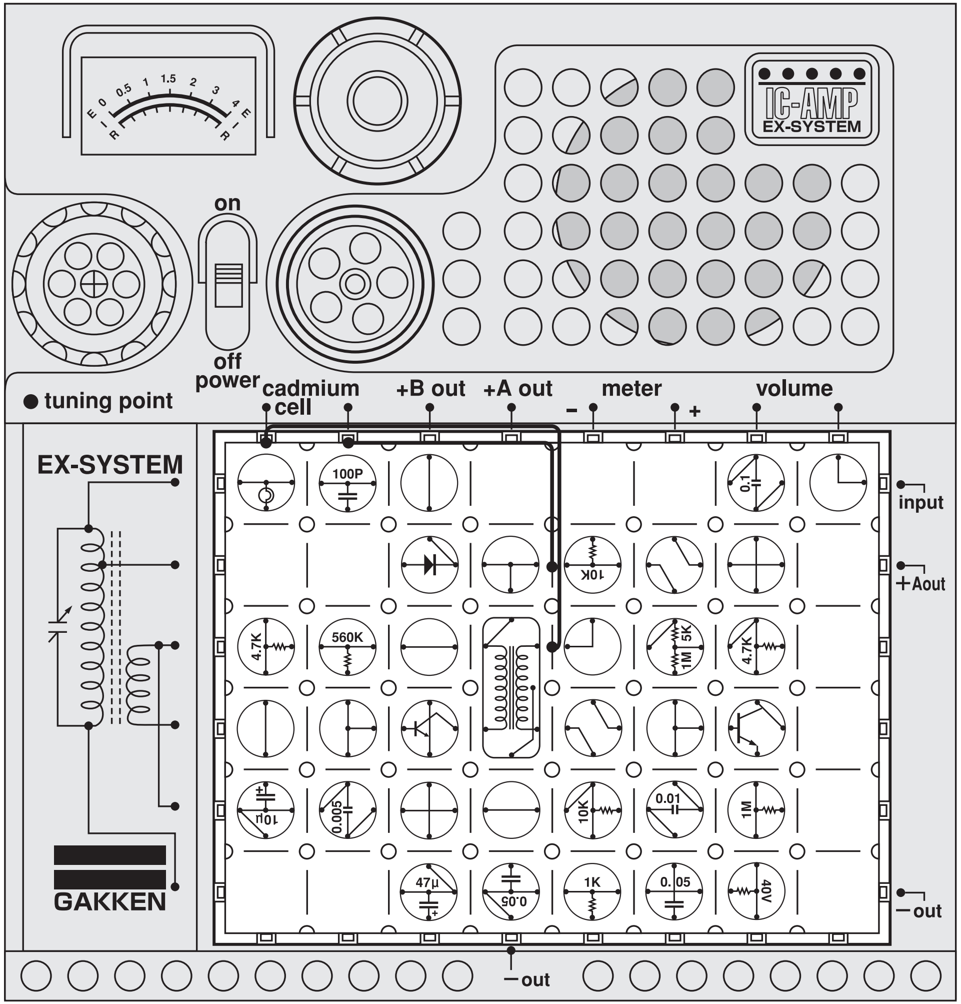
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:



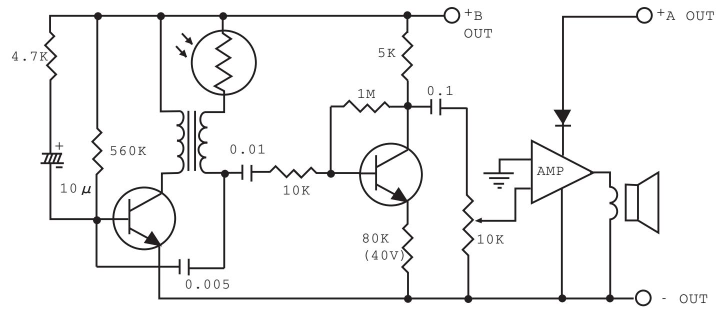
On the preceding page you build a circuit that buzzes when struck by light. This time you will experiment with a circuit that produces a buzzing sound when the CdS cell is shaded from light. Arrange the blocks and connect the 60cm cords as illustrated at left. Turn on the power switch and shade the CdS cell from the light with one hand. A buzzing sound will come out of the speaker.

No.106 Electronic Bird That Sings When It Becomes Light



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

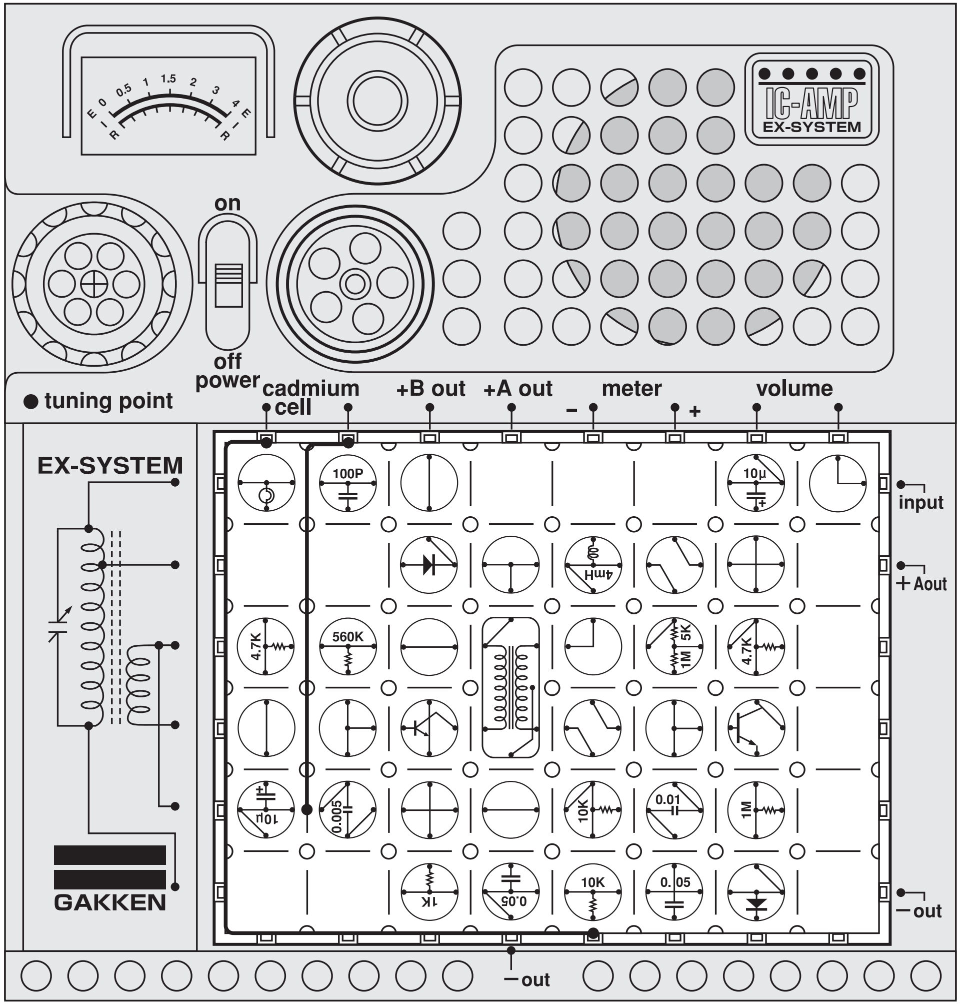


Would you like to be awakened by the song of a bird instead of an alarm clock in the morning? Now let's build a circuit that will allow you to do so.

Arrange the blocks and connect the 60cm cords as illustrated at left. Turn on the main switch and face the CdS cell in the direction of a light source in the room. You will hear the sound of a bird. When you do this experiment in a wellilluminated room, the "bird" will continue singing. Shade the CdS cell with one hand when you want it to stop singing.

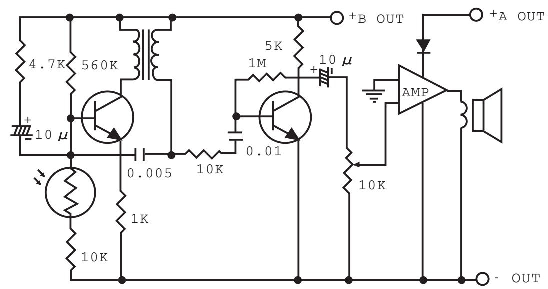
If you want to wake up by the singing, set up the circuit, turn on the power switch, and set the kit by the window. The singing will begin when the sun comes up. The volume can be adjusted by turning the volume control dial.

No.107 EIectronic Bird That Sings When It Becomes Dar



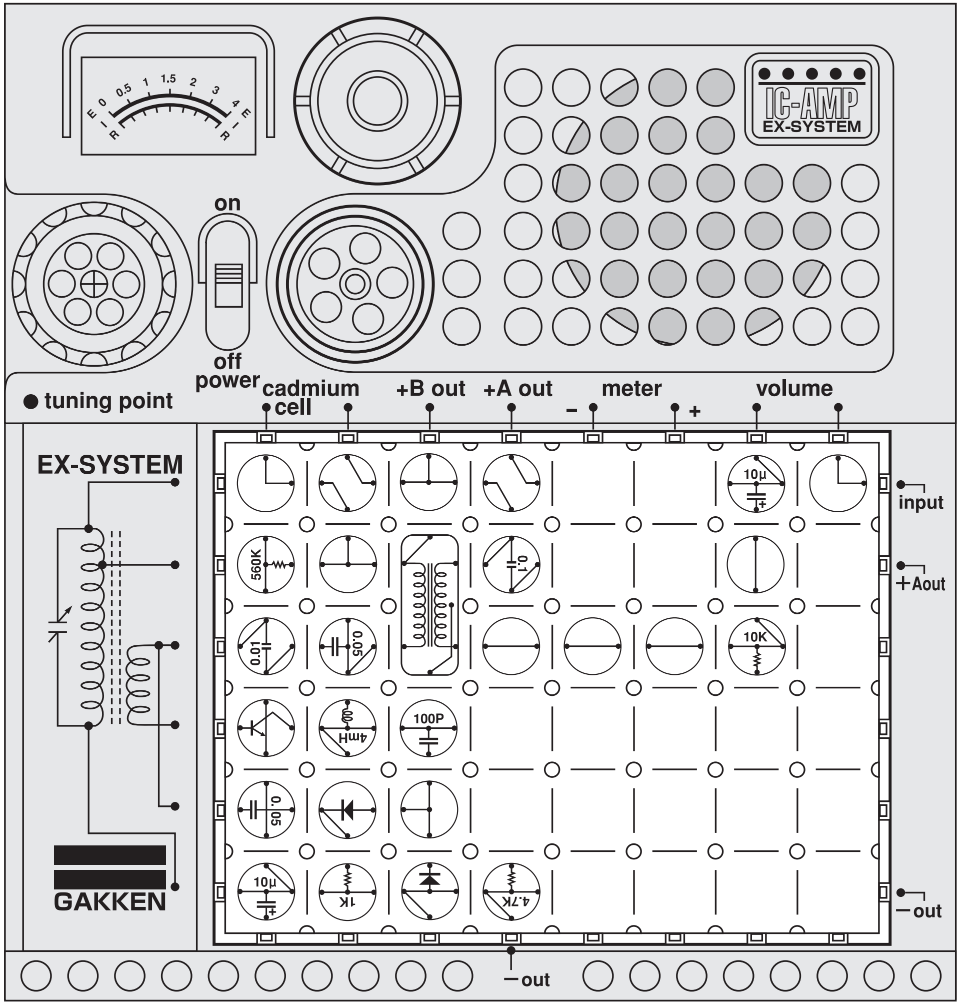
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:



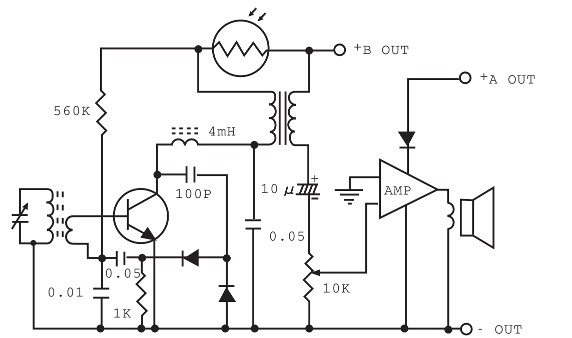
Now you will experiment with a circuit that produces an effect opposite from that of the circuit in the preceding experiment. That is, this circuit produces the sound of a singing bird when it becomes dark. Arrange the blocks and connect the 60cm cords as illustrated at left. Continue as for Experiment No.106. This time, shade the CdS cell with one hand from the light, and the "bird" will begin to sing.

No.108 Photoradio That Is Switched On When It Becomes I

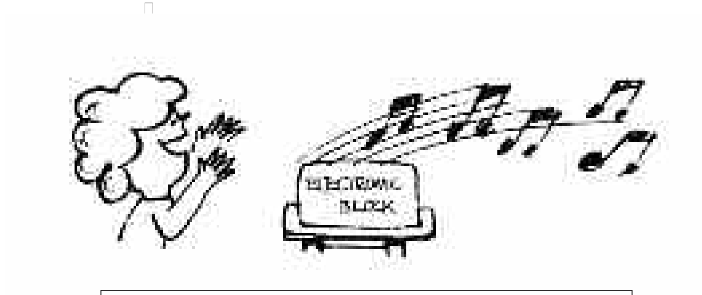


Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

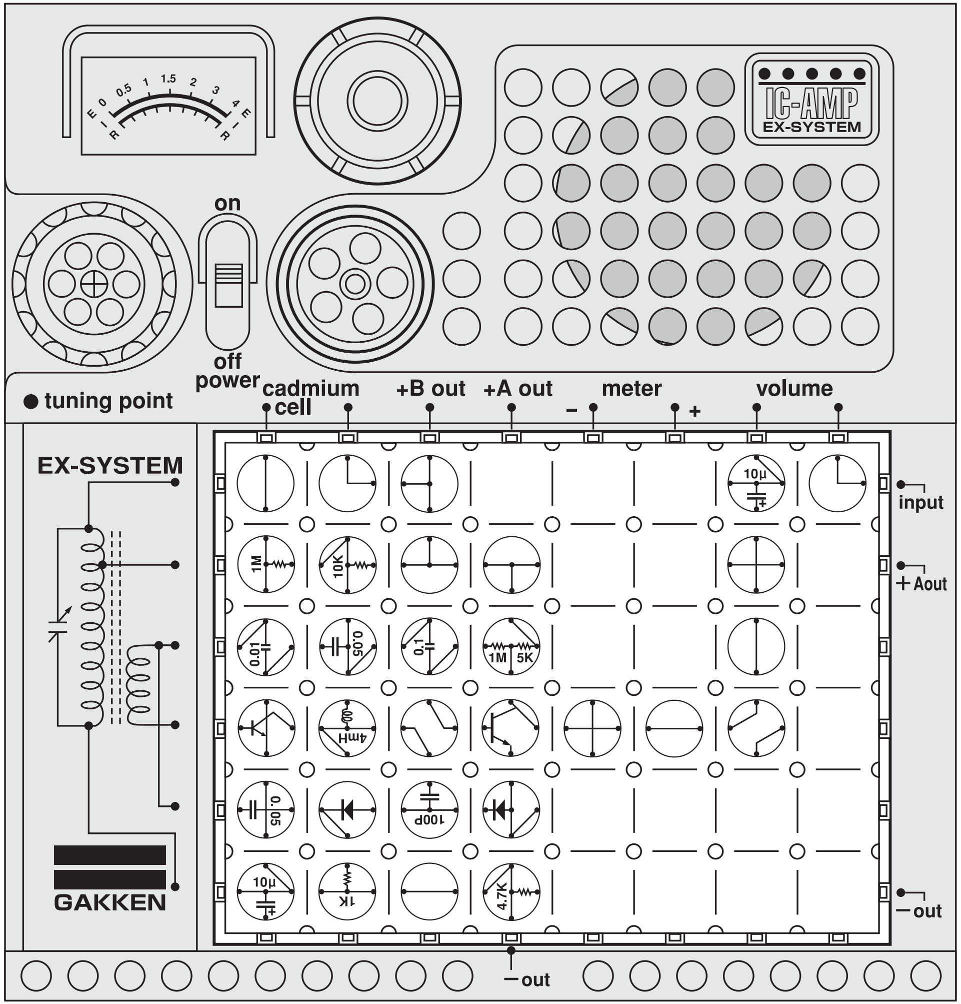


Let's make a radio that is switched on by light, using an ordinary radio circuit and a CdS cell. Arrange the blocks as illustrated at left and turn the kit in the direction of a light source. Turn on the power switch and the radio will begin to play. Turn the kit away from the light source, and the radio will stop playing.



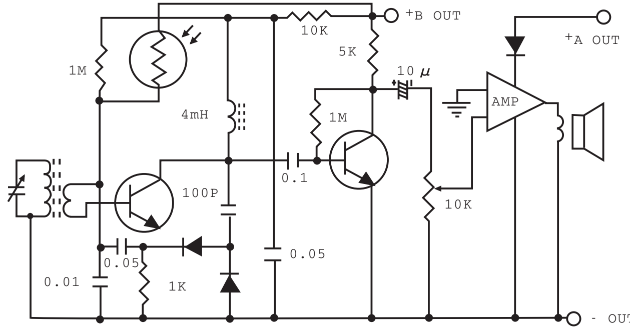
Note: When casting a light, it has to be strong.
If it is feeble, it may not work.

No.109 Photoradio That Is Switched On When It Becomes



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

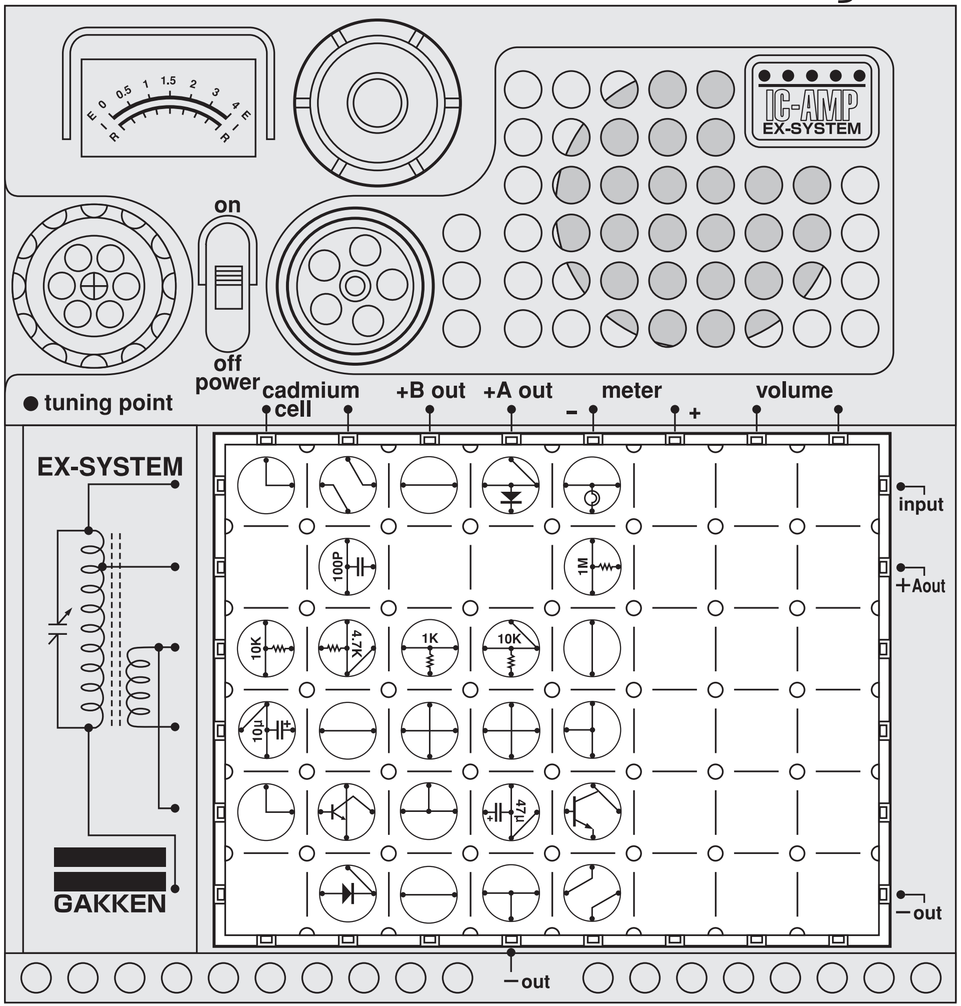
Circuit diagram for this experiment:



This time you will experiment with a radio that goes on when it grows dark. This radio circuit uses one more transistor than the one described on the preceding page.

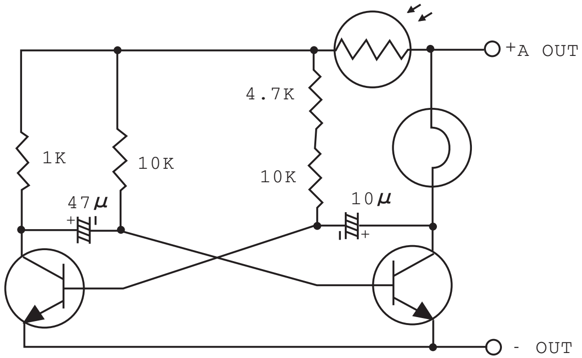
Arrange the blocks as illustrated at left and turn on the power switch. Now shade the CdS cell with one hand from the light, and the radio will begin to play. Remove your hand, and the radio will

No.110 Circuit That Blinks a Lamp On and Off When It Becomes Light



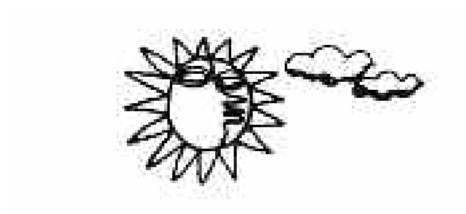
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

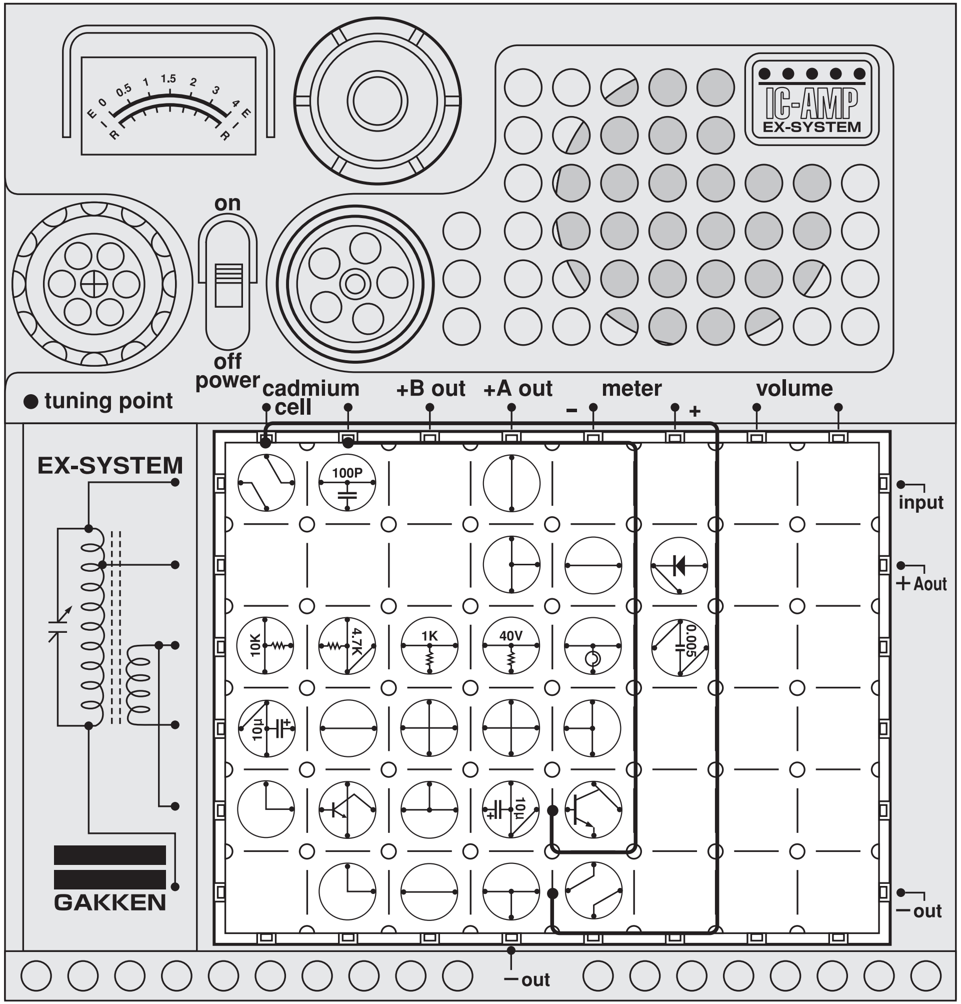


By now you have some knowledge of the properties of the CdS cell. You know it can be used as a switch. This time you wiil do an experiment in which the CdS cell operates somewhat differently. The lamp will go on and off when light shines on the CdS cell.

Arrange the blocks as illustrated at left and turn on the power switch. Shine a strong light on the CdS cell, and the lamp will go on and off.

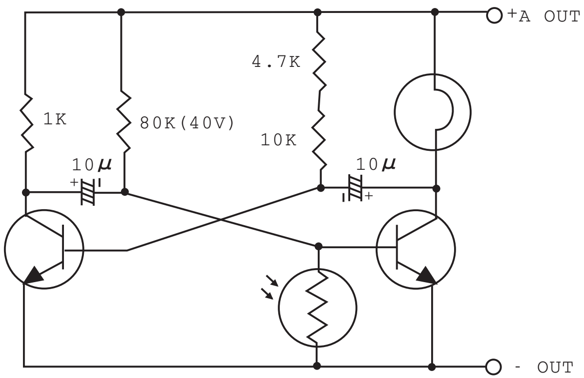


No.111 Circuit That Blinks a Lamp On and Off When It Becomes Dark



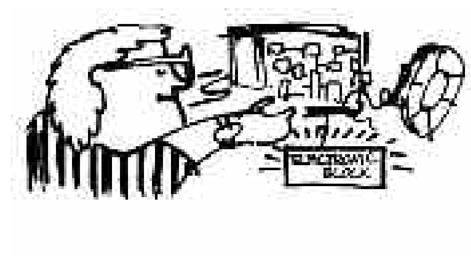
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

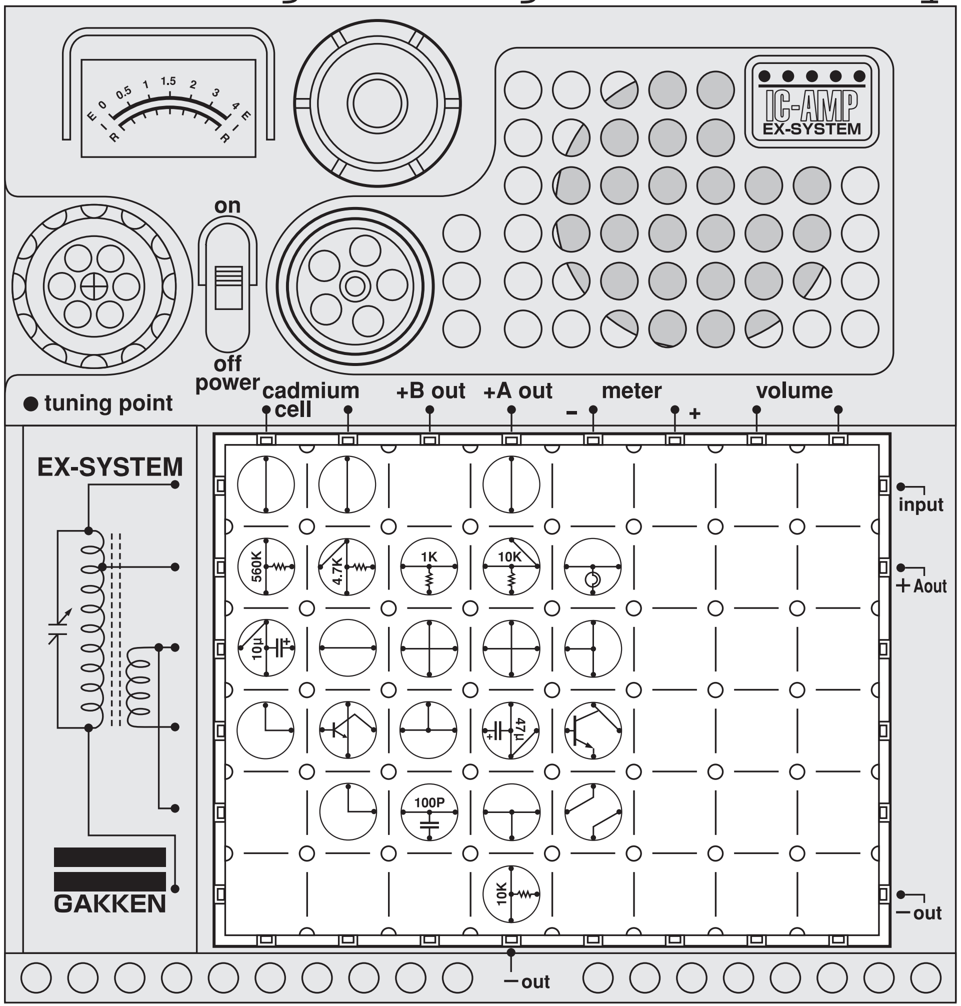


In this experiment you will build a circuit that blinks a lamp on and off when it becomes dark. If you think this circuit is not much different from the one on the preceding page, take a good look at the circuit diagram and you will see that the location of the CdS cell has changed. The same transistors and other electronic parts may be used in many different ways. Carefully study their functions in each experiment.

Now arrange the blocks and 60cm cords as iliustrated at left and turn on the power switch. The lamp will go on and off when the CdS cell is shaded.

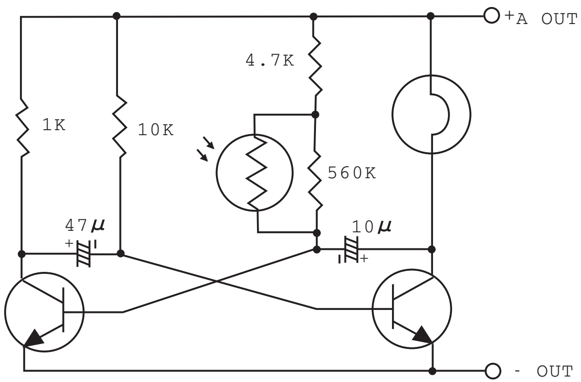


No.112 Circuit That Changes the FIashing Speed of a Lar According to Light Intensity



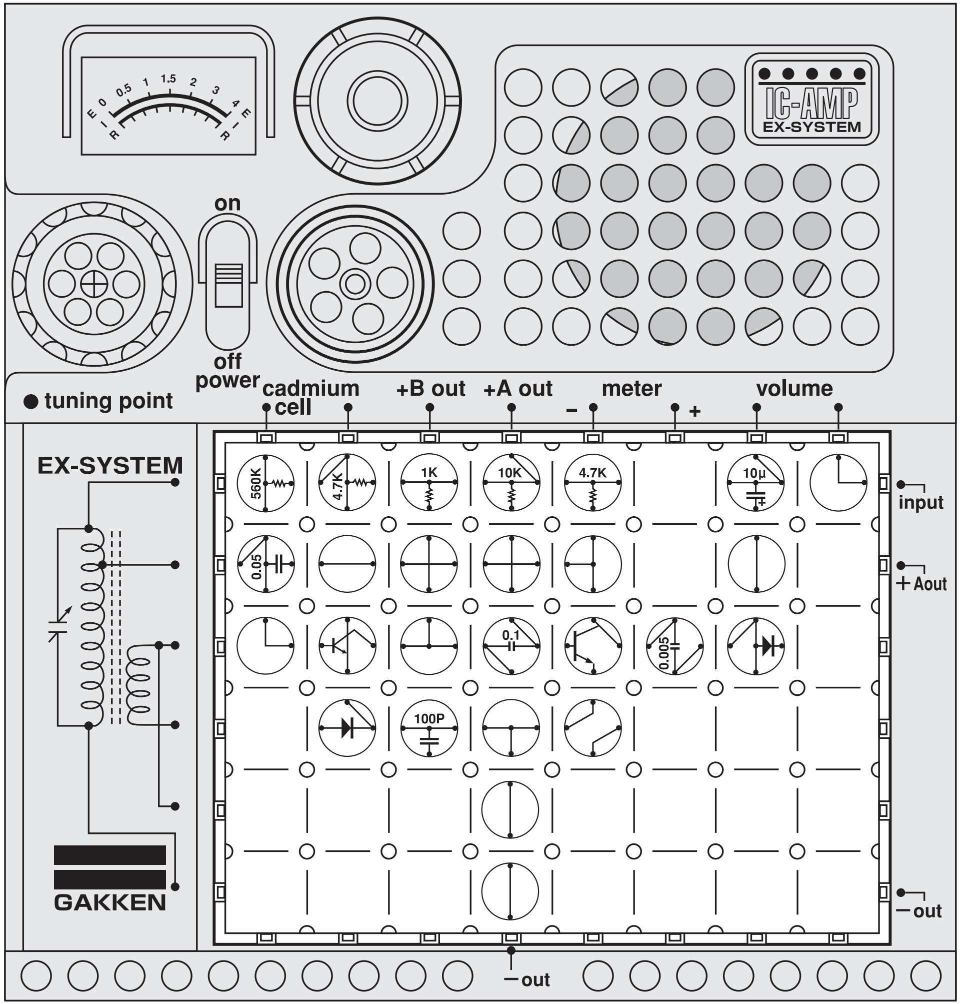
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:



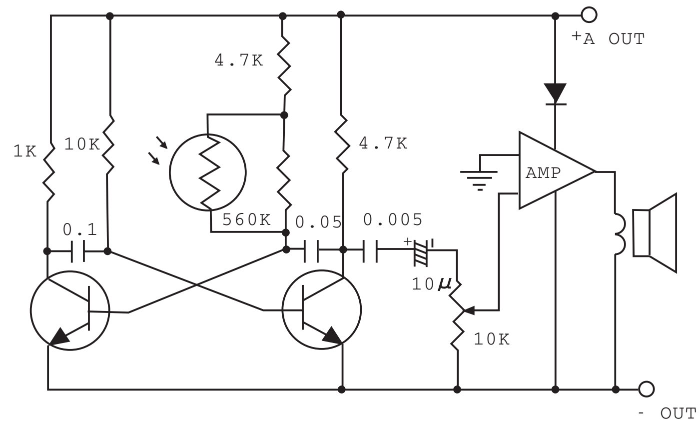
Now we will experiment with a circuit that changes the flashing speed according to the intensity of light falling on the CdS cell. Arrange the blocks as illustrated at left and turn on the power switch. Carry the blocks from light to dark areas of the room, also shading and then uncovering it with your hand. The change in light intensity falling on the CdS cell will affect the speed at which the lamp goes on and off.

No.113 Circuit That Changes the Tonal Quality with Li



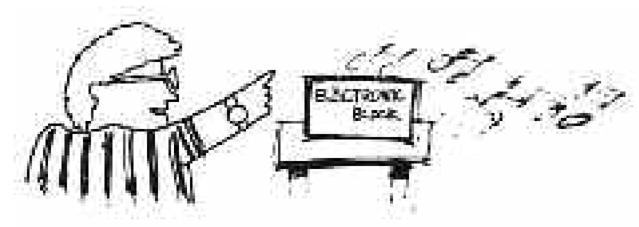
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

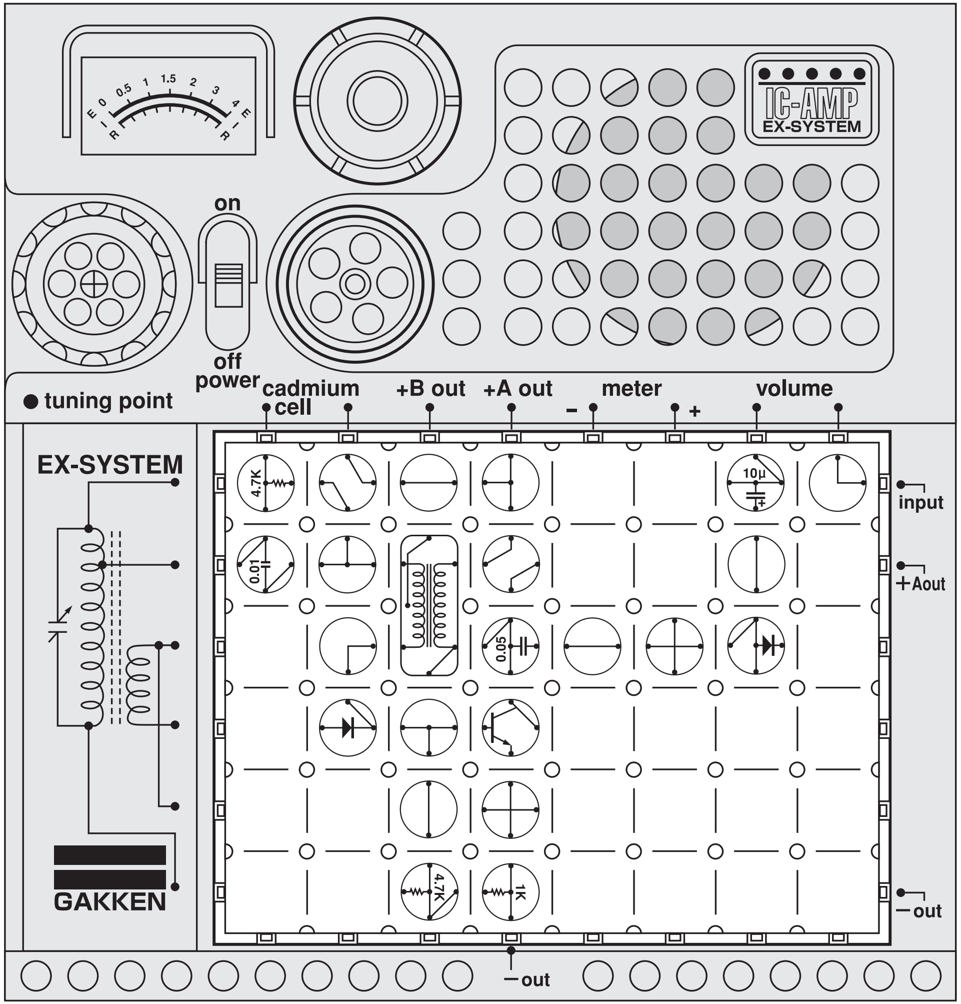


We have learned that the CdS cell changes its electrical resistance according to the intensitv of light falling on it. Now let's build a circuit that alters the quality of sound according to the intensity of light falling on the CdS cell that changes the resistance.

Arrange the blocks as illustrated at left and turn on the power switch. A sound will come from the speaker. Vary the intensity of light falling on the CdS cell and see how the sound quality changes. This circuit may be used as a musical instrument if you cleverly manage the light intensity.

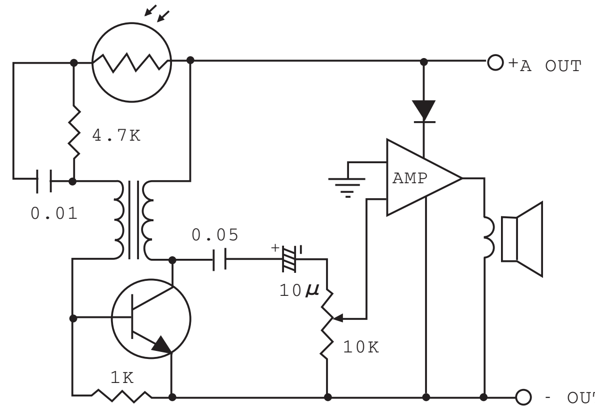


No.114 Basic Circuit of Photogun



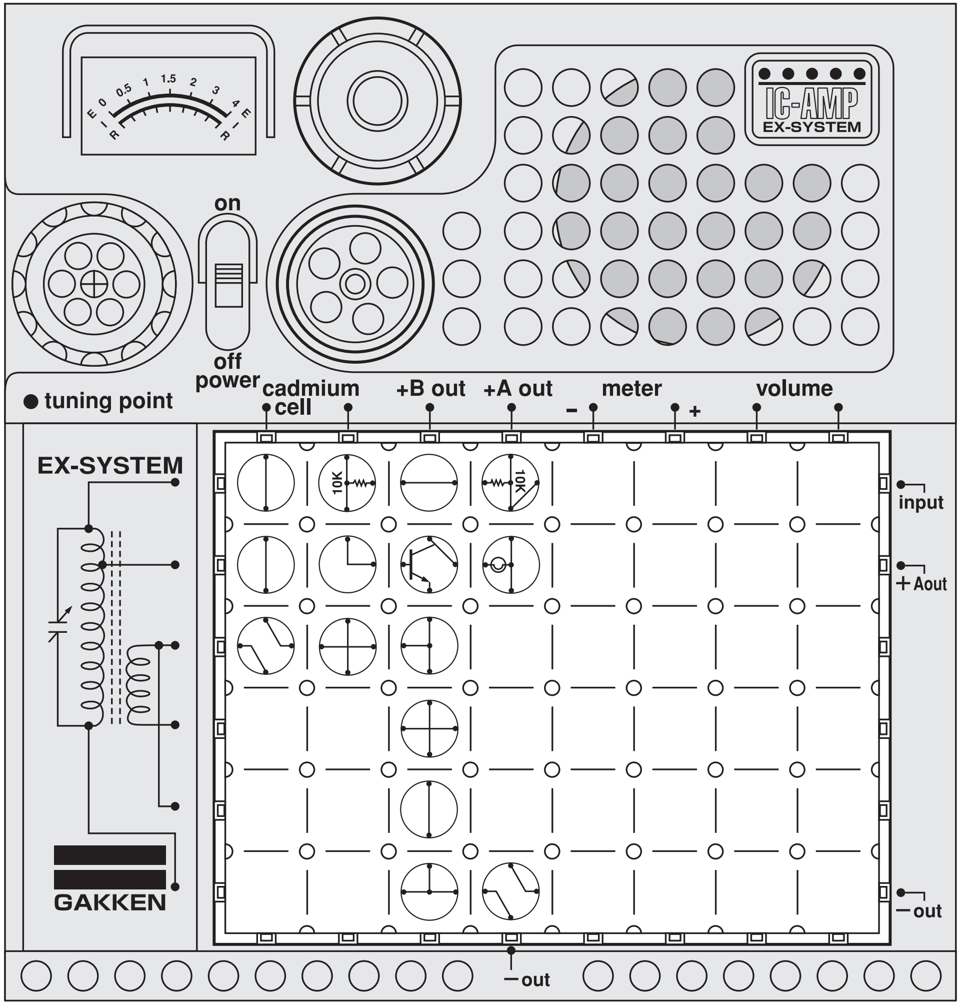
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:



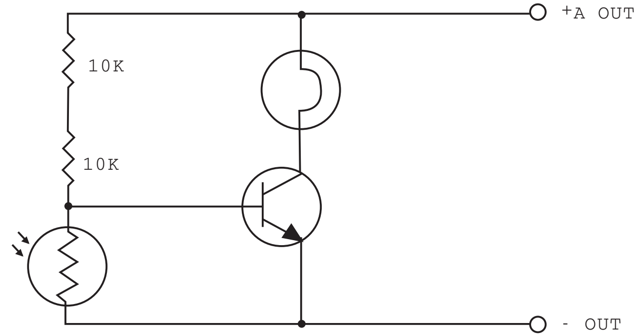
Now let's experiment with the basic circuit of a photogun, using a CdS cell. Arrange the blocks as illustrated at left. Put the kit in a dim area of the room for a while, then turn on the power switch and now move the kit under bright light so that the CdS cell can react. Sound will come out of the speaker when the light hits the cell.

No.115 Automatic Light Control



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

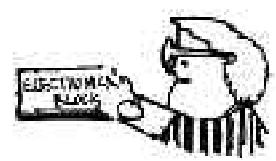
Circuit diagram for this experiment:



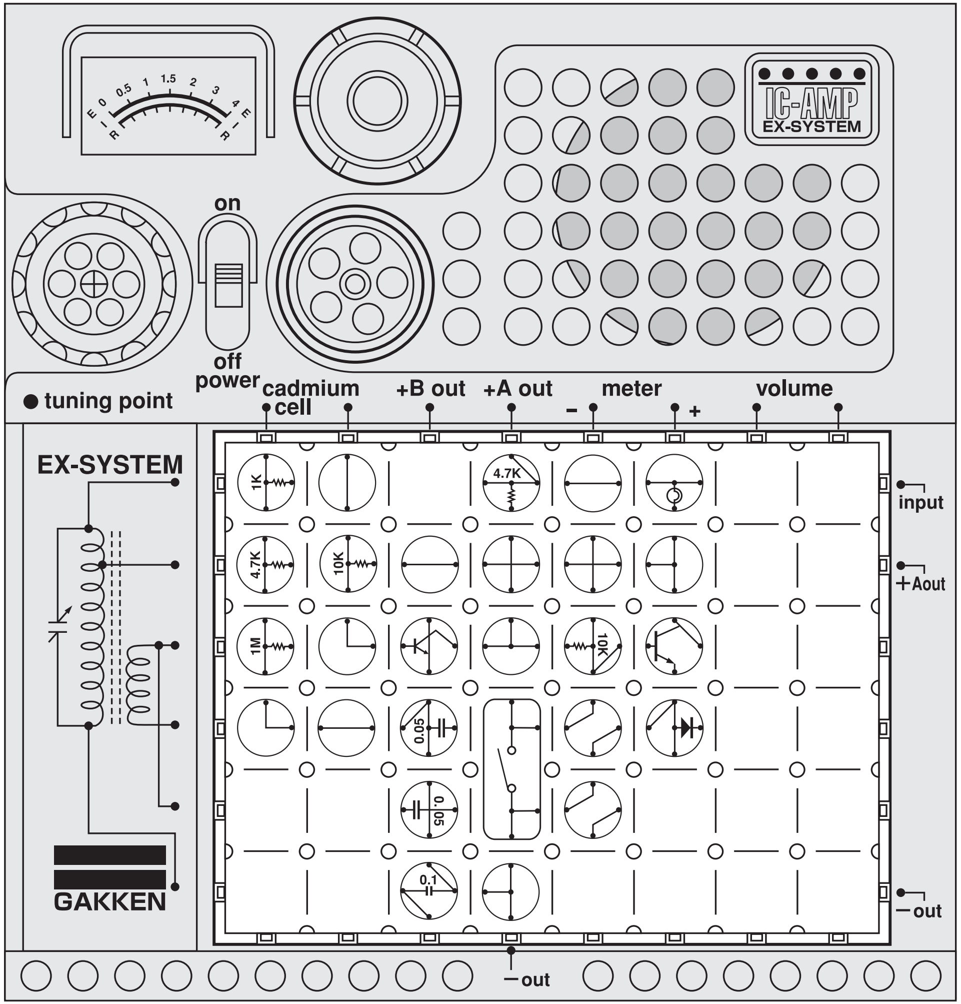
When it grows dark in the evening, lights illuminate streets and expressways. They must be turned off when it becomes light in the morning to avoid the wasteful loss of electric power. Actually, those outdoor lights are turned on and off by the action of electronic switches that work on their own.

Now let's experiment with such an electronic circuit. Arrange the blocks as illustrated at left and turn on the power switch. Expose the CdS cell in the kit to strong light and the lamp will dim. Shade the cell from light and the lamp will grow brighter.

Try to find where the light-sensitive device is

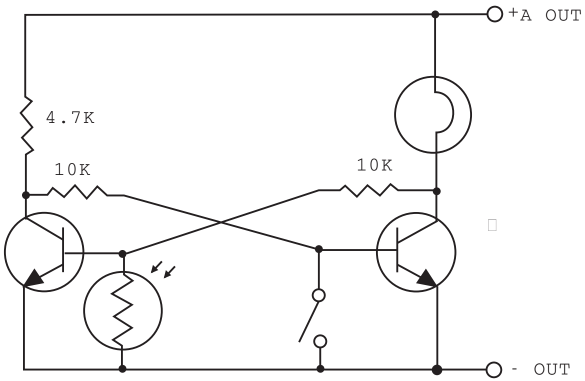


No.116 Light-receiving Device in Photogun



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

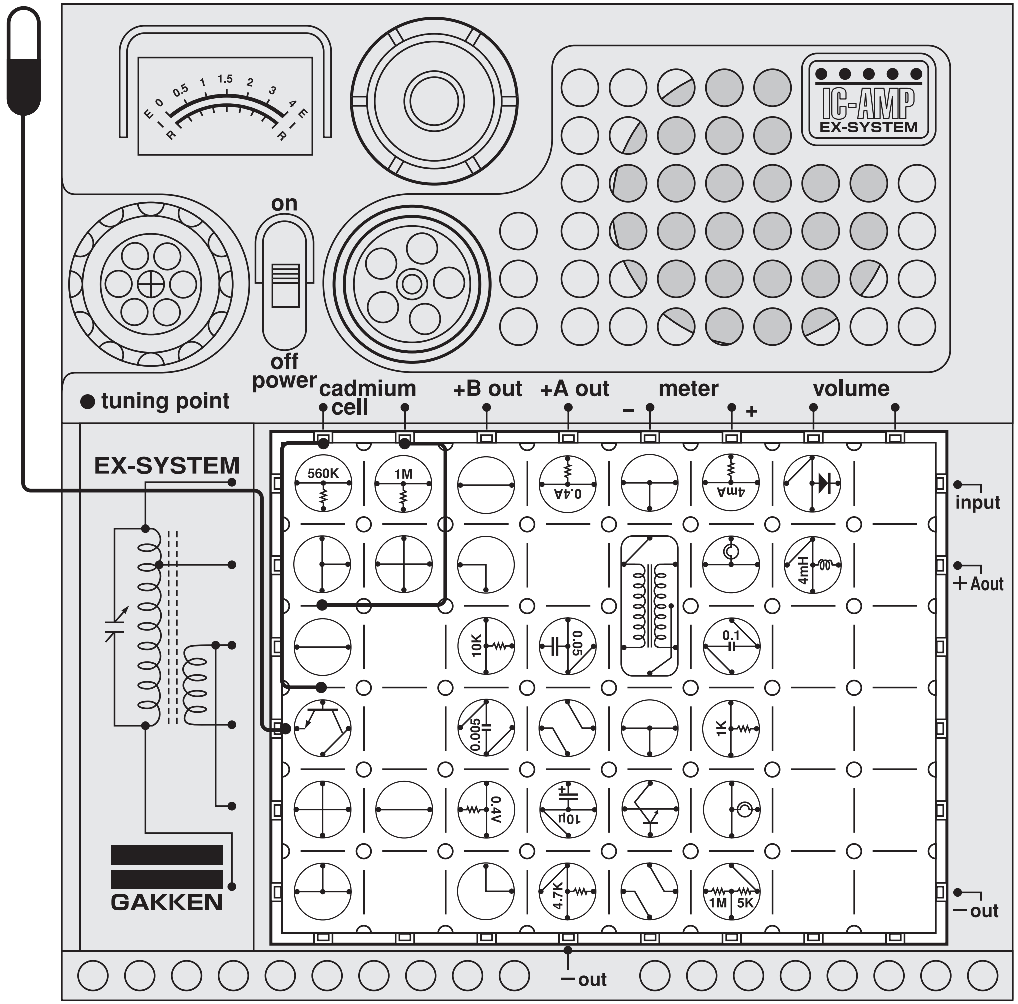


We have made a steady advance in experiments with the CdS cell. Now we will proceed to an experiment with a circuit that has a resetting function.

First make sure you have very strong light available. Arrange the blocks as illustrated at left and turn on the power switch. The lamp will go on when the cell is struck by light. Depress the key switch and the lamp will go off. Release the switch, and the lamp will glow once again.

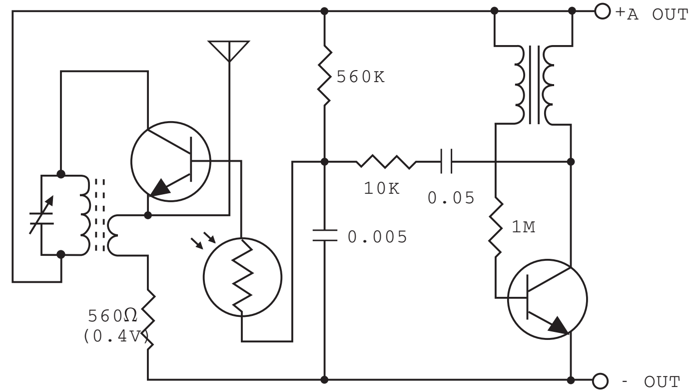
No.117 Circuit Radiating Radio Waves When It Becomes

Antenna ●Dangerous! Do not insert antenna lead into an AC outlet.



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

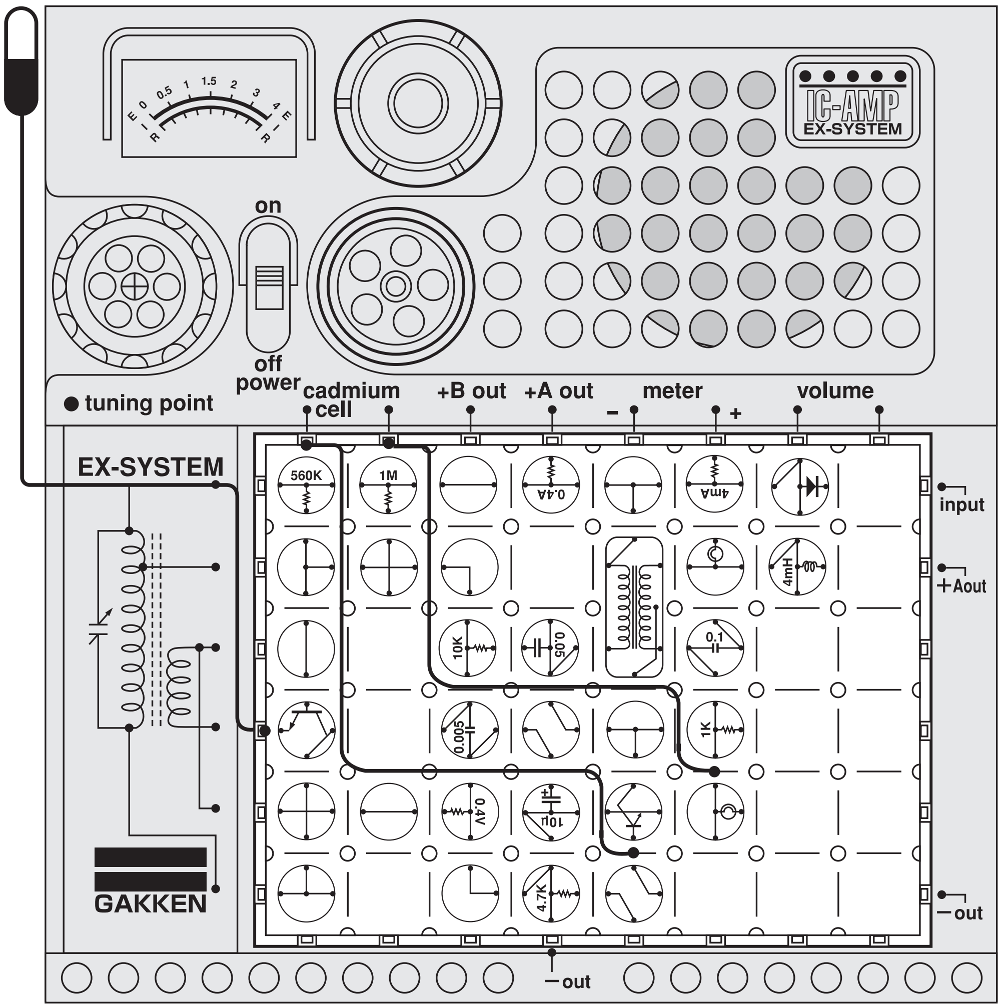
Circuit diagram for this experiment:



This time, we will experiment with a wireless light warning device using a CdS cell. Arrange the blocks and connect the antenna and 60cm cords as illustrated at left. Turn on the power switch. Tune the circuit to a radio set as you did in Experiment No.10. This time you will not hear a whistling sound but a station instead. Expose the CdS cell to light. Then shade the cell with one hand to see what will happen to the sound coming out of the radio.

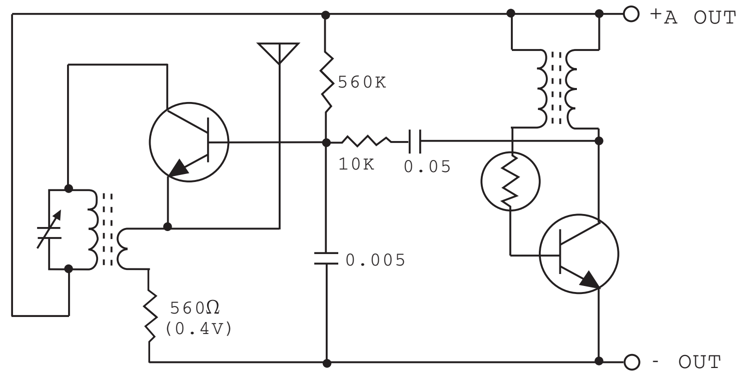
No.118 Circuit Radiating Radio Waves When It Grows Dark

Antenna ●Dangerous! Do not insert antenna lead into an AC outlet.



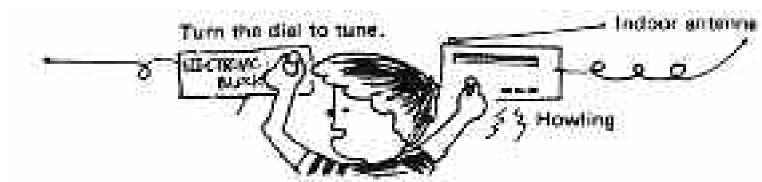
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

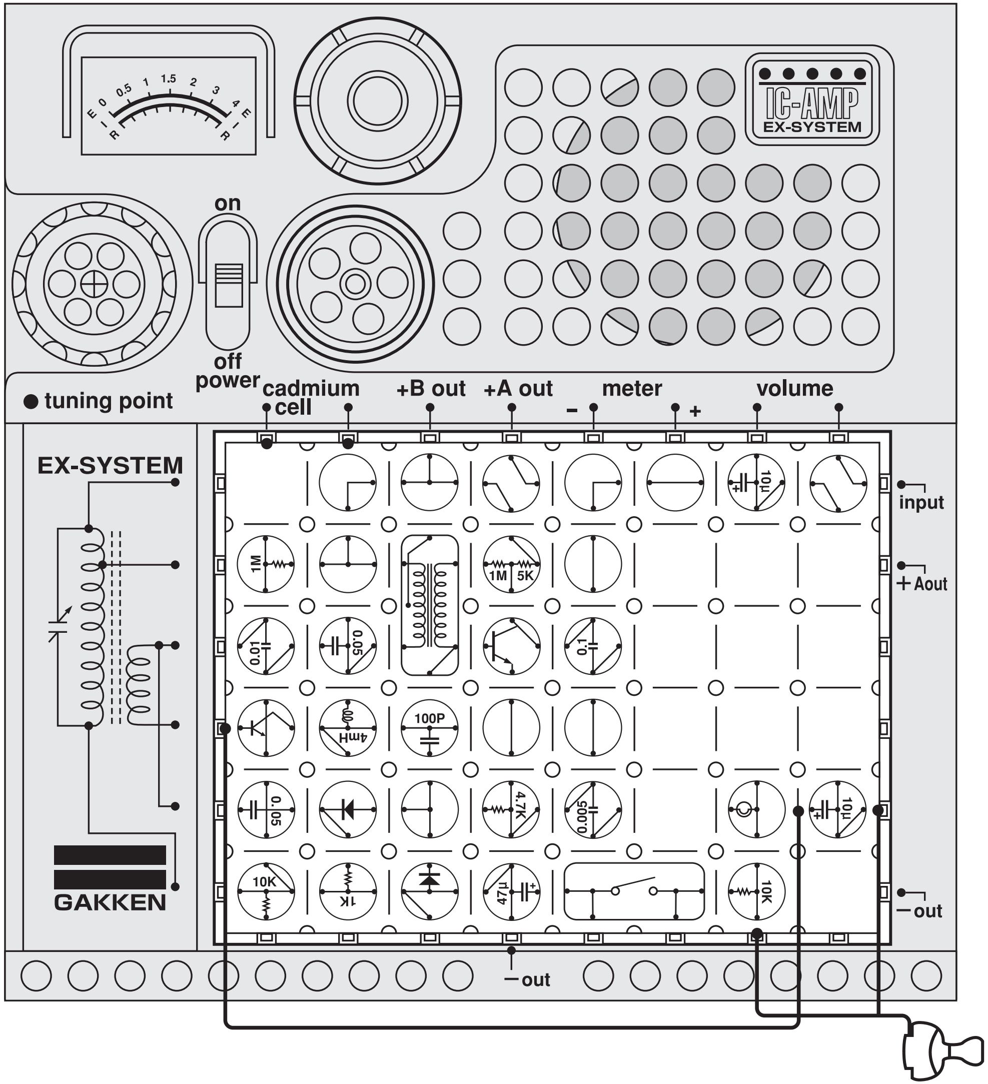


Have you successfully done the experiment on the preceding page? This time we will build a circuit that will radiate radio waves when it grows dark.

Arrange the blocks, antenna, and a 60cm cord as illustrated at left. Tune the kit to a radio set as you did in Experiment No.117. Test the circuit to see what it does when the CdS cell is shaded from light.

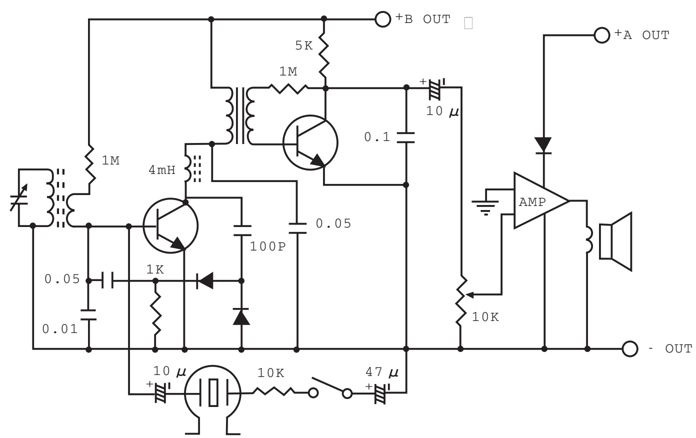


No. 119 Radio with Earphone Mixing



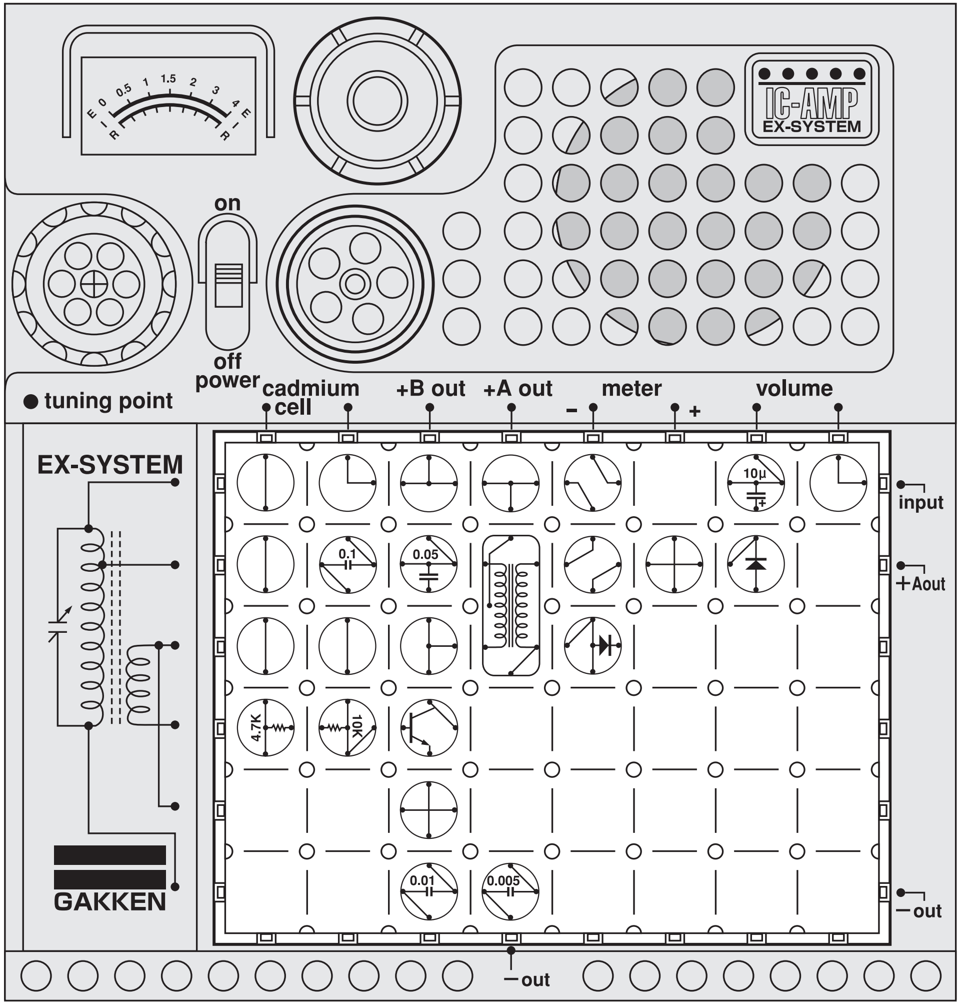
Earphone (as a substitute for a microphone.)

Circuit diagram for this experiment:



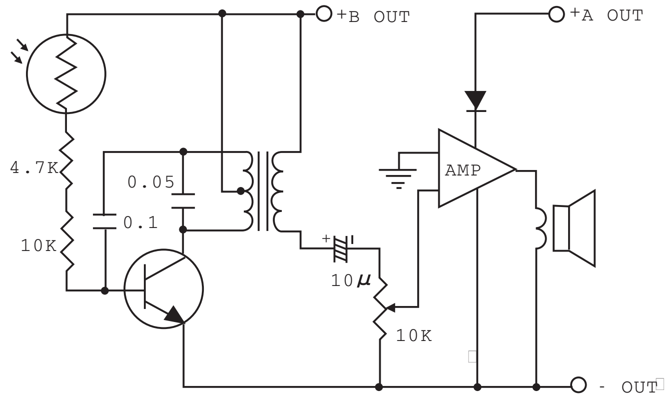
It would be fun to have your voice come out of the radio speaker when you sing along with a favorite recording artist or comment on the monolog of a radio personality. Now let's experiment with a circuit that enables you to do so.
Arrange the blocks, a 60cm cord, and the earphone as illustrated at left and turn on the power switch. Depress the key switch and sing or speak into the earphone.

No. 120 Illuminometer by Sound



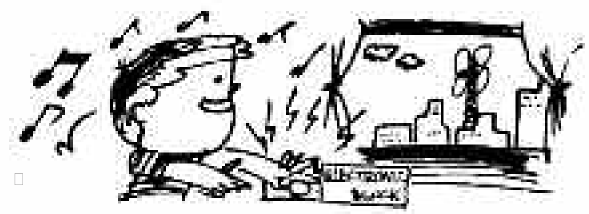
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

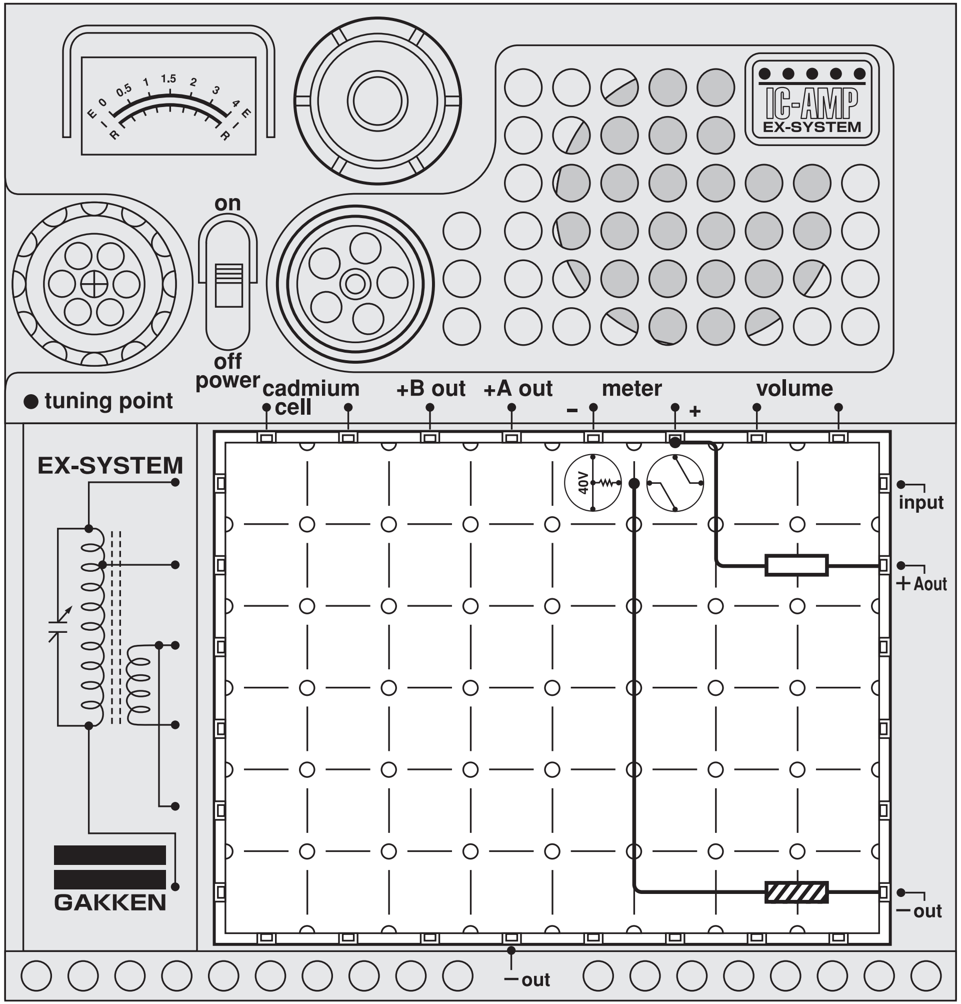


So far you have done several experiments with the CdS cell. It has many other uses. Now you will learn about another application of the CdS cell; that is, an illuminometer which is an instrument for measuring the intensity of light.

Arrange the blocks as illustrated at left and turn on the power switch. Change the light falling on the CdS cell, listening to the sound this circuit makes. The stronger the light striking the CdS cell, the higher the voice coming out of the speaker.

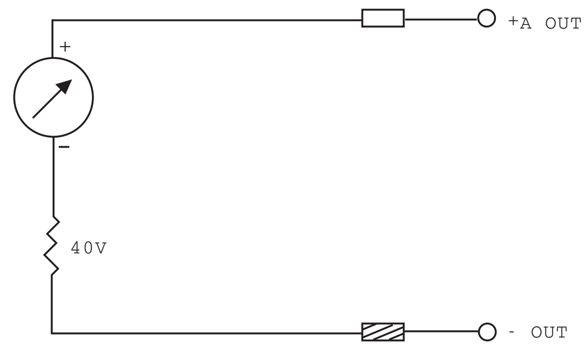


No.121 40V DC Voltmeter



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

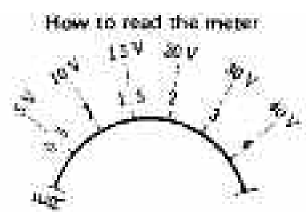
Circuit diagram for this experiment:



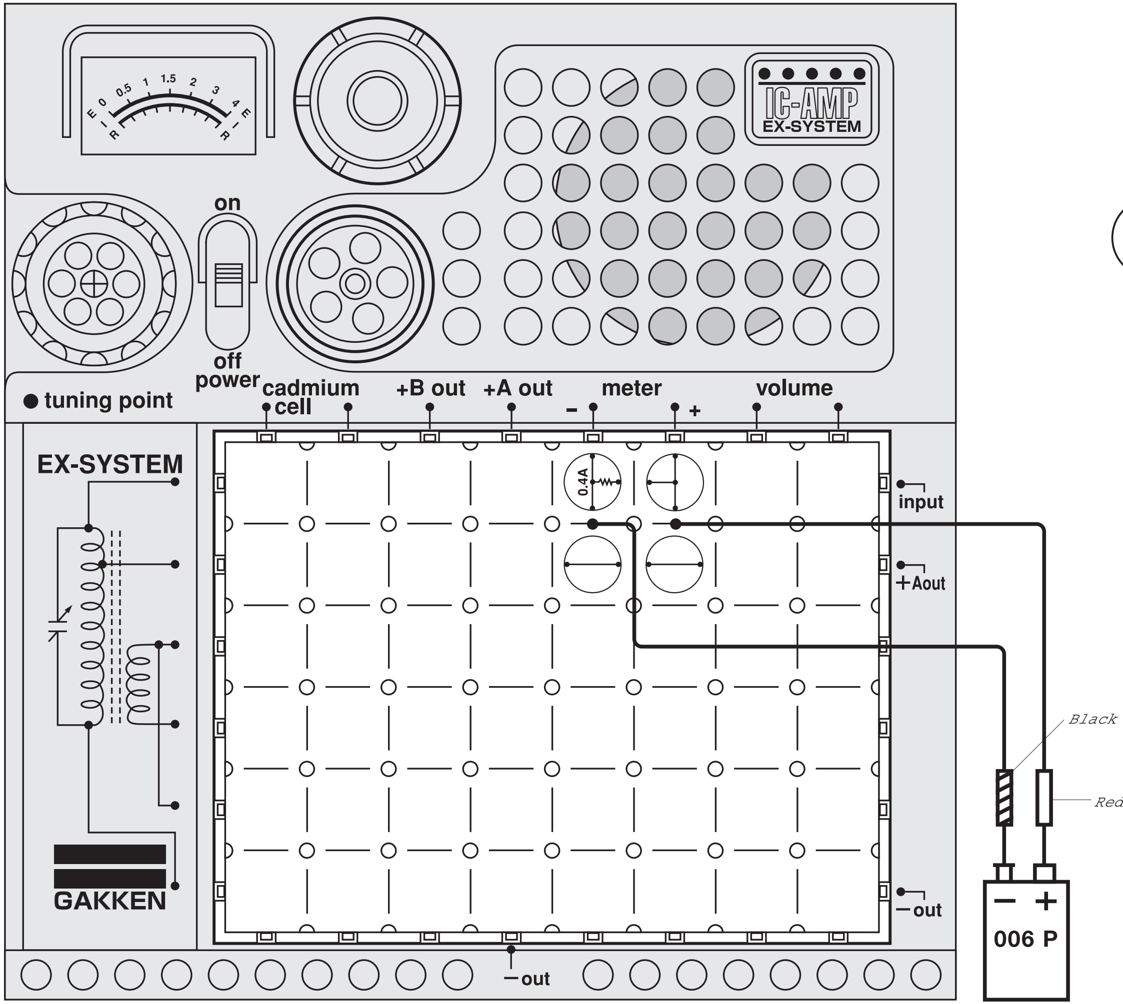
Your kit needs dry-cell batteries as a source of electric power to operate the circuits built with the blocks. As the batteries are used, their power output becomes weaker until finally they are used up. When the kit's radio produces too soft a sound or no sound at all, it is necessary to check the battery potential. For this purpose, you need a voltmeter.

You are now going to build a 40V voltmeter circuit. Your set of electronic blocks uses only a 6V power source, so the meter pointer should indicate about 6V on the scale. If the meter reads below 5V, it is time to replace the batteries with new ones.

Arrange the blocks and tester rods as illustrated at left. The black tester rod goes in the minus terminal and the white tester rod goes in the plus terminal. Now turn on the power switch. Watch the battery potential register on the meter.

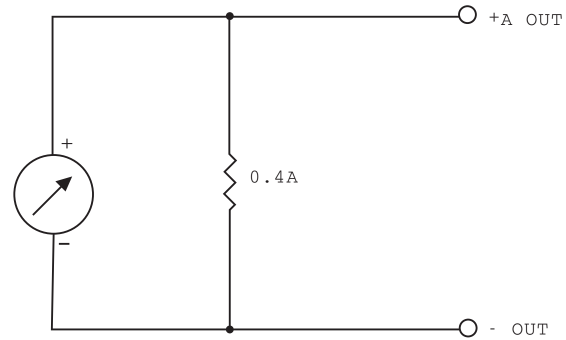


No.122 400mA (Milliamperes) Ammeter



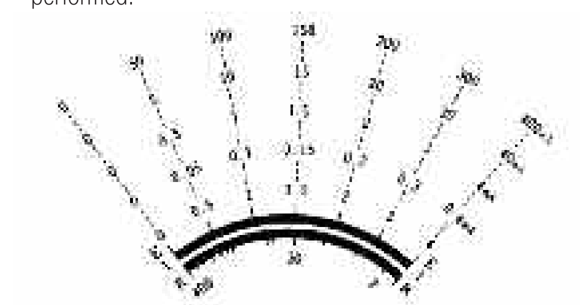
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

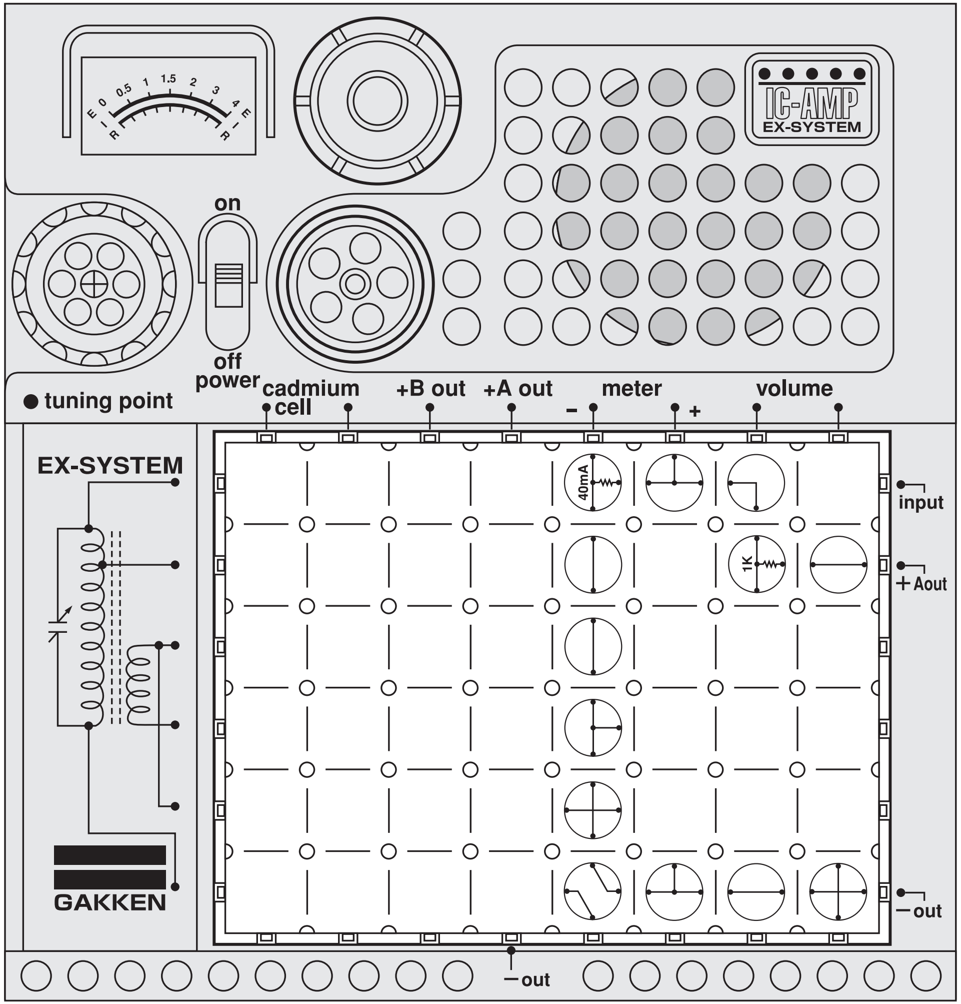


In this experiment you will test the battery potential of a square-shaped dry-cell battery OO6P-9V. First, see if you can find this type of battery around the house. If not borrow one from a friend or, if necessary, purchase one.

Arrange the blocks as illustrated at left. Connect the black tester rod to the ⊖terminal and the red one to the ⊕terminal of the battery. Do not leave the testers connected to the battery too long. (About 0.2 second) When the meter pointer indicates about 400mA on the scale, the battery is still usable. The power switch must be in its OFF position when this experiment is performed.

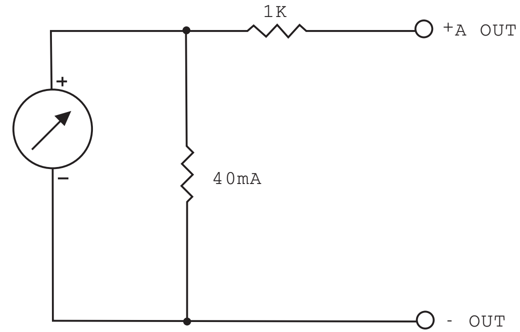


No.123 Test on Ohm's Law



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

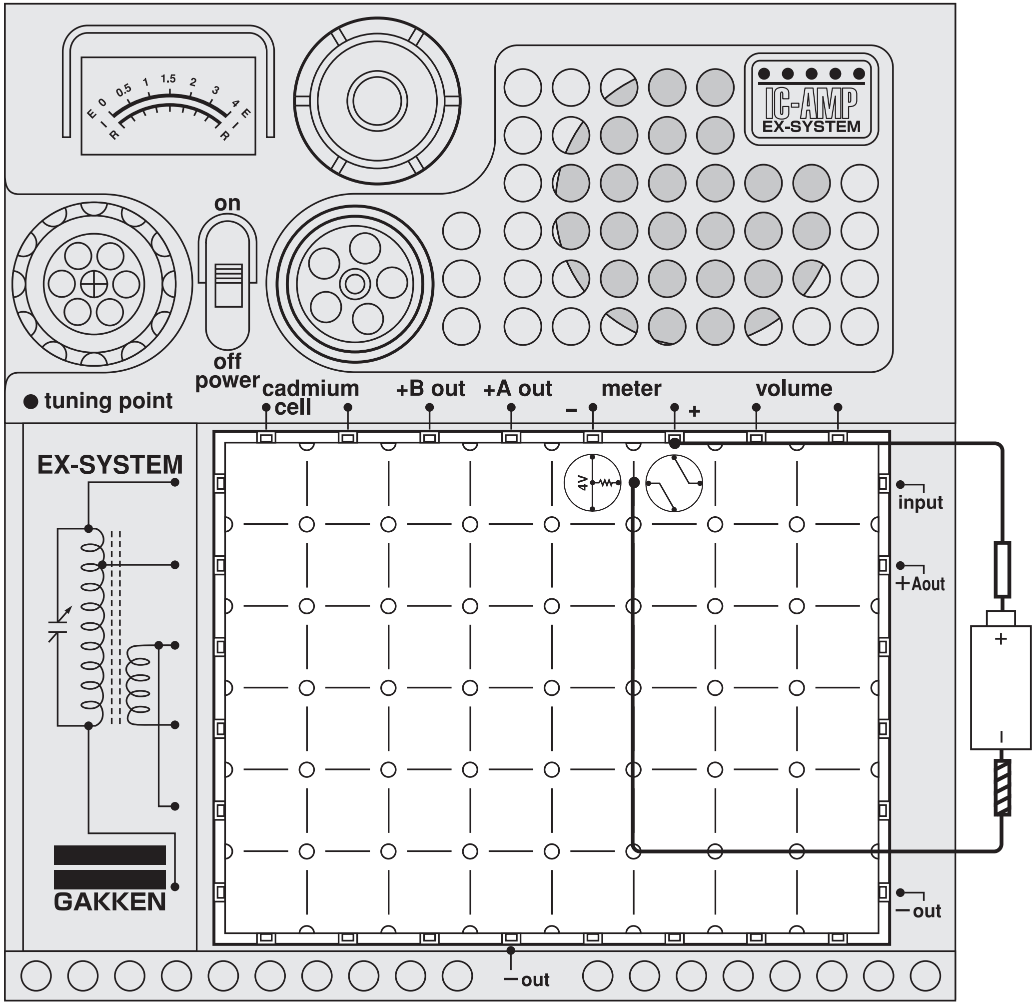
Circuit diagram for this experiment:



A very important law you should know is Ohm's Law. Once you learn it, you can calculate a current without taking measurements with an ammeter.
Now let's take measurements to test the law.
Arrange the blocks as illustrated at left and turn on the power switch. Now the meter pointer indicates about 6mA. This is a current of electricity flowing through a resistance of 1K. The batteries used for these electronic blocks have a power output of 6V. There is a certain relationship between the figures 6V, IK, and 6mA. It is as follows:
Battery voltage   Resistance = Current
That is to say, the above figures have this relationship:

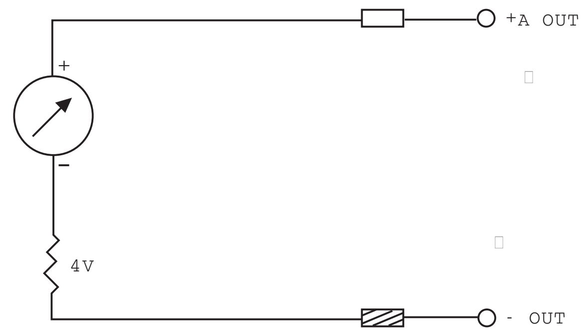
$$\frac{6}{\mathrm{I\,K}(1000\Omega)} = 6\mathrm{mA}\ (0.006\mathrm{A})$$

No.124 4V DC Voltmeter



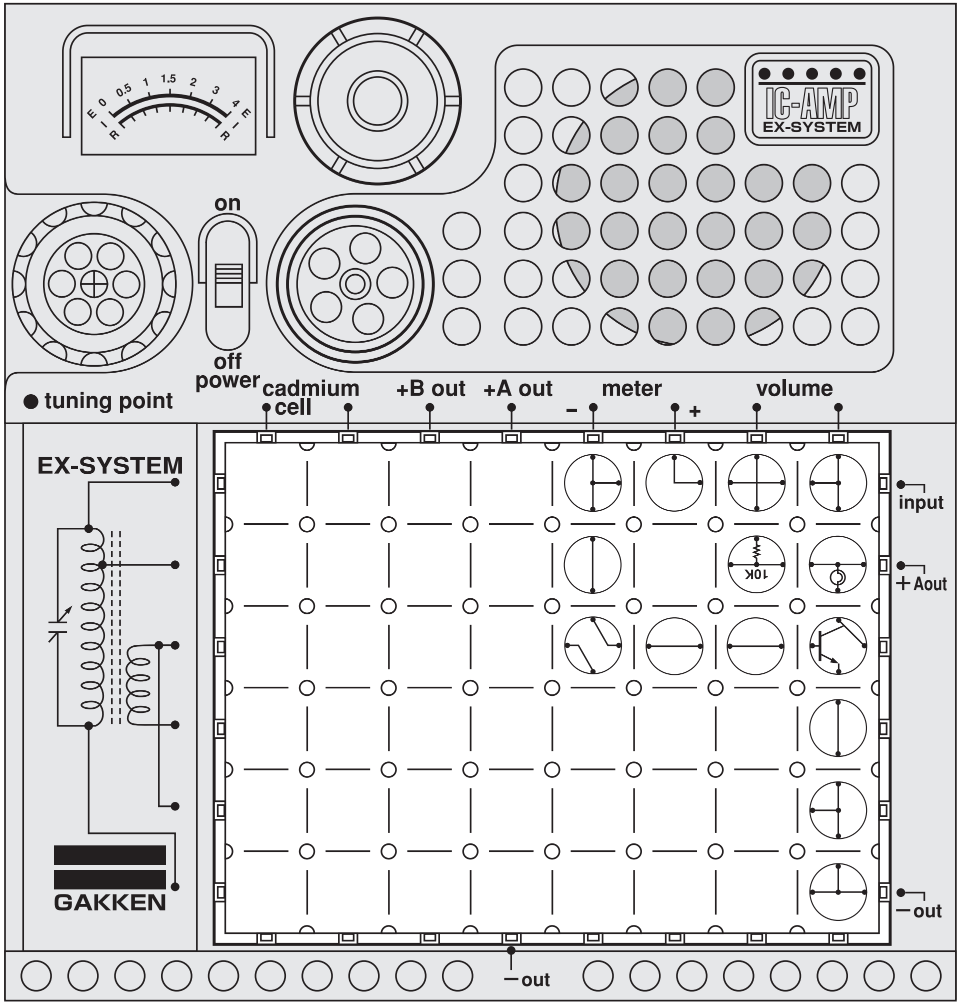
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:



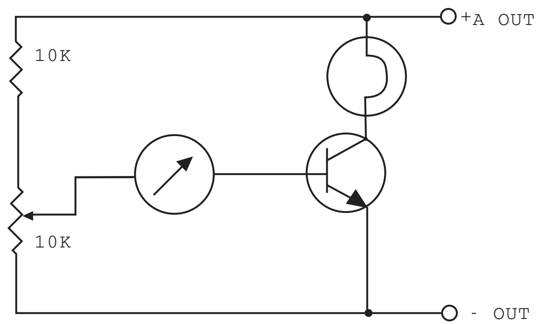
To do this experiment, you will first have to get a AA battery. You are going to measure its voltage by using a 4V voltmeter.
Arrange the blocks and tester rods as illustrated at left and turn on the power switch. Touch the plus and minus terminals of the battery as indicated. Then check the meter for their voltage. This voltmeter circuit can take measurements up to 4V, so it can also be used to measure the voltage of D and C batteries.

No.125 Measurement of Fixed-Bias Base Current



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

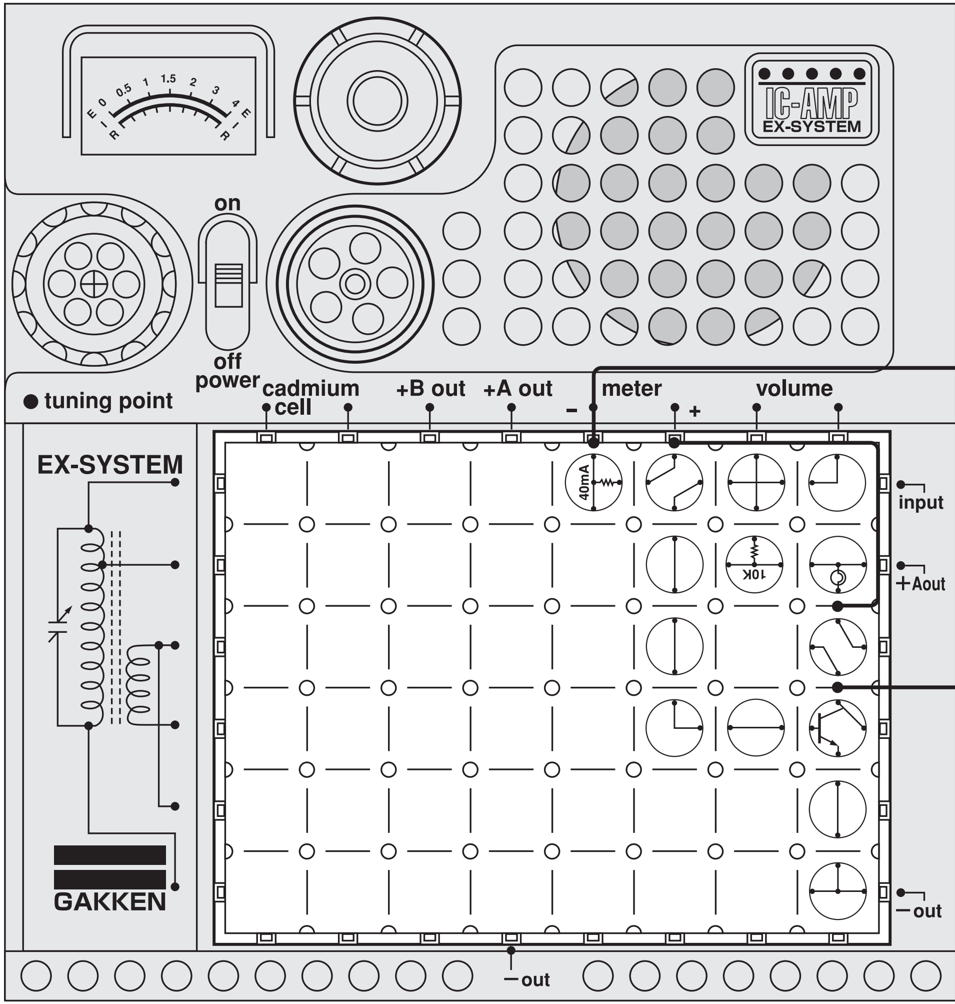


You have already learned that transistors do not work if a voltage is not applied to their base. In this experiment you will test how transistors work by using the meter.

Arrange the blocks as illustrated at left and turn on the power switch. Turn the volume control dial all the way to the right and the lamp will go on. This is because a voltage has been applied to the base of the transistor. Now turn the dial slowly to the left and the lamp will grow dimmer.

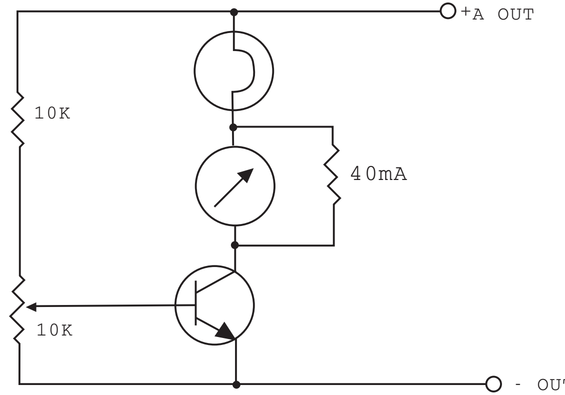
This test shows that the voltage entering the base of the transistor determines the current that flows to the collector. The circuit has a meter between the base and the power source so that you can see how much current is needed to flow to the base to light the lamp.

No.126 Measurement of Fixed-Bias CoIIector Current



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

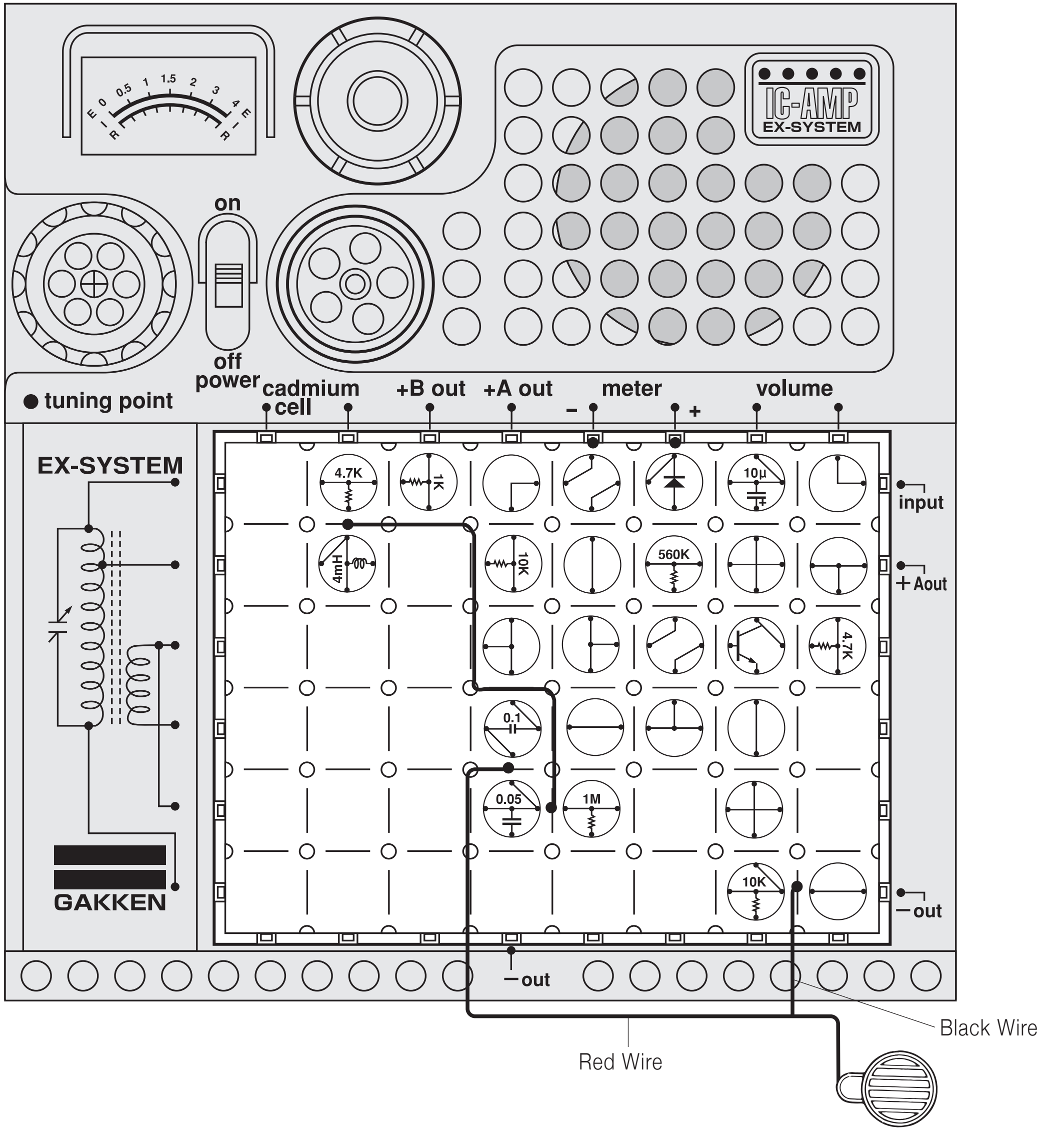
Circuit diagram for this experiment:



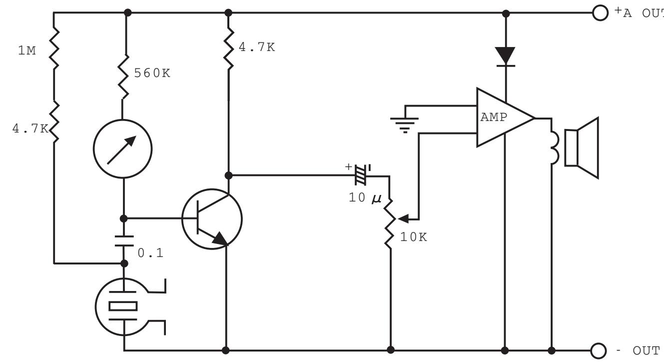
After doing the experiment on the preceding page, you should have a general idea of how a current flows to the base of a transistor. Now you will do an experiment to see how a current flows to the collector by measuring the collector current.

Arrange the blocks and connect the 60cm cords as illustrated at left. Turn on the power switch and continue as Experiment No. l25, noting the volume control position and the brightness of the lamp. If you make graphs of the base current tested in the preceding experiment and the collector current in this experiment,it will be interesting.

No.127 Measurement of Collector Current in Audio Ampl

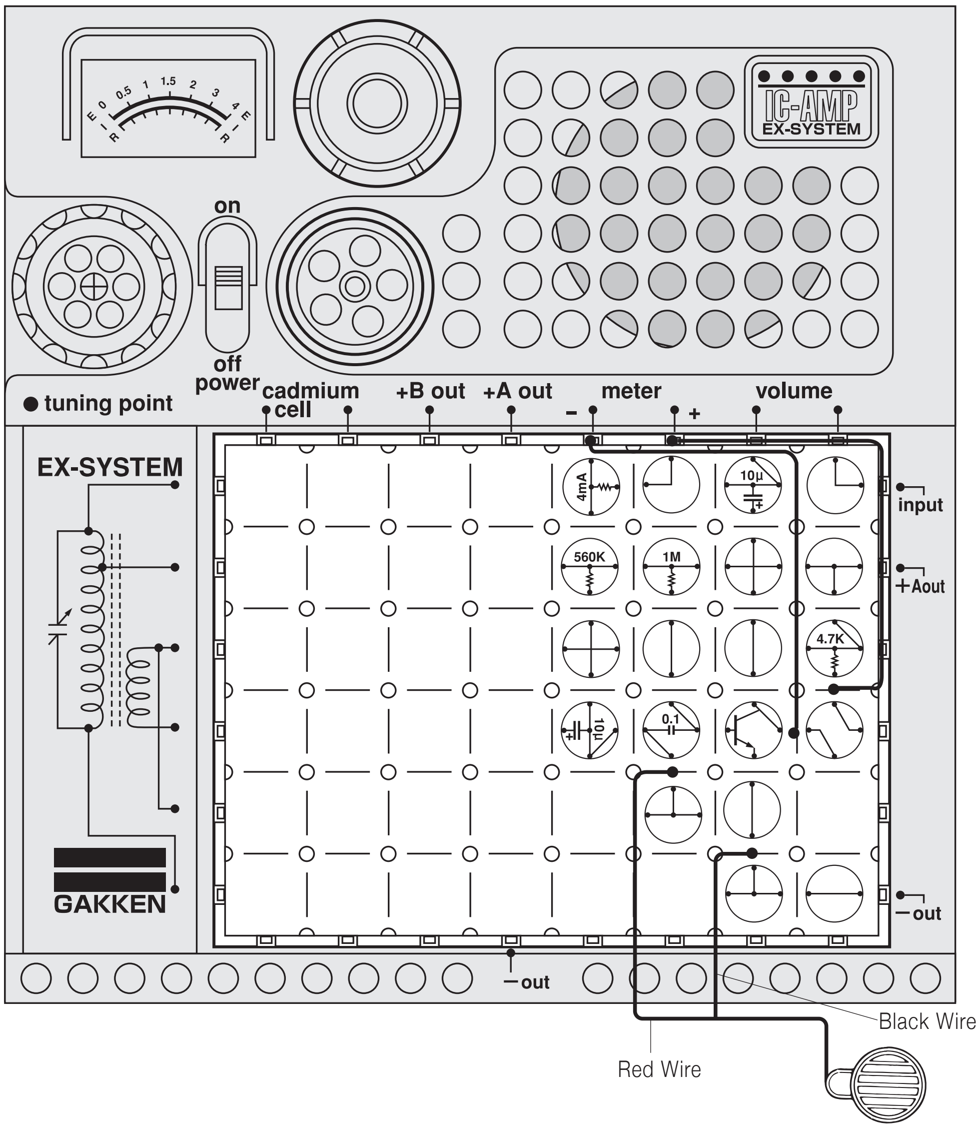


 Circuit diagram for this experiment:

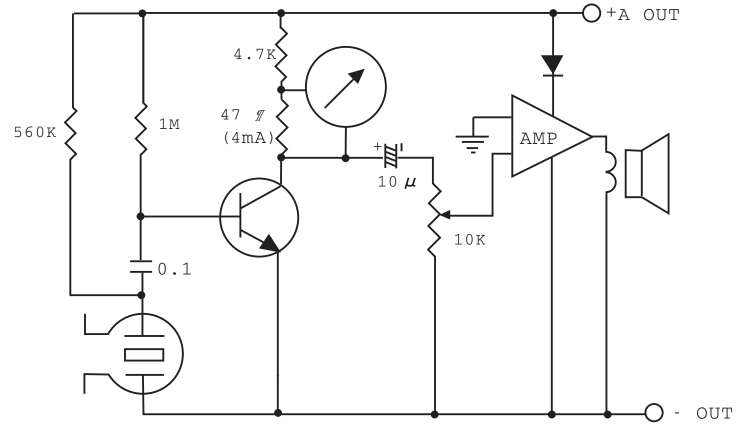


In this experiment you will take measurements of the collector current in a circuit that controls the loudspeaker by the slight change in the current of a earphone. Arrange the blocks and connect the earphone as illustrated at left. Turn on the main switch and speak into the earphone. You will see the meter pointer swing, indicating that there is current flowing through the meter. The pointer swings as the voice changes. This experiment may not produce a highly accurate value of the current amplification of the amplifier circuit.

No.128 Measurement of Emitter Current in Audio Amplifie

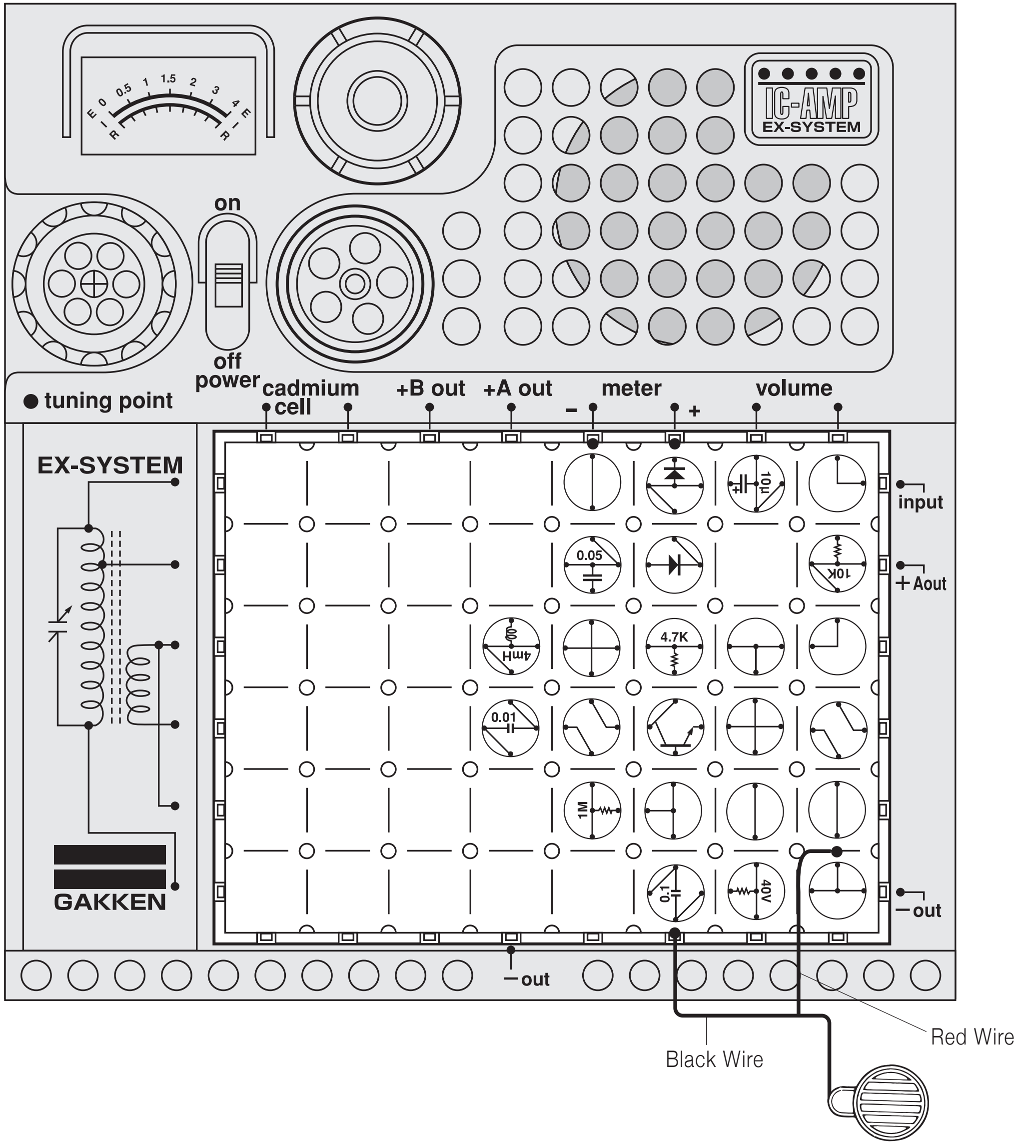


Circuit diagram for this experiment:

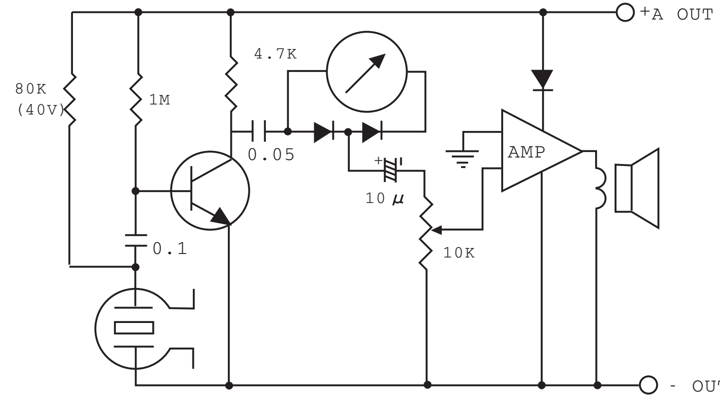


When we measure the emitter current in the audio amplifier circuit, we will find the emitter current is almost the same as the collector current. When the current flows through a NPN transistor base, because the transistor will amplify the current, the collector will have times current. Base current and collector current will flow toward emitter, so $I_E = I_B + I_C$. Because I_B current is very small, I_E is almost identical to I_C.

No.129 Sound-Level Meter



Circuit diagram for this experiment:

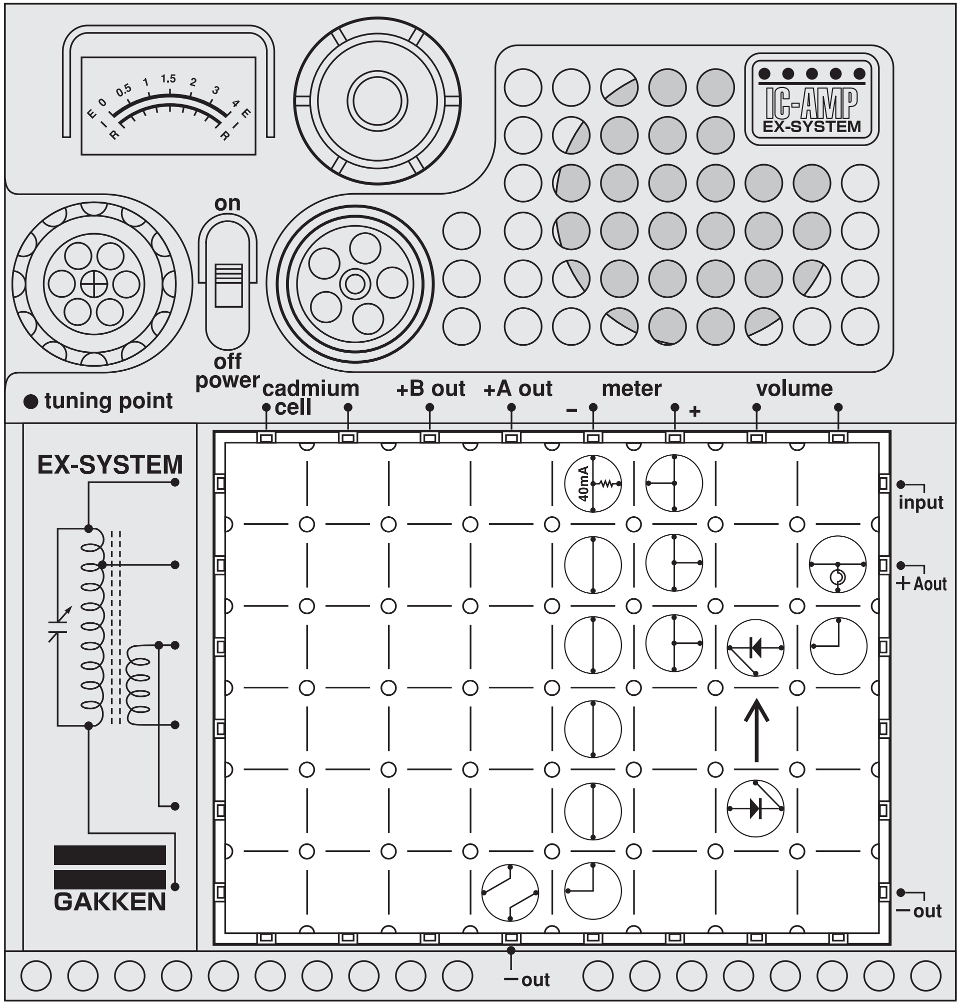


Have you seen the sound-level meter in a tape recorder or a stereo set? The meter pointer swings when a voice comes out of the speaker. The higher the sound level is, the greater the deflection of the meter pointer becomes.

This meter is necessary for recording sounds on a tape at a constant level. Watch the meter in this experiment to see the changes in the audio signal of your voice.

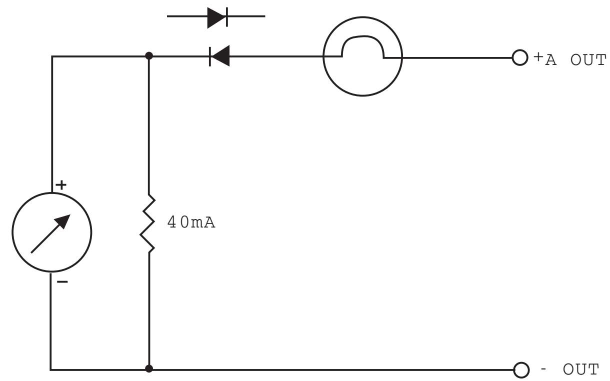
Arrange the blocks and connect the microphone as illustrated at left. Turn on the power switch. Speak into the microphone and you will see the meter pointer swing in proportion to the loudness of your voice.

No.130 Properties of Diode



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

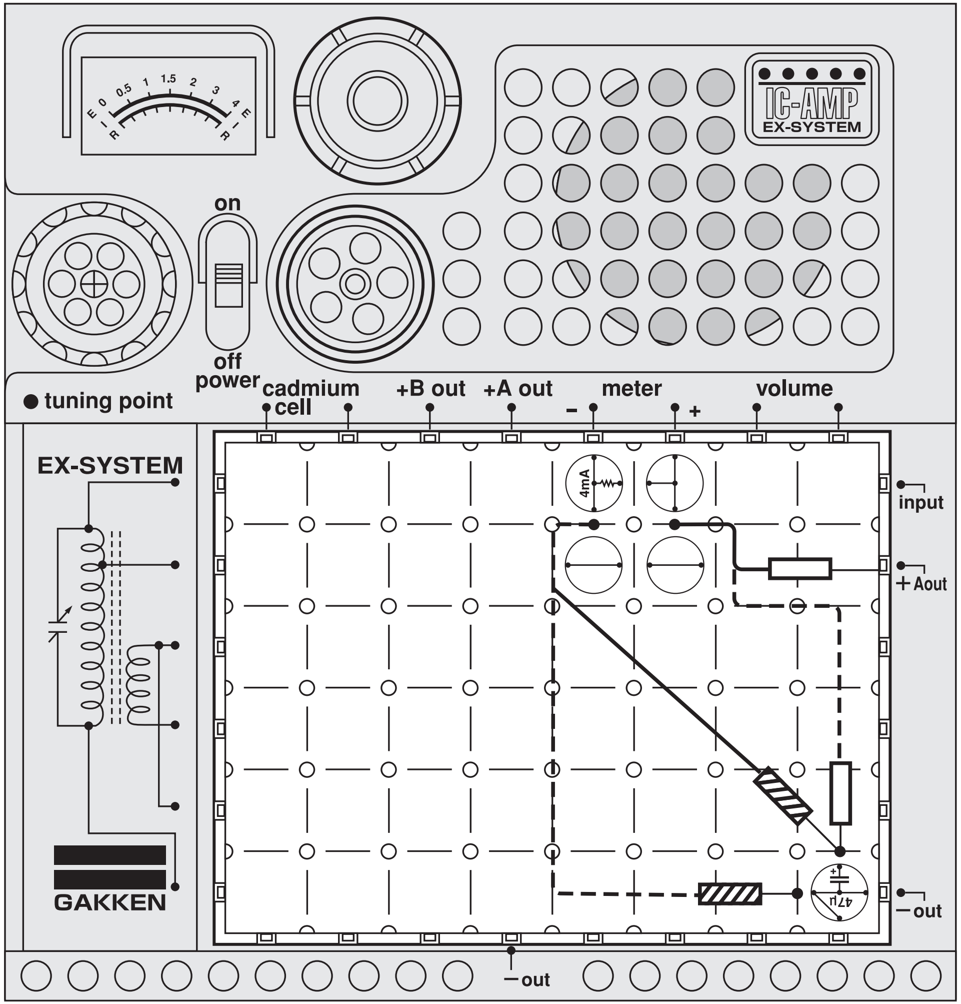
Circuit diagram for this experiment:



By now you would have a good understanding of the properties and functions of the diode. In this experiment, let's test the diode using a meter.
Arrange the blocks as illustrated at left. Before turning on the main switch, try to figure out whether the lamp will go on when you do so. Now turn on the power switch. The lamp has lighted. This is because the ⊕6V power delivered from +A OUT enters the diods via the lamp and a current flows to the -OUT of the battery.
Look at the meter to see how much current is flowing through it. This is the current flowing to the diode. Reverse the direction of the diode as indicated by the arrow on the electronic board and see if the current is still flowing. The meter pointer will not move and the lamp will not go on.

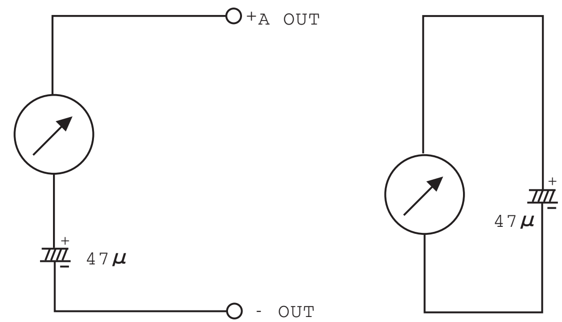
```
Note: Be sure to turn off the switch before pullin
 out a block or changing blocks.
If the switch is on, over-current flows and
it breaks electronic parts (such as transistors an
 diodes).   (Be sure to turn off the switch
 when moving on the next experiment.)
```

No.131 Charging and Discharging of Capacitors



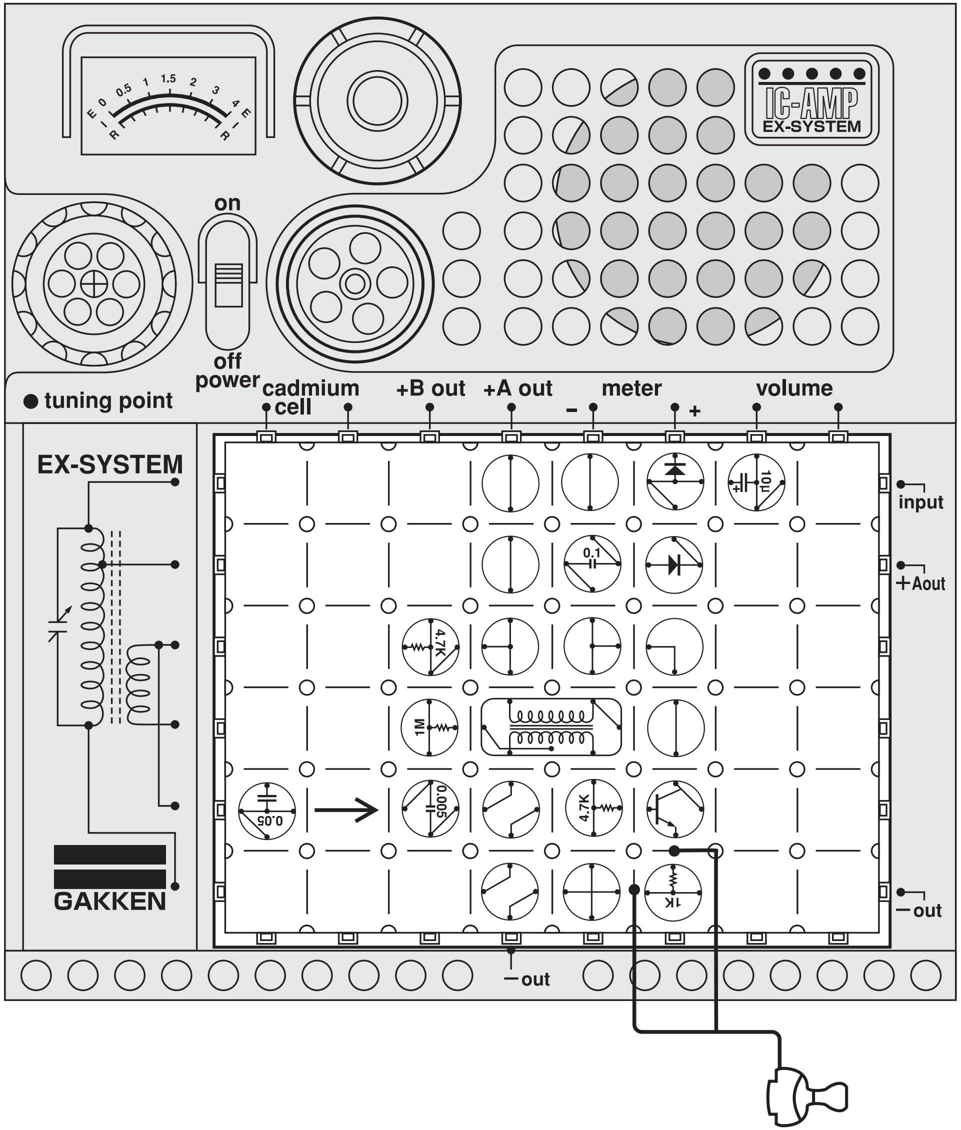
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

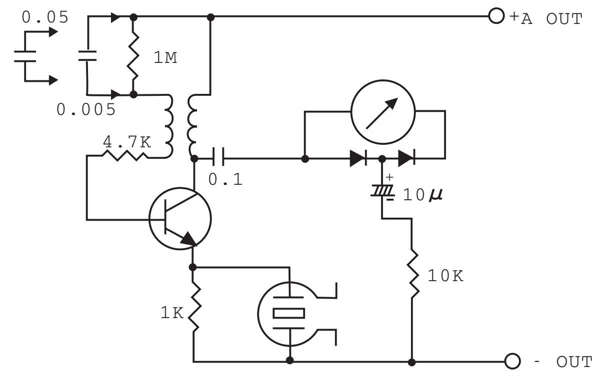


There are many kinds of capacitors : paper, ceramic, MYLAR and oil capacitors, for instance. Here we will experiment with the charging and discharging of a capacitor. Arrange the blocks as illustrated at left. Connect the black and red tester rods as indicated by the solid lines, turn on the power switch, and leave the rods for about 2 seconds. Then change the connections as indicated by the broken lines. You will see the meter pointer swing forward and return to its original position, although the circuit is not connected to the battery. This is because the electricity stored in the capacitor was released to flow through the circuit for a short time. This phenomenon is called the "discharging" of the capacitor. You would have noticed that the meter pointer also swung when the tester rods were connected, as indicated by the solid lines. This phenomenon is called the "charging" of the capacitor.

No.132 Oscillation Frequencies by Meter



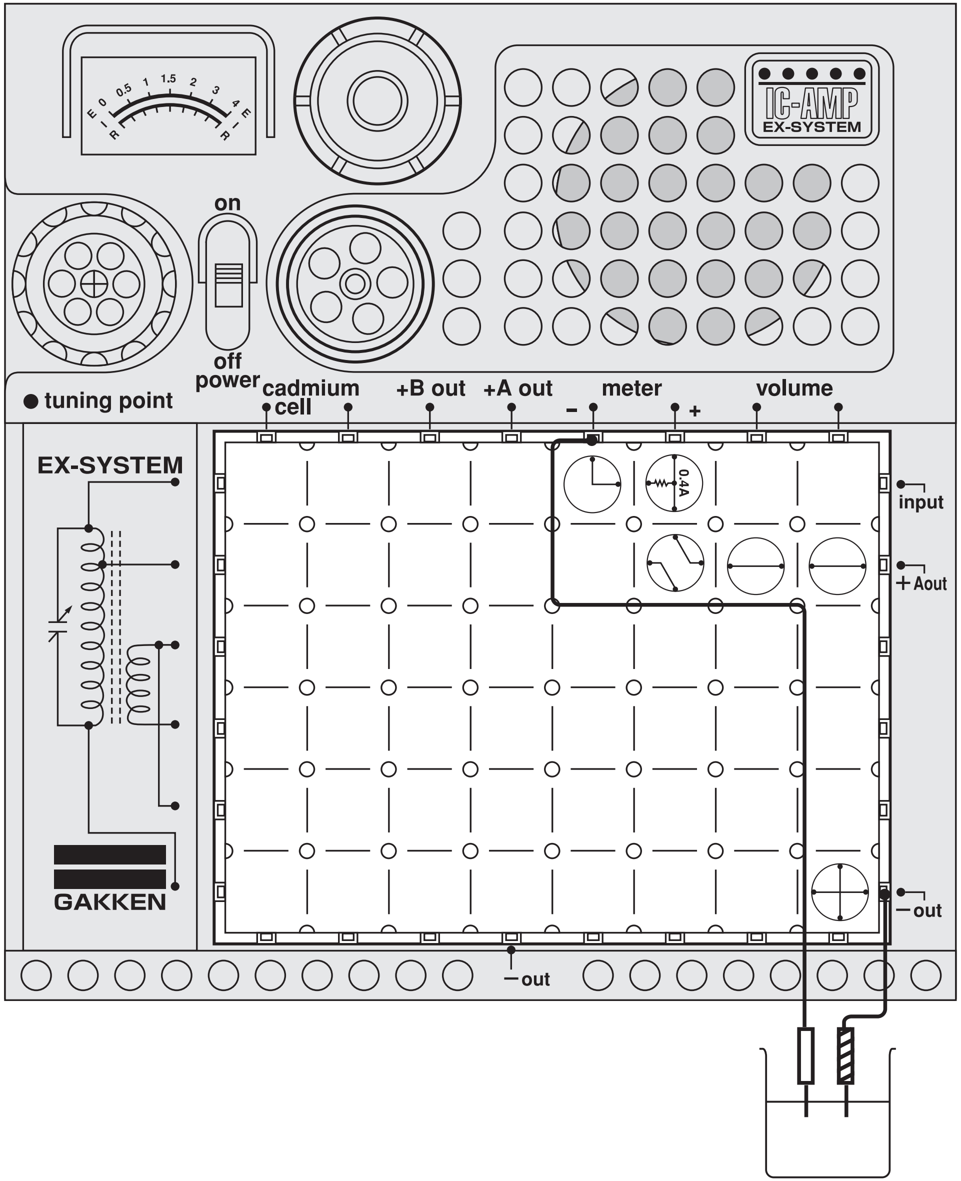
Circuit diagram for this experiment:



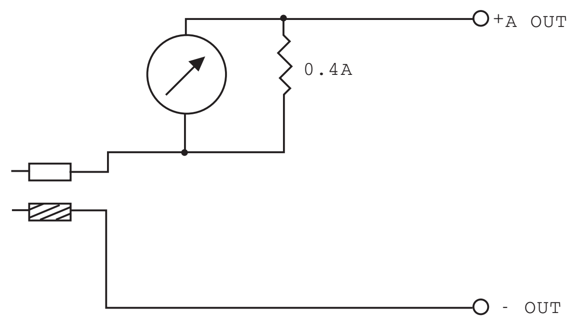
In this experiment, you'll hear the sounds of oscillations by a capacitor. We just experimented on the charging and discharging of a capacitor. This time, we'll study the relationship between oscillation frequencies and capacitors by using 0.005μ and 0.05μ capacitors. Arrange the blocks and earphone as illustrated at left and turn on the power switch. Place the earphone in your ear and listen to the sound of oscillation. Next, change the 0.005μcapacitor to the 0.05μ capacitor as indicated by the arrow on the electroinc board, and you will hear a different tone. This is because the oscillation frequency has changed.

A higher oscillation frequency produces a higher tone and a lower frequency a lower tone. Watch how the meter pointer swings according to the capacitance of the capacitor.

No.133 Electric Current Flowing in Pure and Salt Wat



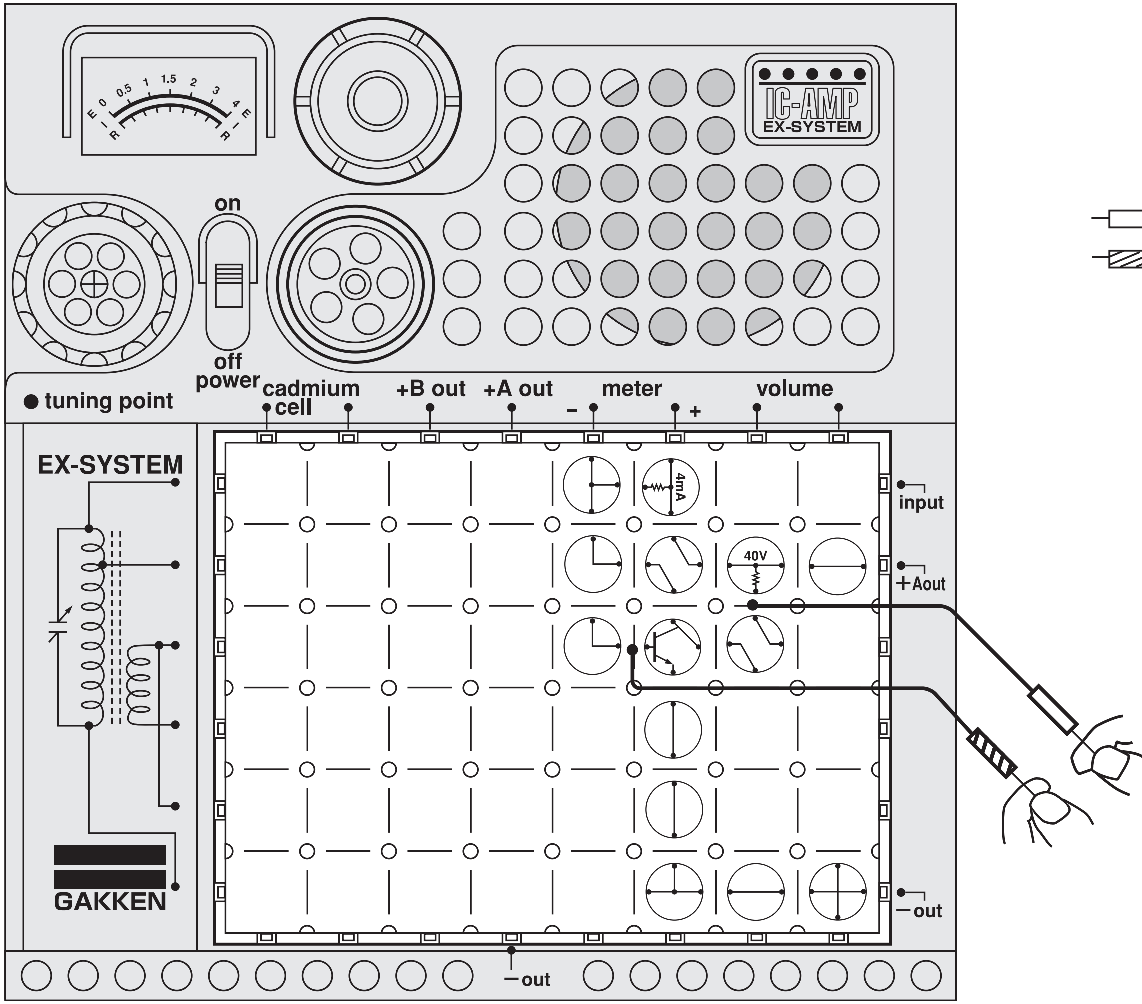
Circuit diagram for this experiment:



Pure water scarcely allows the passage of electric current, but water mixed with some substances is a much better conductor. When you use this phenomenon, you can easily determine how pure water is by passing an electric current through it. Arrange the blocks and connect the tester rods as illustrated at left. Put the tester rods into a glass of tap water and turn on the power switch. The meter pointer will move slightly. Next, add some sugar to the water and measure the current flowing in the circuit. You will find substantial differences in the electrical conductivity of tap water and sugar water.

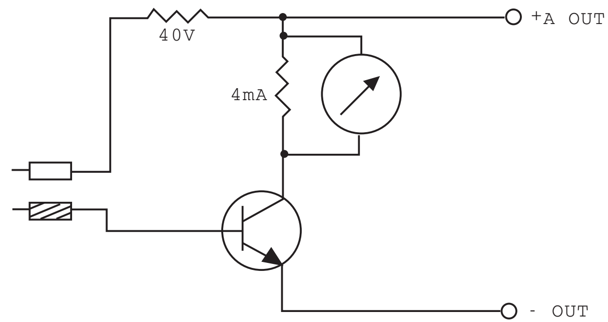
Now repeat the experiment, adding salt to the tap water. Again, you will find a difference in conductivity.

No.134 Meter-type Lie Detector



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:



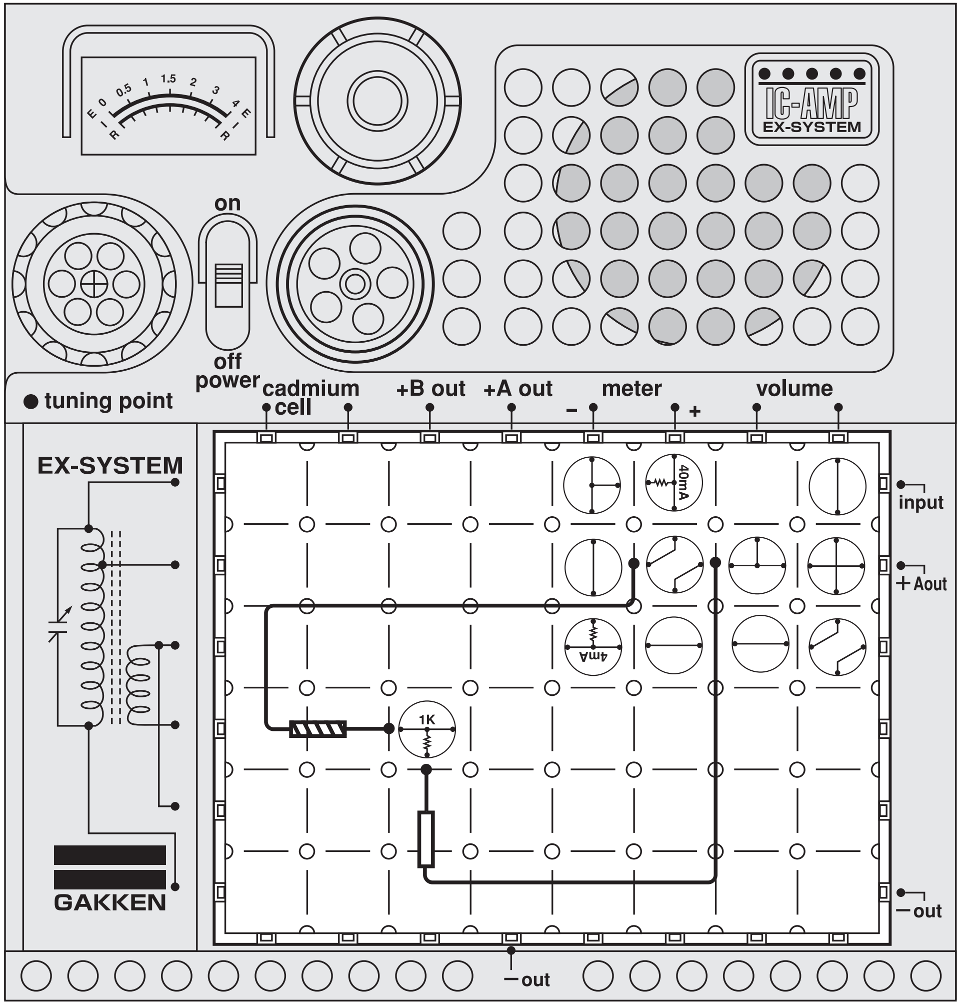
The electrical resistance of our skin changes when we perspire. As in earlier experiments, this phenomenon can be utilized for electronically finding whether a person is telling a lie. For this experiment, you will add the meter to your lie detector device.

Arrange the blocks and connect the black and red tester rods as illustrated at left. Have your friend hold the rods, one in each hand, and ask him or her questions while watching the movement of the meter pointer. Note that the pointer swings differently according to the condition of the skin; that is, according to how moist it is.

Ask your friend to grasp them so that the pointer comes around 1.5.

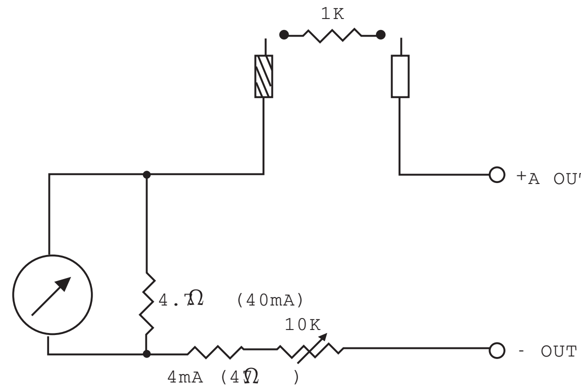
Note: The experiment is only for fun.
Please note that the result is not always reliable.

No.135 2KΩ Range Ohmmeter

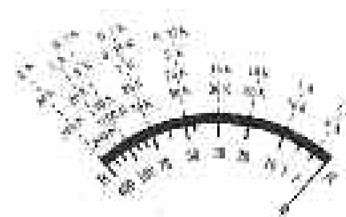


Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

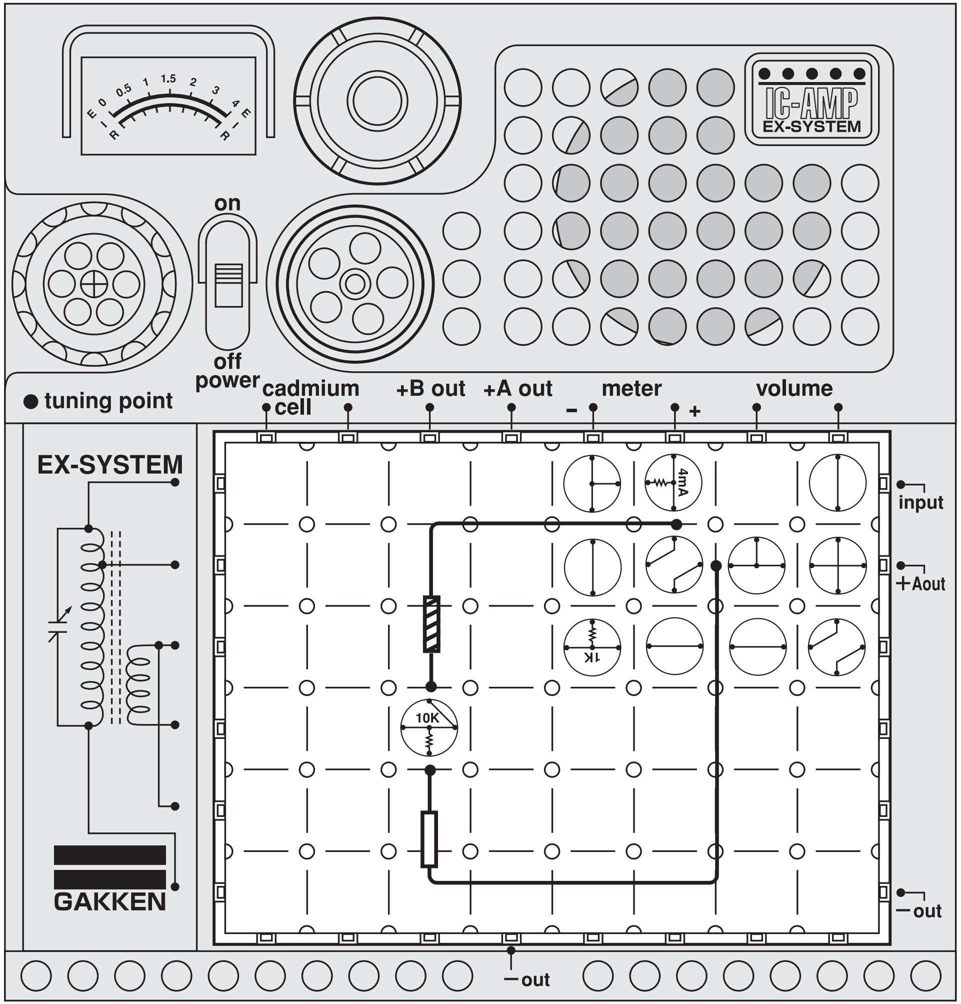
Circuit diagram for this experiment:



In addition to current and voltage, resistance also can be measured by testers. This type of circuit is useful once you learn how to operate it. Arrange the blocks and black and red tester rods as illustrated at left. With the volume control dial turned all the way to the right, turn on the power switch. With the ends of the two tester rods touching each other, slowly turn the volume control dial to the left until the meter pointer comes to 0. Now you can measure an electrical resistance of up to 2KΩ. Test this ohmmeter by measuring 1KΩ Resistance first. Use the 1K block, as shown on the electronic board.
The meter, illustrated below, will read differently when you change the block to 1/10, 1/100, 1/2, and 1/200, according to the ranges you wish to test.

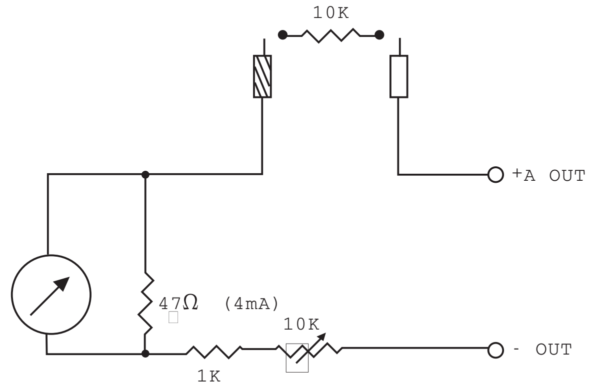


No.136 20KΩ Range Ohmmeter



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

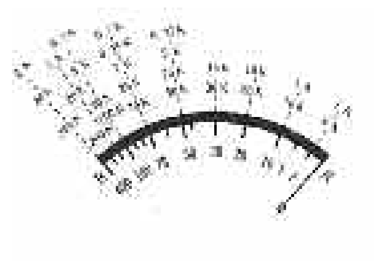
Circuit diagram for this experiment:



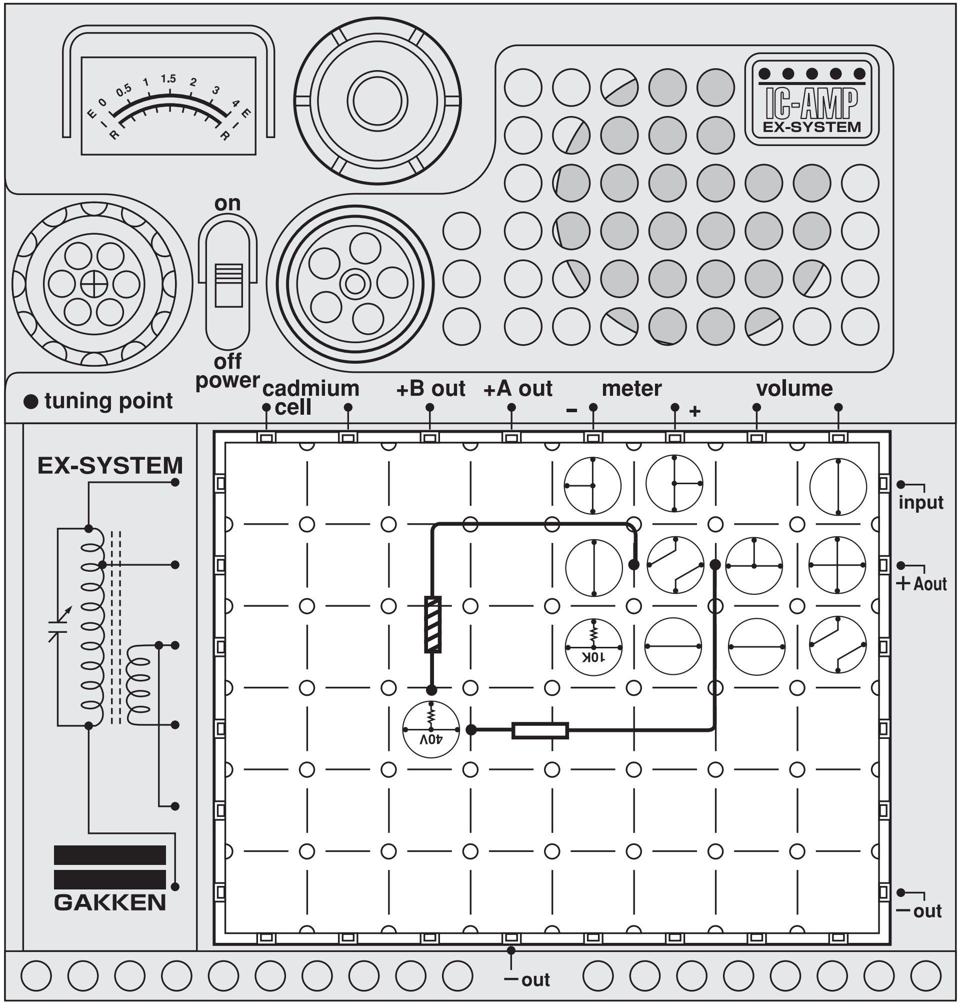
We use different kinds of scales to weigh different kind of things. A bathroom scale, for example, is not the same as a grocery scale. It is also necessary to use different kinds of meters for measuring different electrical resistances. Now let's build a 20KΩ ohmmeter, which is different from the 2KΩ ohmmeter in Experiment No. 135.

Arrange the blocks as illustrated at left and continue as you did on the preceding page. Test the circuit by measuring a 10KΩ resistance.

The meter, illustrated below, will read differently when you change the block to 1/10, 1/l00, 1/2, or 1/2000, according to the ranges you wish to test.

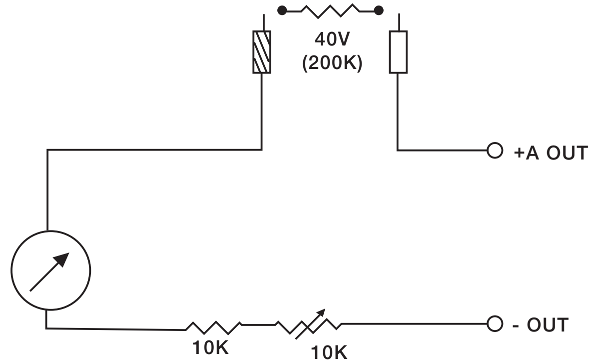


No.137 200KΩ Range Ohmmeter



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

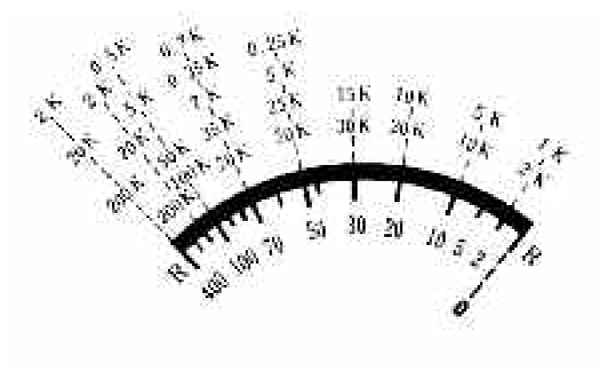
Circuit diagram for this experiment:



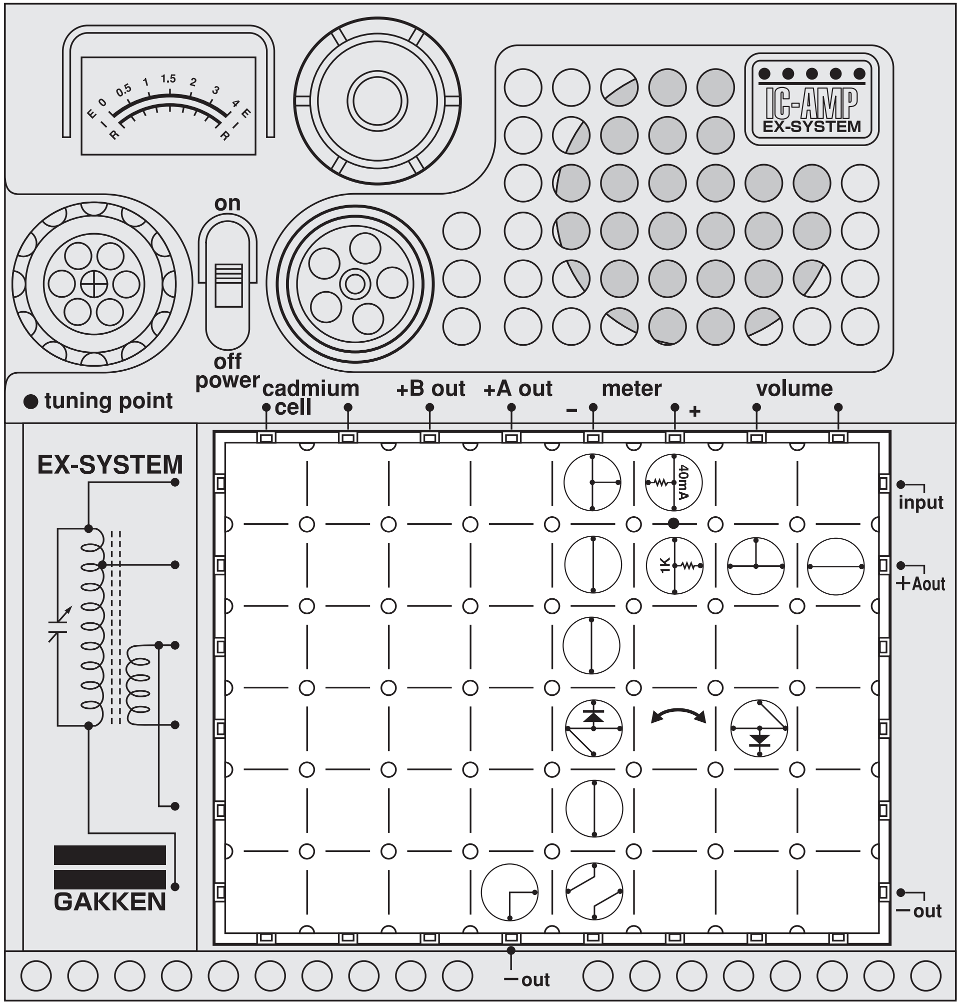
We will build one more ohmmeter. This one can take measurements of up to 200K.

Arrange the blocks as illustrated at left. Continue as for Experiment No. l35. This time, measure a 40V resistance. This block has an 82K resistor in it.

The meter, illustrated below, will read differently when you change the block to 1/10 , 1/100 , 1/2, and 1/20, according to the ranges you wish to test.

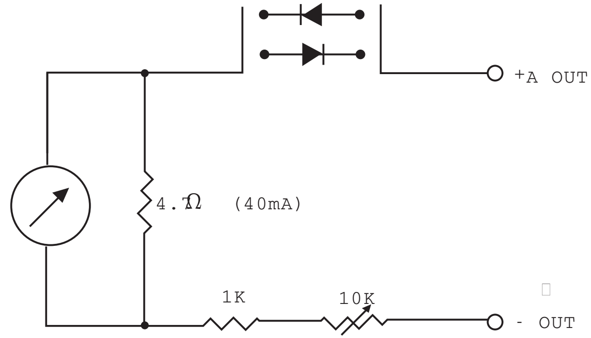


No.138 Diode Tester



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

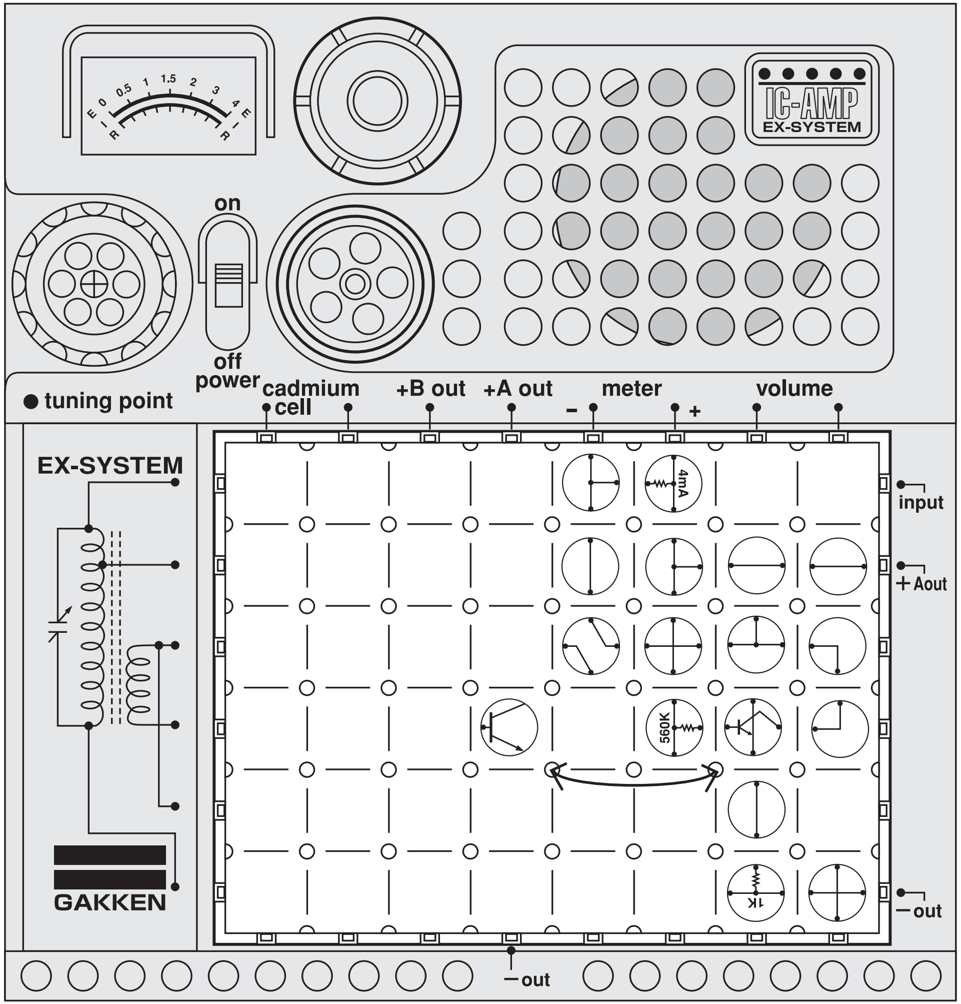


You have so far learned various basic methods of electrical measurement using a meter. Now you will study the practical applications of the knowledge you have gained. First you will do an experiment with a diode tester using the rectifying function of the diode. Other related experiments will follow.

Arrange the blocks as illustrated at left. Turn on the power switch; the meter pointer does not move. invert the diodes as shown by the arrow in the illustration. This time the meter pointer swings to indicate that a current is flowing through the diode. When the meter pointer shifts to this extent, the diode works well.

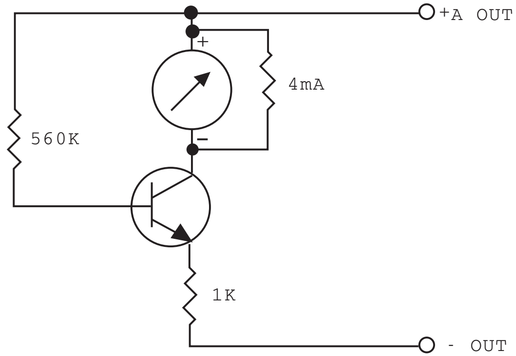
If the meter reads about 0.5, the quality is good.

No.139 Transistor Tester



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:



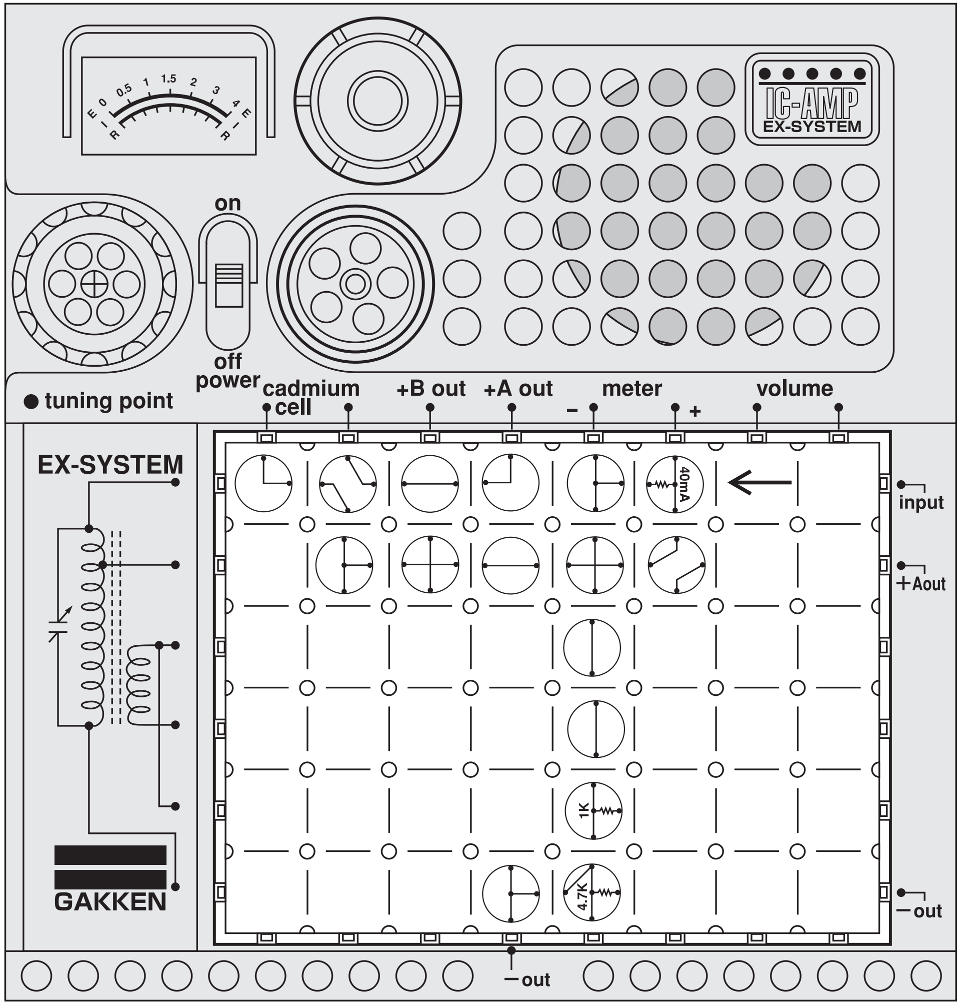
This experiment tests two transistors in one circuit alternately. You will check them one by one to see if they are working properly.

Arrange the blocks as illustrated at left and turn on the power switch. If the meter pointer swings when the power switch is turned on, there is nothing wrong with the first transistor.

Now replace the first transistor with the second one, as indicated by the arrow on the electronic board. What does the meter tell you this time?

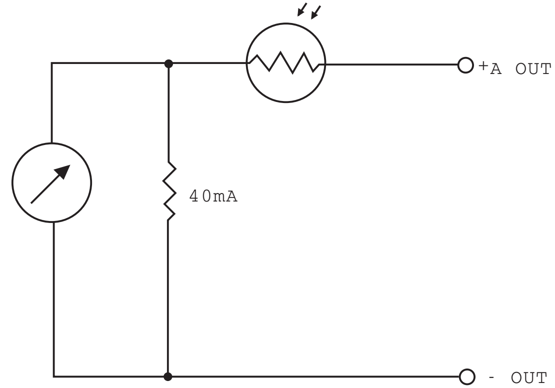
If the meter reads about 1.5, the quality is good.

No.140 Meter-type Illuminometer



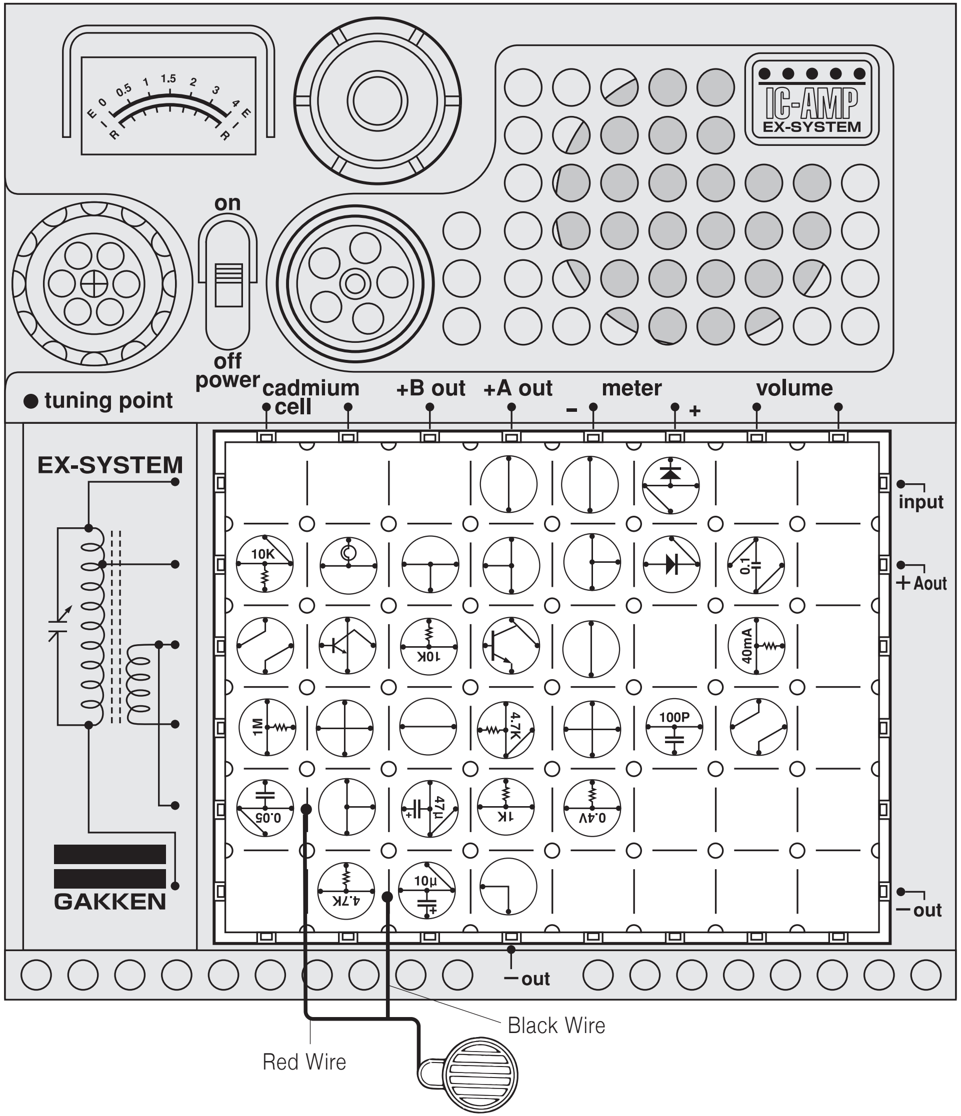
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

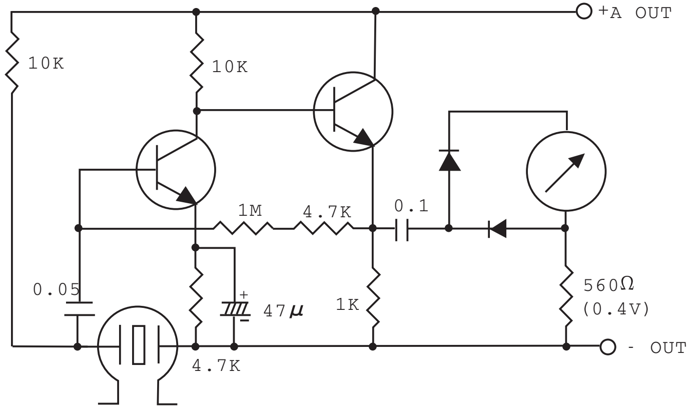


Now you will experiment with a meter-type illuminometer. The intensity of illumination is measured in units called "luxes". With the circuit you are now going to build, you cannot obtain an exact reading of illumination in luxes. You will, however, be able to take approximate measurements by reading the meter.
Arrange the blocks as illustrated at left and turn on the power switch. Take measurements of light intensity in various places under different lighting conditions. You can do so because CdS cell is in this circuit. Use this cell in well-illuminated places. Replace it with in dimmer places, at the point indicated by the arrow on the electronic board.

No.141 Meter-type Sound-Volume Indicator



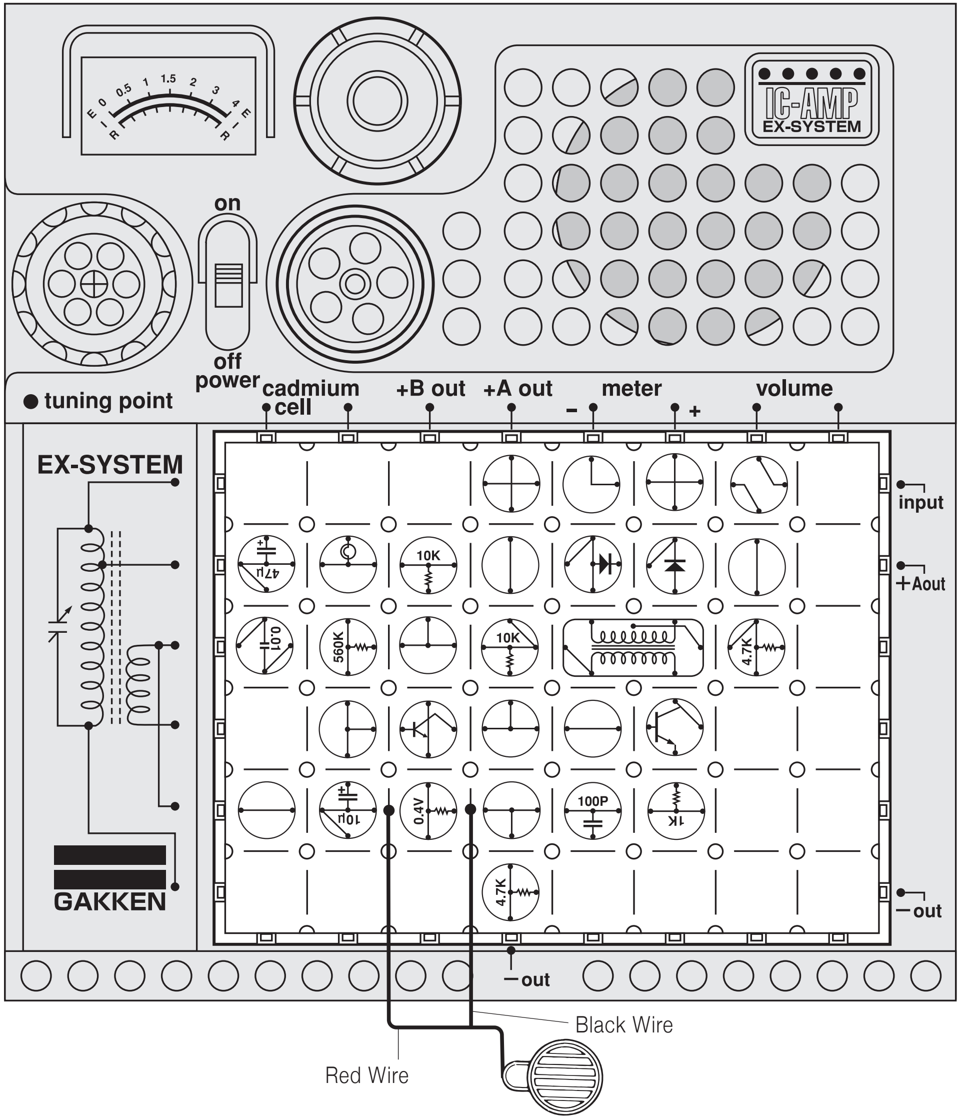
Circuit diagram for this experiment:



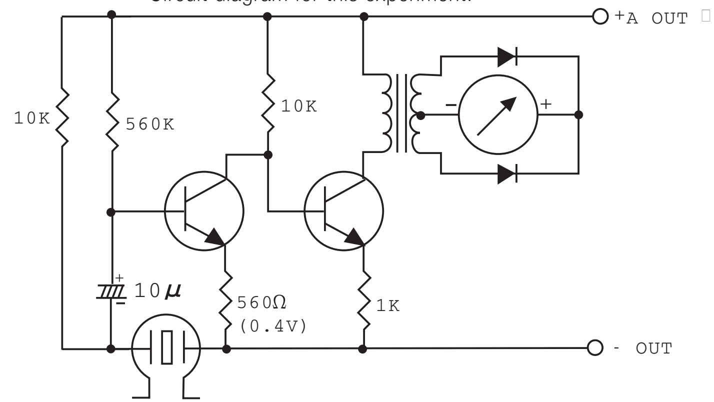
Have you ever heard of the words digital and analog? You may have heard the first word in terms like digital computers, and digital clocks and watches. The "digital" means that the device measures values in digits, or numbers, 0 through 9. The "analog" is used for such devices as ordinary clocks and watches, slide rules and the like. The meter used for this set of electronic blocks is analog. Both systems have their merits and demerits.

Arrange the blocks and connect the microphone as illustrated. Turn on the power switch and speak into the microphone. The sound volume of your voice will be indicated on the meter.

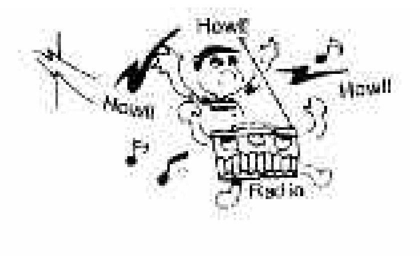
No.142 Noise-Level Meter



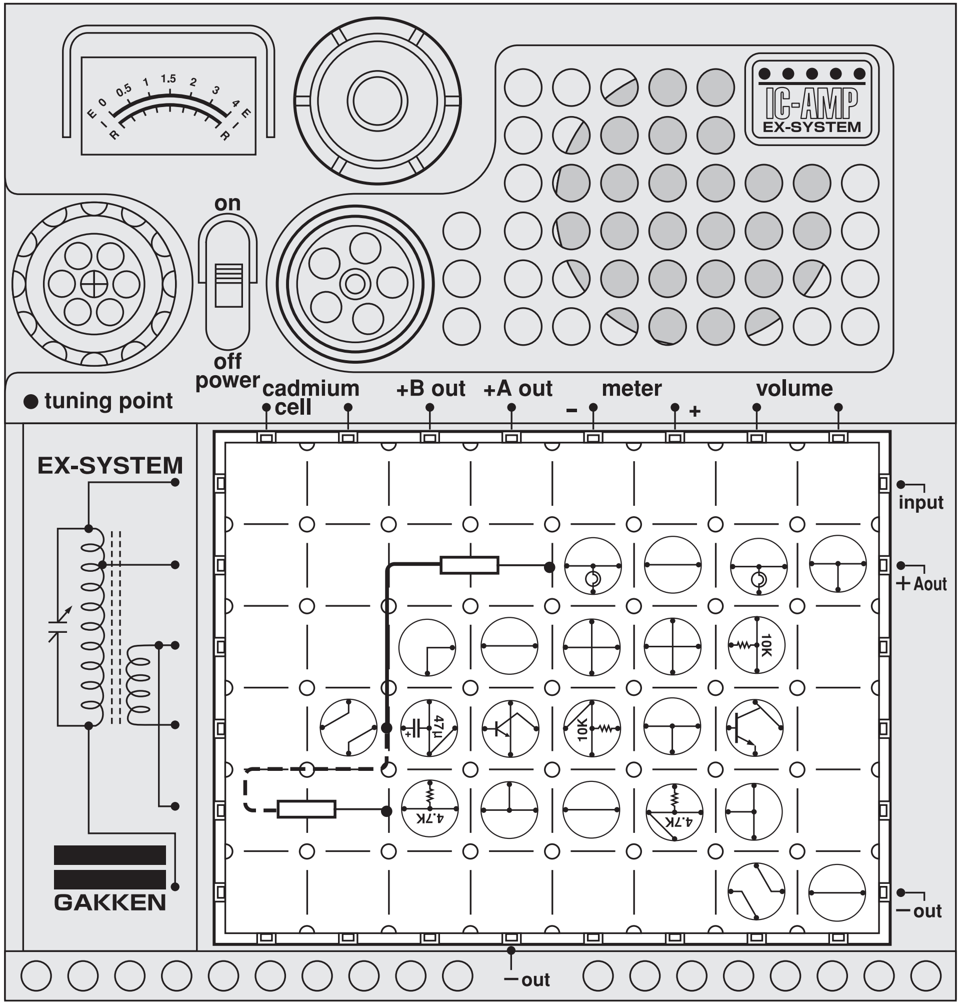
Circuit diagram for this experiment:



Have you ever heard of or read about "decibels" in relation to the noise pollution that is much talked about these days? There are units in which the level of noise is measured. Now let's experiment with a noise level meter circuit using two transistors. Various sounds reach the human ears but the sounds audible to the ear are within a range of frequencies from about 16 cycles to 20,000 cycles and the sound frequencies exceeding 20,000 cycles or below 16 cycles are inaudible to the human ear. An inaudible sound over 20,000 will cause a pain to our ears. It would be fun to measure the noise level in your neighborhood.

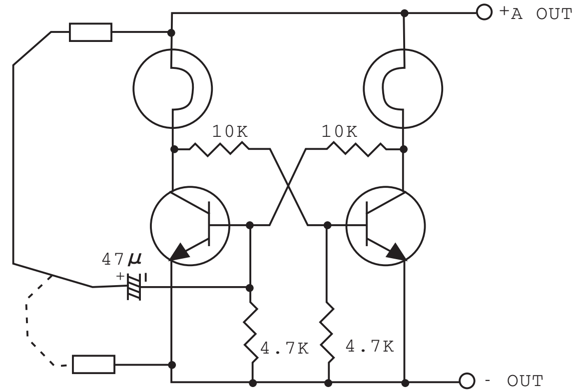


No. 143 Flip-FIop Circuit with Two Lamps



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

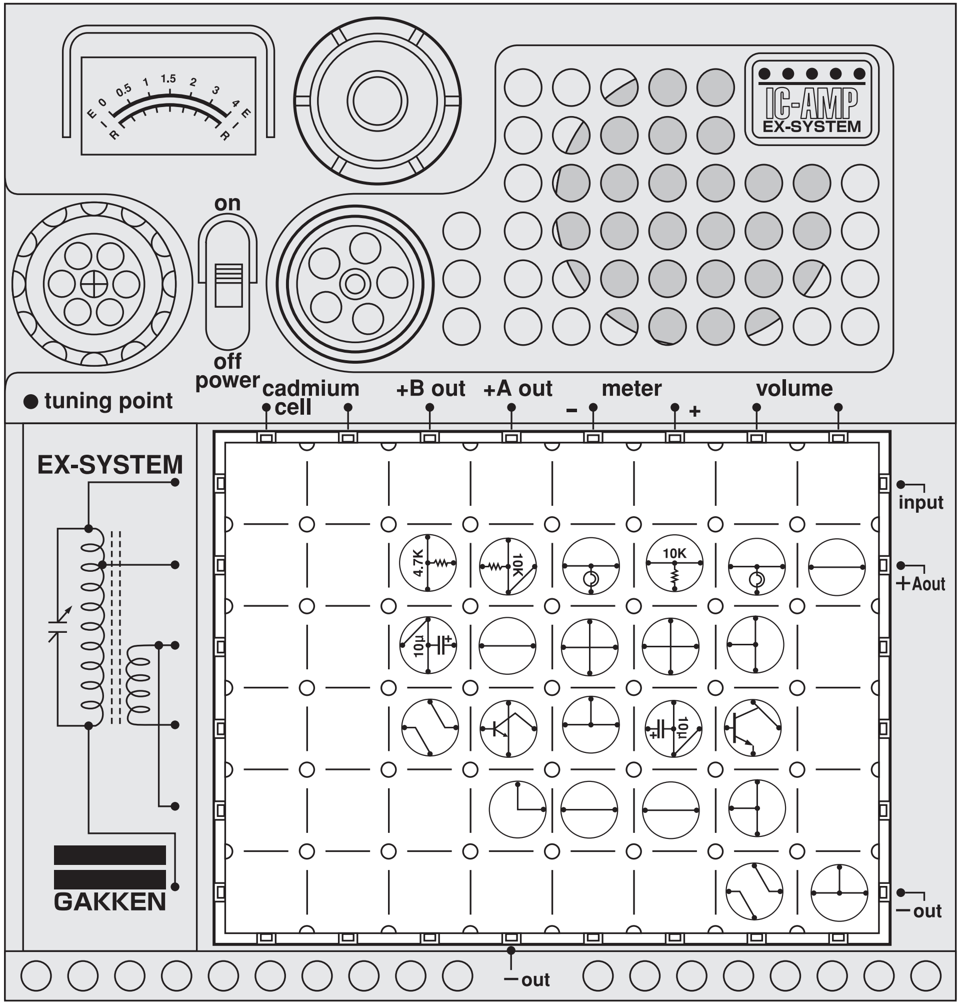
Circuit diagram for this experiment:



This is a circuit that uses two tamps to test two transistors which works as memories. It is the same type of circuit found in electronic calculators. When a calculator key is depressed once, the circuit memorizes the instruction until a calculation is finished. You will now set the circuit for this experiment to memorize two instructions.

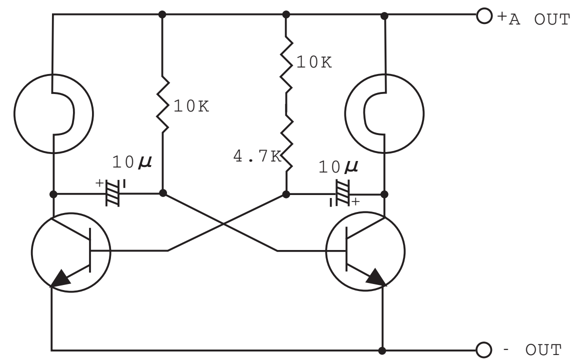
Arrange the blocks as illustrated at left and turn on the power switch. Connect the white tester rod as indicated by the solid line and one lamp will go on and stay on after the tester rod is disconnected. Now connect the tester rod as indicated by the broken line. The other lamp will glow and stay on in a similar way.

No.144 Two Lamps Alternating On and Off



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

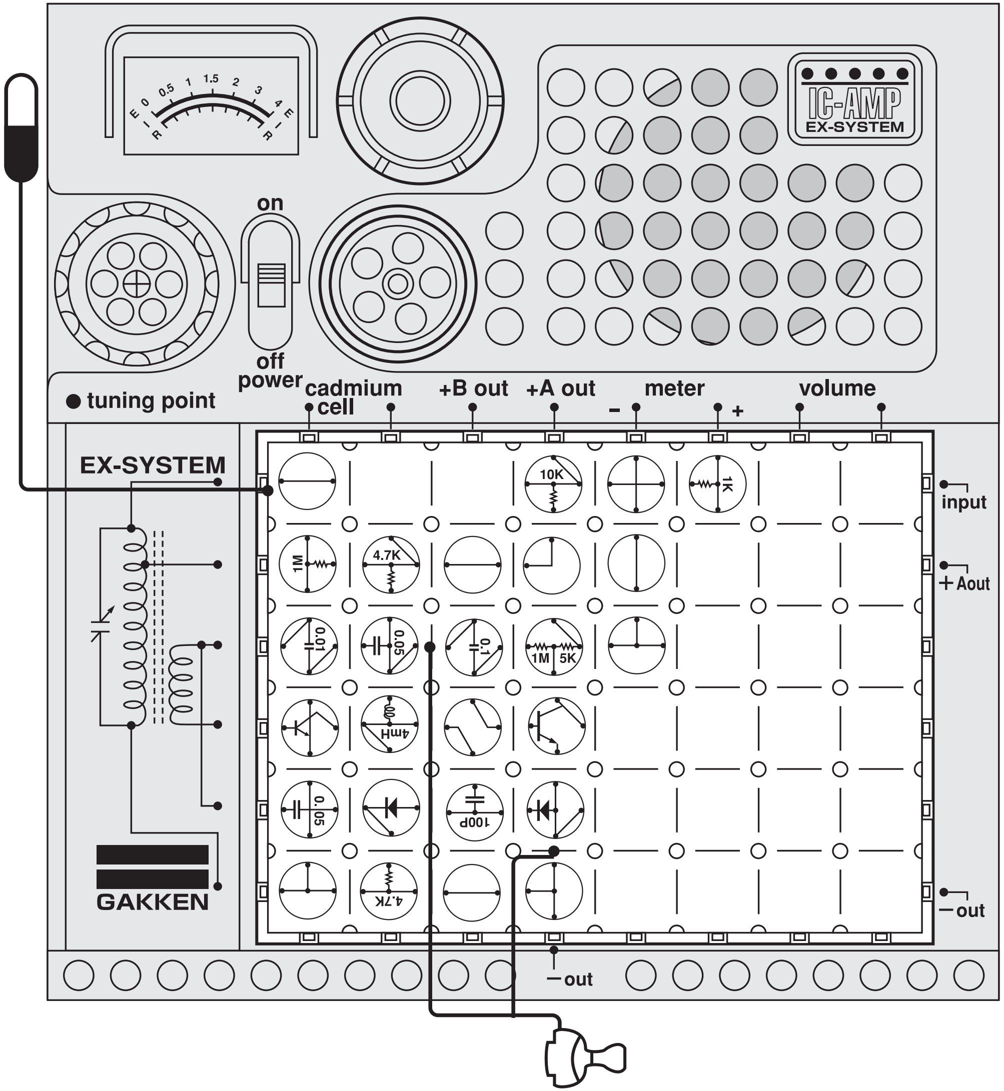
Circuit diagram for this experiment:



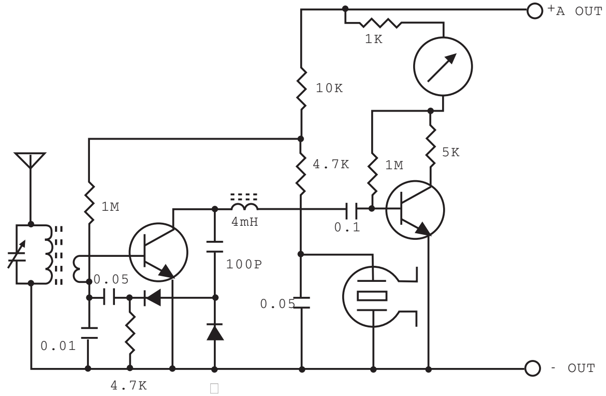
Now we will experiment with an interesting circuit using two lamps that alternately go on and off like a railway crossing warning signal. Arrange the blocks as illustrated at left. Turn on the power switch and the two lamps will alternately go on and off.

No. 145 Field Strength Meter

Antenna ●Dangerous! Do not insert antenna lead into an AC outlet.



Circuit diagram for this experiment:



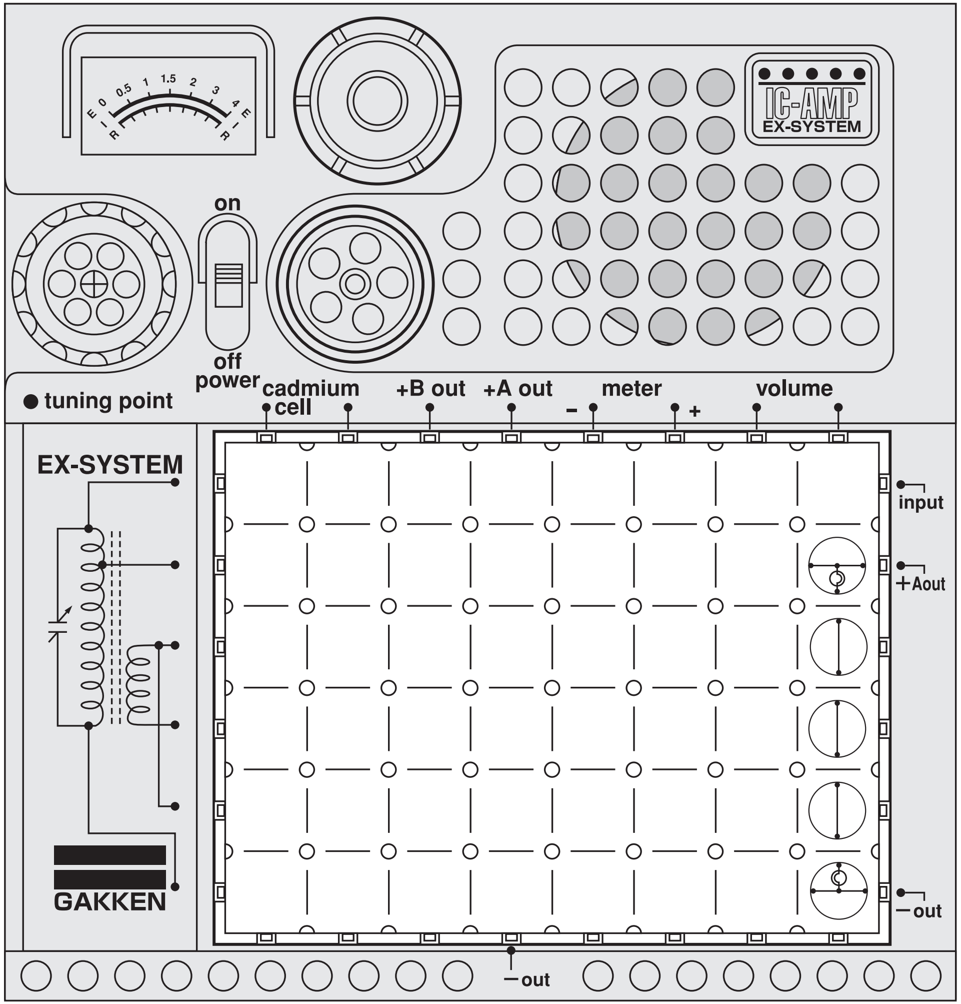
Now let's build a circuit for measuring the strength of an electric field by reading the strength of radio waves on the meter. This device will be useful in checking to see if an antenna is correctly positioned.

Arrange the blocks and connect the earphone as illustrated at left. Place the earphone in your ear and turn on the power switch. Change the position of the antenna. The meter pointer will swing toward 0 as an electric field get stronger. You will be able to hear the sound changing with the field strength, along with a high-pitched note, which is a little oscillation that this circuit produces.

Now point your radio or TV antenna in the direction where it will work with the greatest efficiency; that is, where the greatest field strength lies.

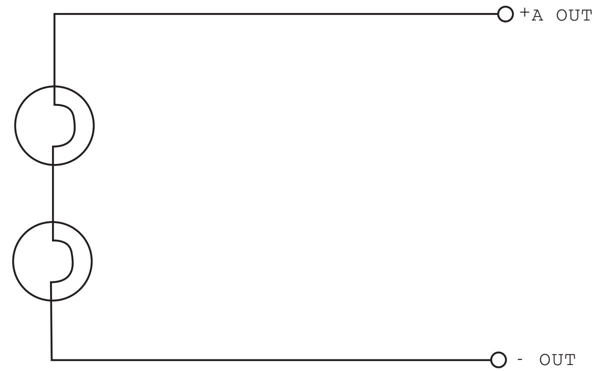
<Regarding the meter>
When the meter reads 4, the electric field is most feeble and gets stronger as it comes near to 0. Regard 4 as the lowest scale and 0 as the highest one.

No. 146 Series-connected Lamps



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

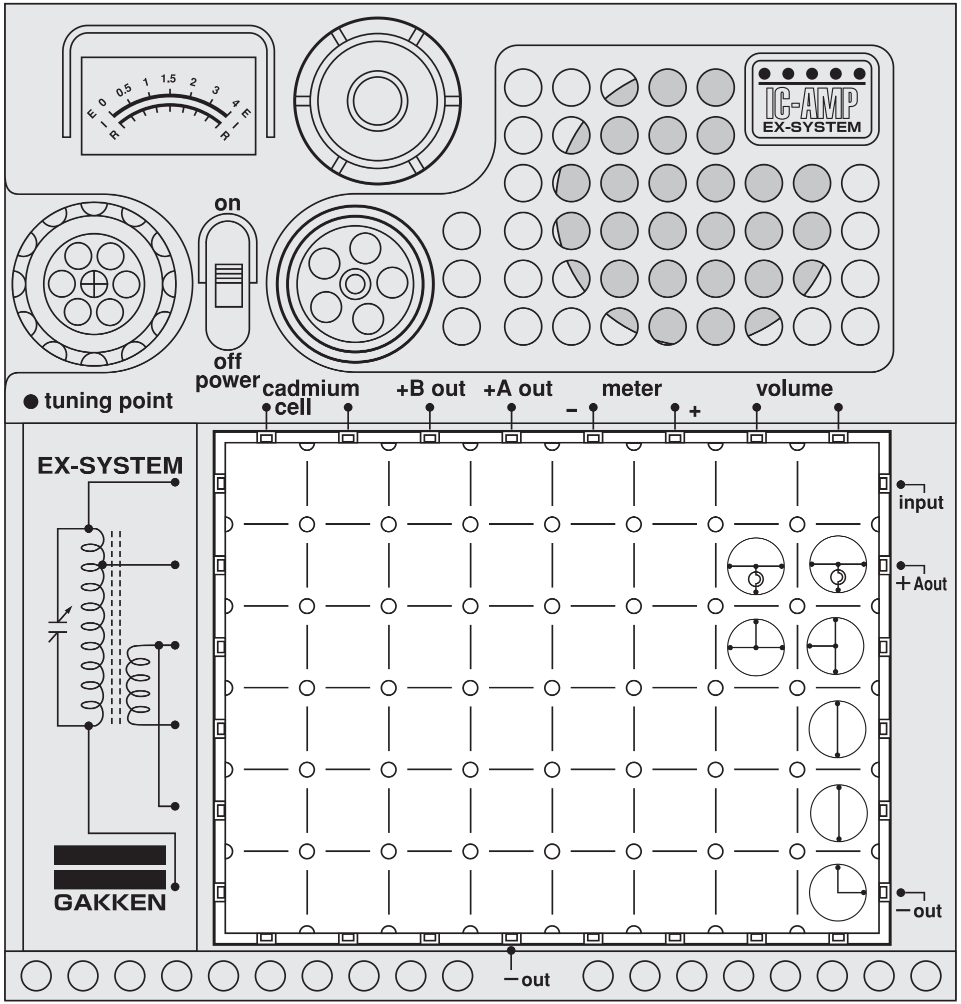


We have previously experimented with series-connected and parallel-connected batteries. Now we are going to do two experiments with series-connected and parallel-connected lamps.

Arrange the blocks as illustrated at left. Turn on the power switch and the lamps will go on.

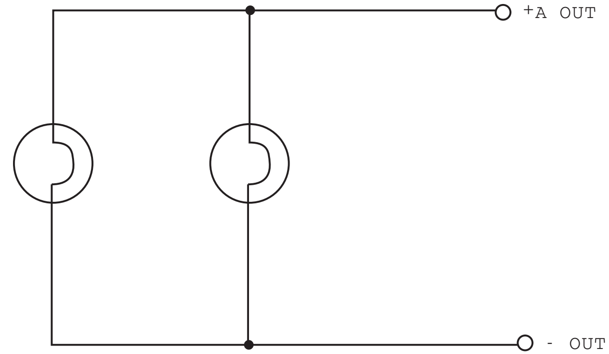
In this experiment, the lambs are connected in series. They glow but not so brightly as in the case of the parallel-connected lamps in the next experiment.

No. 147 ParaIIeI-connected Lamps



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

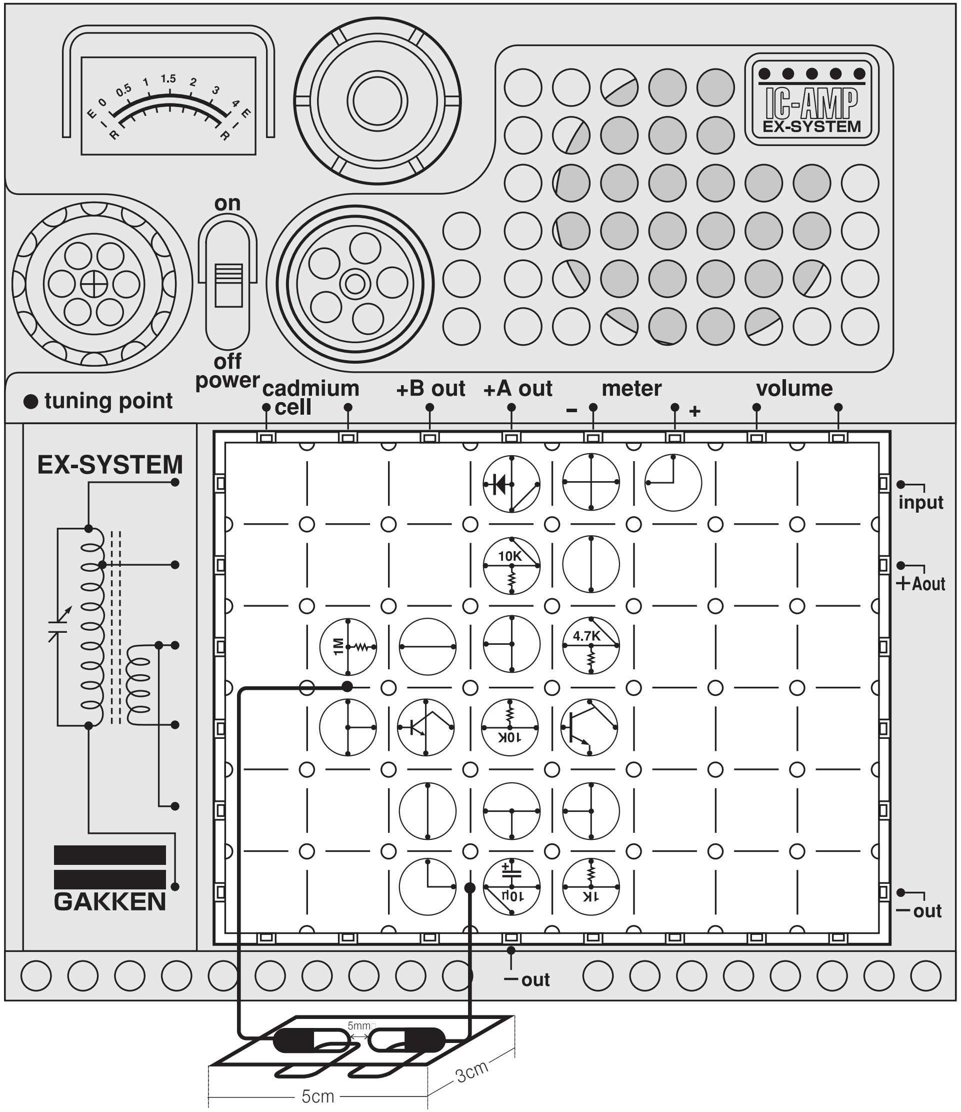
Circuit diagram for this experiment:



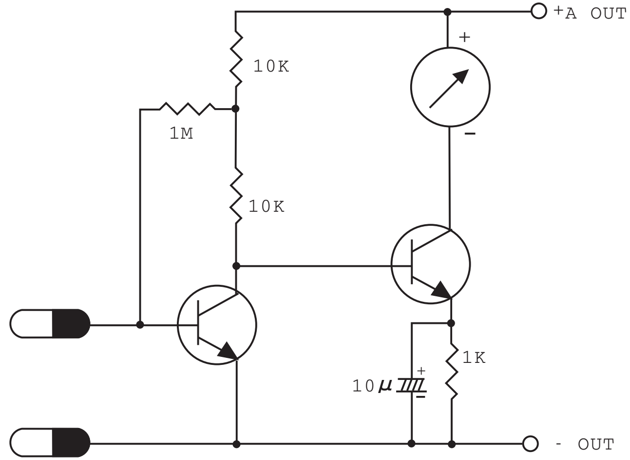
This is an experiment with parallel-connected lamps. Arrange the blocks as illustrated at left and turn on the power switch. The lamps will glow brightly.

There are various ways of making connections for simple circuits like the ones you built in this and the previous experiment. Repeat them until you have a clear understanding of electrical wiring connections.

No.148 Meter-type Hygrometer



Circuit diagram for this experiment:

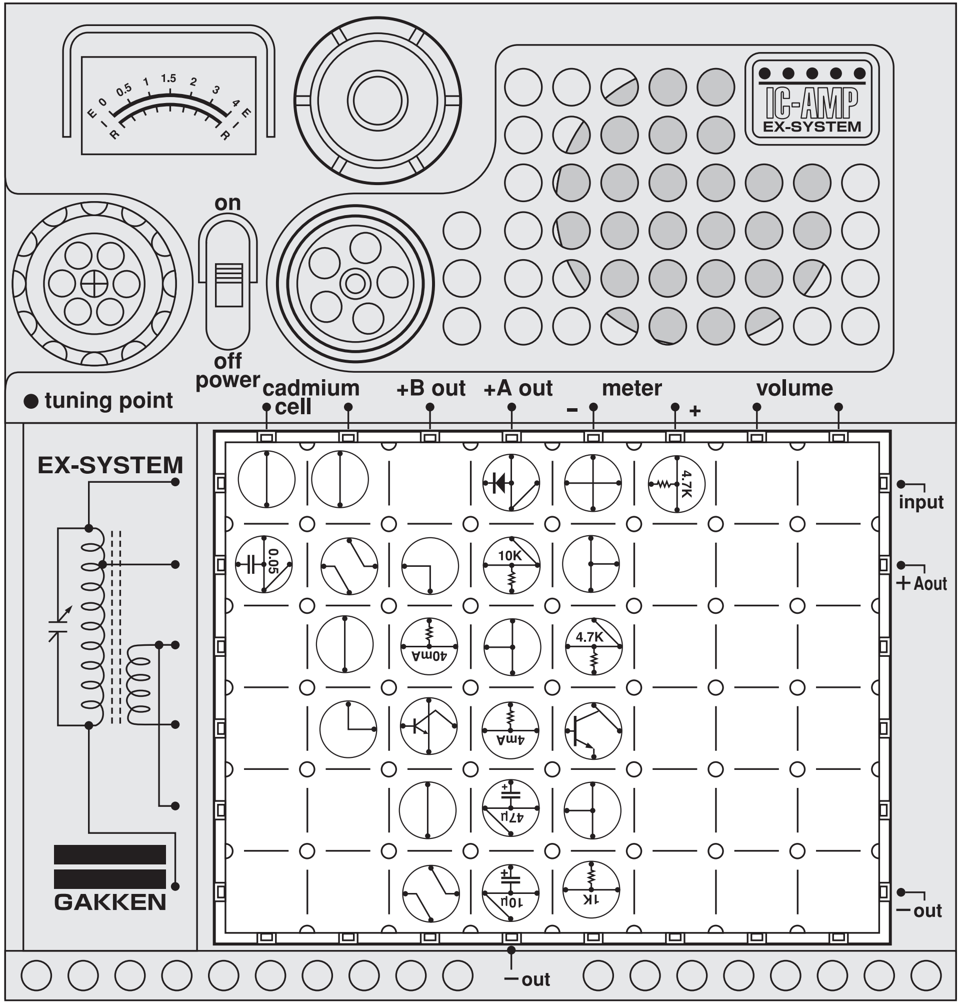


Do you know what a hygrometer is? It is a device that measures humidity. Let's make an electronic hygrometer that will indicate the humidity level on the meter.

First, dissolve two spoonfuls of salt in a glass of water. Dip a piece of drawing paper (about 3cm x 5cm) in the water saturated with salt and place the paper where it can dry. When it is dry, arrange the blocks and connect the 60cm cords as illustrated at left. Fasten the ends of the cords to the paper with paper clips, as illustrated. Turn on the power switch and spray water on the paper. Then you will see the meter pointer move, measuring the water content of the paper. Spray on more water and see it move again.

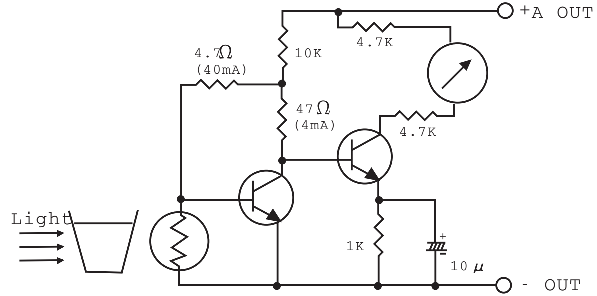
If possible, now locate a nonelectrical hygrometer. Make a scale for the electrical one by comparing them.

No.149 Meter-type Transparency Indicator



Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

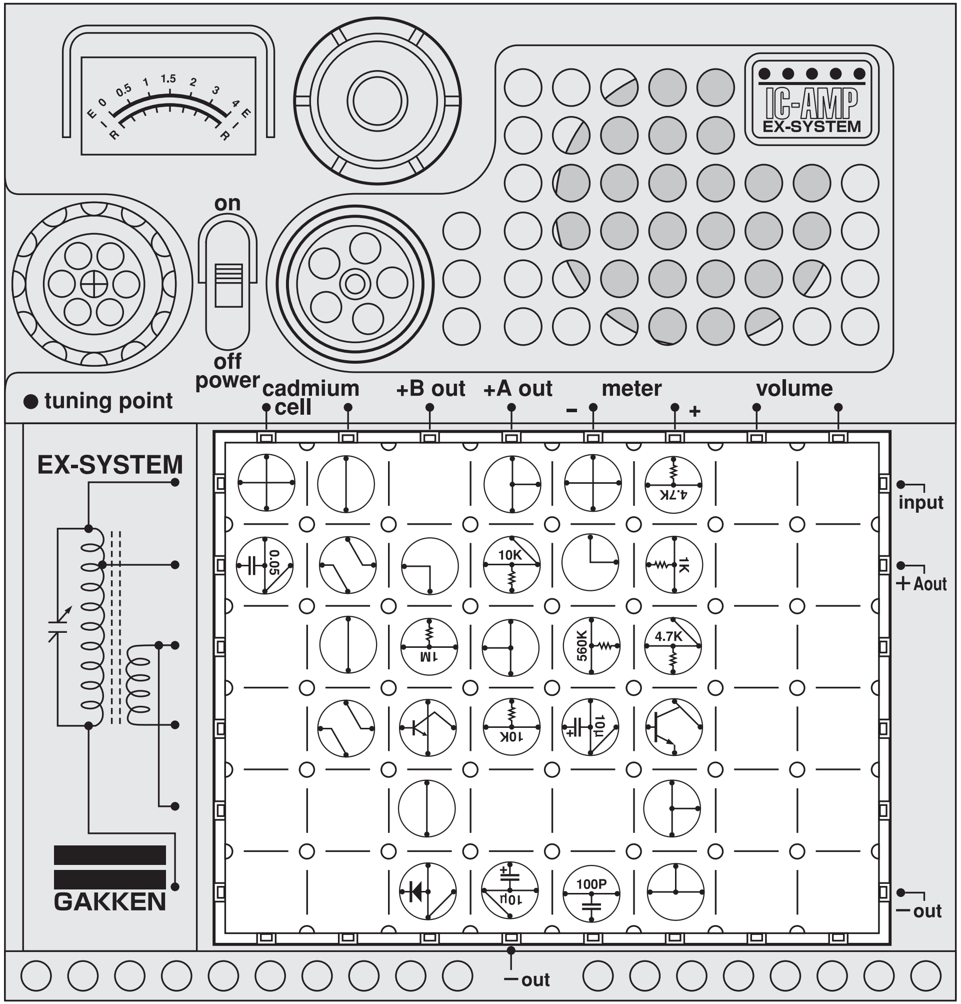


You have already learned that the CdS cell changes its electrical resistance according to the intensity of light falling on it. Here we will build a circuit using the CdS cell for measuring the transparency of water and some other substances.You will need a flashlight for this experiment.

Arrange the blocks as illustrated at left. Position the kit upright. Place a glass of water in front of the CdS cell and shine the flashlight on the cell through the water. Watch the movement of the meter pointer.

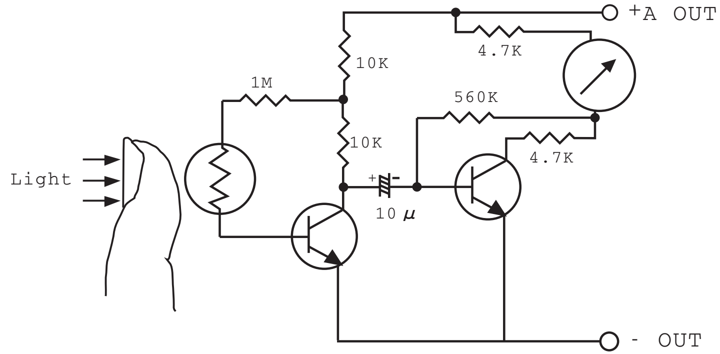
Similar tests now should be made with substances such as window glass and plastics.

No.150 Finger Pulse Detector



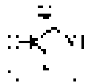
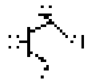
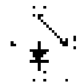
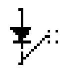
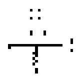
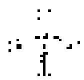
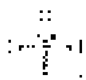
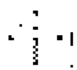
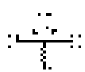
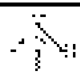
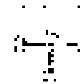
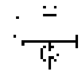
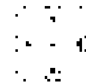
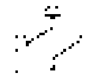
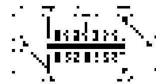
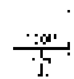
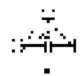
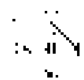
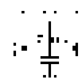
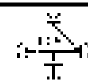
Caution : Follow the diagram for block placement exactly when you do this experiment. If you do not, the blocks may be damaged. Check to see that the four 1.5 volt batteries are in place before you begin.

Circuit diagram for this experiment:

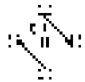
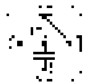
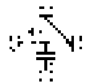
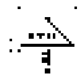
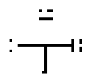
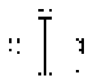
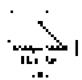
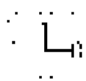
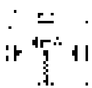
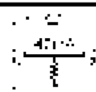


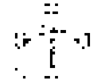
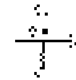
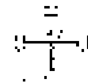
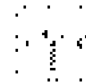
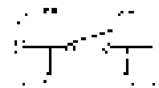
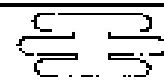
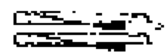
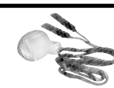
A finger pulse detector measures the pulse of blood. Now we will build a circuit for this useful device. You will need a flashlight for this experiment.
Arrange the blocks as illustrated at left and turn on the power switch. Lightly put your finger on the CdS cell and shine a flashlight on it from above. You will see the meter pointer swing slightly with your pulse.

★EX-150 PARTS LIST★

	PATRTS	BLOCKS	STANDARDS	NUMBER
1	TANSISTOR STR-E		the equivalent of 2SC372Y	1
2	TANSISTOR STR-C		the equivalent of 2SC945Q	1
3	GERMANIUM DIODE SD-X STR-E		the equivalent of 1S426	1
4	GERMANIUM DIODE SD-V STR-E		the equivalent of 1S426	1
5	RESISTOR SRT-1M		1/4W 1KΩ	1
6	RESISTOR SRT-560K		1/4W 560KΩ	1
7	RESISTOR SRT-10K		1/4W 10KΩ	1
8	RESISTOR SRX-10K		1/4W 10KΩ	1
9	RESISTOR SRT-4.7K		1/4W 4.7KΩ	1
10	RESISTOR SRX-4.7K		1/4W 4.7KΩ	1
11	RESISTOR SRT-1K		1/4W 1KΩ	1
12	LAMP ST-LP		LAMP	2
13	LEAD S-I'			2
14	LEAD S-L'			2
15	TRANSFORMER S2P-T		8K : 3K	1
16	CAPACITOR SCT-100P		50V 100PF	1
17	CAPACITOR SCZ-0.005		50V 0.005μF	1
18	CAPACITOR SCZ-0.01		50V 0.01μF	1
19	CAPACITOR SCI'-0.05		50V 0.05μF	1
20	CAPACITOR SCX-0.05		50V 0.05μF	1

★EX-150 PARTS LIST★

	PATRTS	BLOCKS	STANDARDS	NUMBER
21	CAPACITOR SCZ-0.1		50V 0.1μF	1
22	CAPACITOR SCX-10μ		10V 10μF	2
23	CAPACITOR SCX-47μ		10V 47μF	1
24	COIL(CHOKE) SLX-4		4mH	1
25	LEAD S-T			4
26	LEAD S-I			4
27	RESISTOR SRX-1M-5K		1MΩ 5KΩ	1
28	S-L			2
29	RT-4mA		1/4W 5KΩ	1
30	RT-40mA		1/4W 4.7Ω	1

	PATRTS	BLOCKS	STANDARDS	NUMBER
31	RT-0.4A		1/2W 0.5Ω	1
32	RT-0.4V		1/4W 560Ω	1
33	RT-4V		1/4W 8KΩ	1
34	RT-40V		1/4W 80KΩ	1
35	SWITCHES			1
36	EARPHONE			1
37	ANTENNA		5m	1
38	CLIP			1
39	60cm CORD			1
40	TESTER ROD S-TCD			1
41	MICROPHONE			1

* Beyond that, there is a ENAMEL CODE for extension.