Gakken PRESENTS

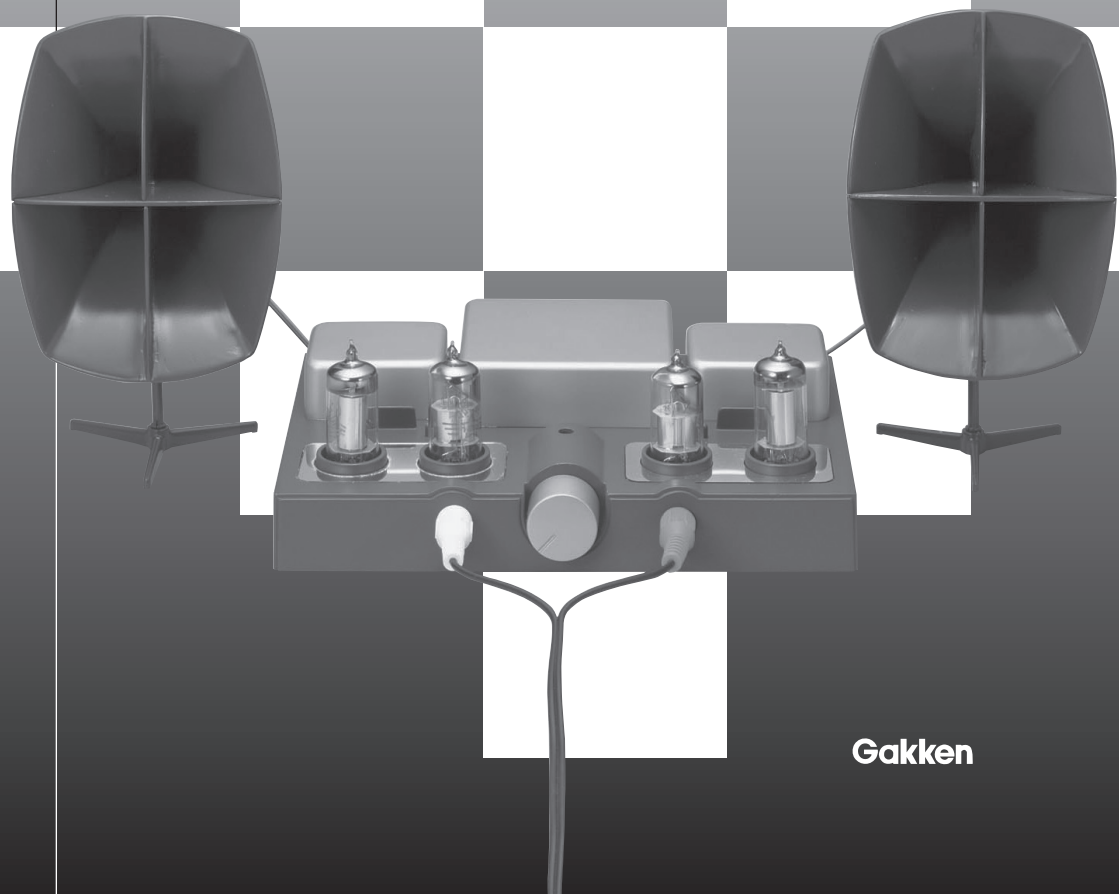
Otona no Kagaku

(Science for Adults)

Product Version

Vacuum Tube Amplifier

Instructions for Assembly and Operating

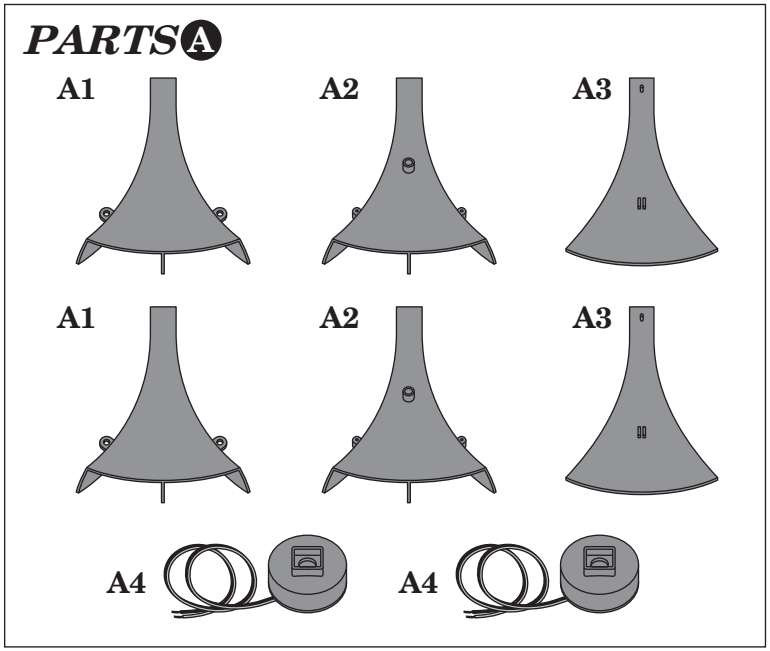


Gakken

Parts List Vacuum Tube Amplifier

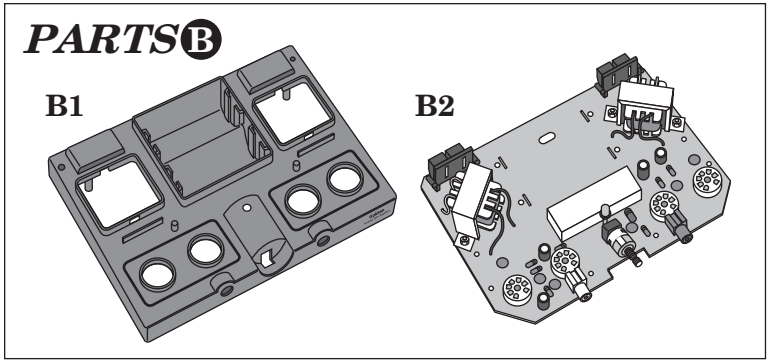
PARTS A

A1: Horns (top) (2)
A2: Horns (bottom) (2)
A3: Partition plates (2)
A4: Speakers (2)



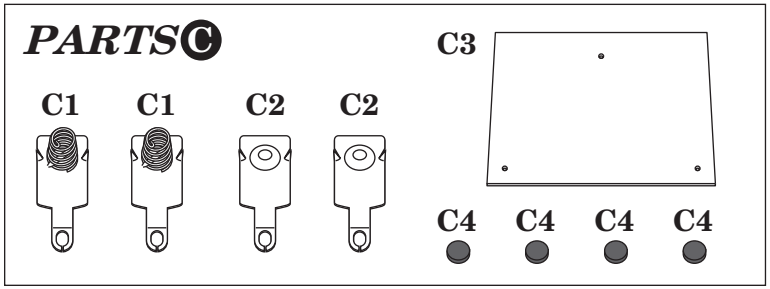
PARTS B

B1: Main unit
B2: Printed circuit board



PARTS C

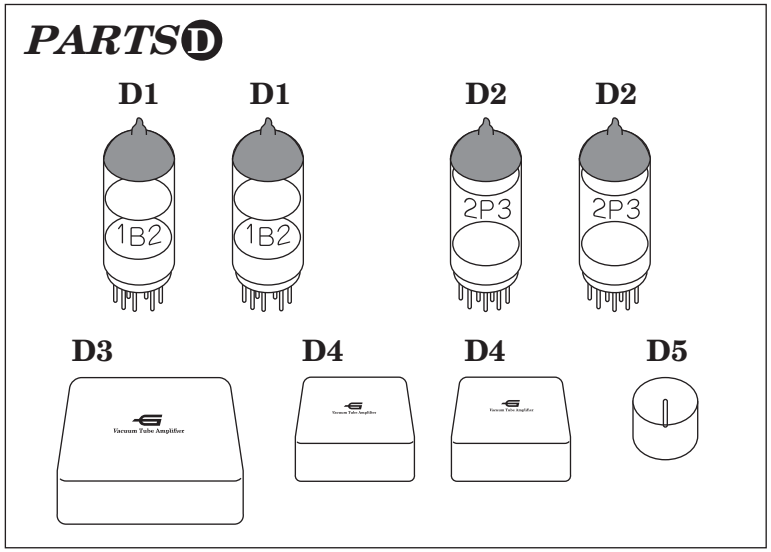
C1: Battery contacts (negative) (2)
C2: Battery contacts (positive) (2)
C3: Back cover
C4: Rubber pads (4)



NOTE: The actual shapes of some parts may differ from the illustrations above.

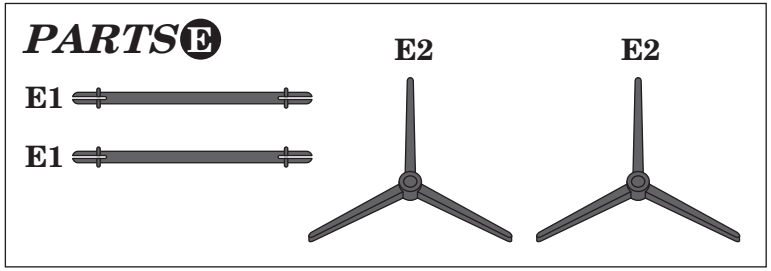
PARTS D

D1: Vacuum tubes (1B2/blue) (2)
D2: Vacuum tubes (2P3/yellow) (2)
D3: Battery box cover
D4: Output transformer covers (2)
D5: Volume knob



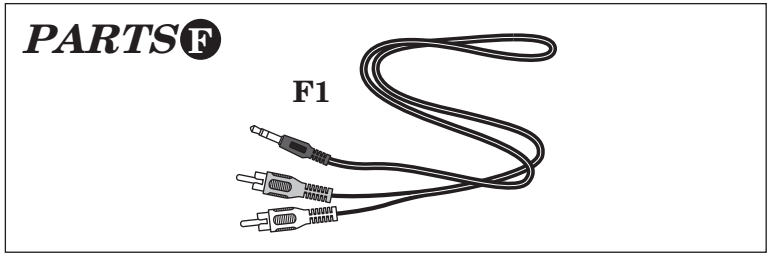
PARTS E

E1: Support posts (2)
E2: Tripods (2)



PARTS F

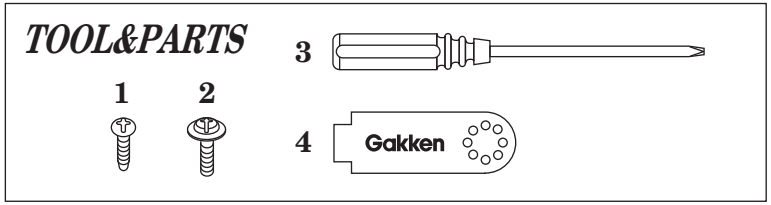
F1: Audio cable



TOOL&PARTS

1: Screw
2: Washer head screw
3: Screwdriver
4: Pin straightener

CAUTION: The kit may contain more screws, etc. than actually required, for use as spares.



⚠ CAUTION * Please read the following instructions before assembling this kit.

☒ The vacuum tubes are made of glass. Take necessary caution when handling them. There is a risk of injury.
☒ For best performance, the fixtures are made of thin metals. Take necessary caution when handling them. There is a risk of injury.
☒ The tip of a vacuum tube is sharply pointed. Take necessary caution when handling them. There is a risk of injury.
☒ There are small parts included in the kit. Be careful not to swallow them. There is a risk of suffocation.

Two D dry cells are used. Incorrect use of the batteries may cause the generation of heat, explosions or liquid leakage. The following precautions should be taken.
☒ To avoid heater problems, do not use Oxyride batteries.
☒ Do not use NiCd and other rechargeable batteries. With such batteries, the amplification process may not operate properly.
☒ Ensure that the positive and negative terminals of the batteries are aligned correctly.
☒ If liquid that leaked from batteries gets into your eyes, rinse it well with plenty of water and consult a doctor immediately. If liquid leaks onto your skin or clothes, immediately wash it off.
☒ When the amplifier is not used for a long time, have the batteries removed.

☒ Please read the instructions and cautions thoroughly before use.
☒ For your safety, be sure to follow the instructions in this manual. In addition, do not use any parts that have become damaged or deformed during use.
☒ Store the kit in a location out of the reach of small children.

● Plastic materials used in this kit
Main unit, cover, horn, support post, screwdriver handle, etc.: ABS
* Vinyl chloride resin is used in the lead wire cover.
* Please dispose of this product in accordance with local regulations.

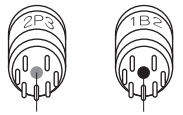
Before Assembling the Kit

1. About the vacuum tube

A. The vacuum tubes in this kit were manufactured in China, more than 30 years ago. They may have some scratches and smudges. However, they will perform well. (We do not accept returns of scratched or dirty vacuum tubes. Tubes that do not work will be exchanged.)
B. There are two types of vacuum tubes. If it is too dirty to tell what type it is, you can identify it by the color on the bottom of each vacuum tube.
C. Vacuum tubes are fragile. Please handle them carefully.

How to identify a vacuum tube

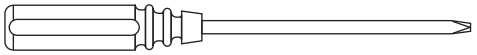
If the printed characters are too faint to read, go by the color on the bottom of the vacuum tube.



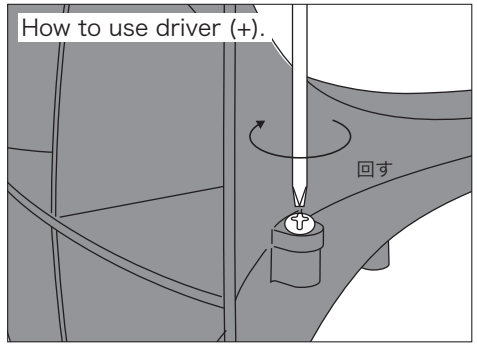
Yellow Blue

2. Using the supplied tool

●Screwdriver (Phillips)



The screwdriver is used when tightening a screw.
* The screws in this kit are “tapping screws” that carve grooves into the material as they are inserted.



3.Other required items

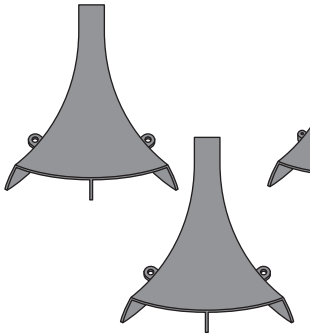
Two D alkaline batteries

* NiCd rechargeable batteries or Oxyride batteries cannot be used instead of D alkaline batteries.
* The “Speaker sound experiment” and “Circuit modification experiment” require other items (see pages 12 and 14.)
* Note: In some cases, the shape and the length of materials may differ somewhat from the photographs and illustrations provided in this manual.

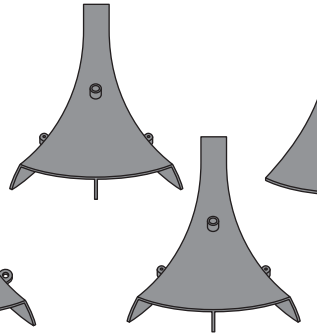
1 Assembling the Horns

Parts to be used *PARTS* A

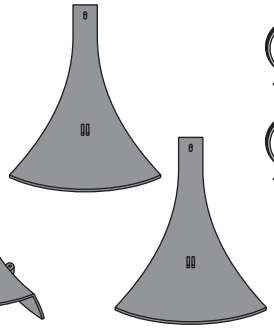
A1: Horns (top) (2)



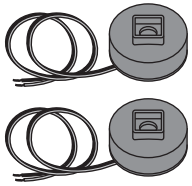
A2: Horns (bottom) (2)



A3: Partition plates (2)



A4: Speakers (2)



Screws (4)

Figure-(1)
Insert an A3 partition plate between an A1 horn (top) and an A2 horn (bottom).
When doing so, insert the pins on the partition plate into the A1 horn (top) and the A2 horn (bottom).
Make two sets.
After that, secure them with screws.

(1) Assemble two sets of horns.

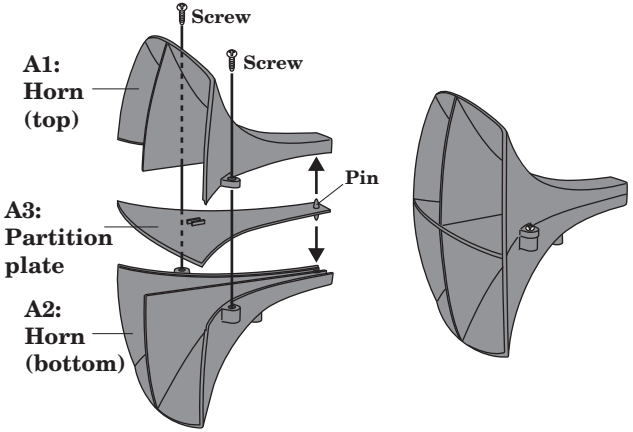
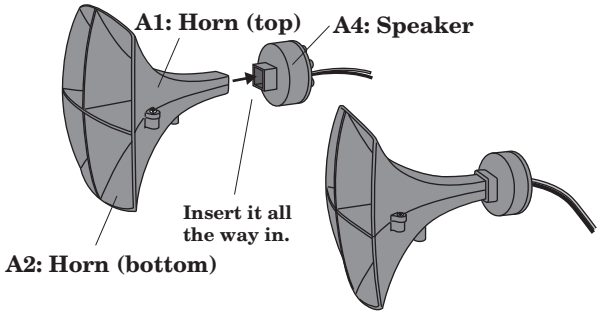


Figure-(2)
Attach the A4 speakers to the two sets of horns assembled in Figure-(1).

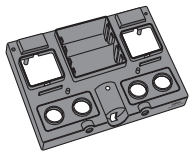
(2) Attach the A4 speakers to the horns.



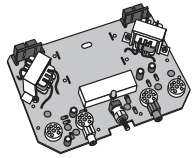
2 Assembling the Main Unit

Parts to be used *PARTS* B

B1: Main unit



B2: Printed circuit board



Screws (8)

Figure-(3)
Align the RCA terminal on the B2 printed circuit board with the volume. While using caution not to break the pilot light, install the B2 printed circuit board into the B1 main unit.

How to install the B2 printed circuit board

Align the RCA terminal, the volume, and the pilot light with the holes on the B1 main unit, and then fit it into the B1 main unit.

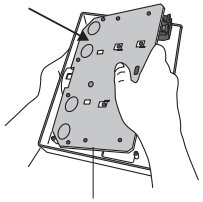
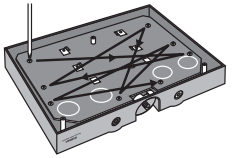


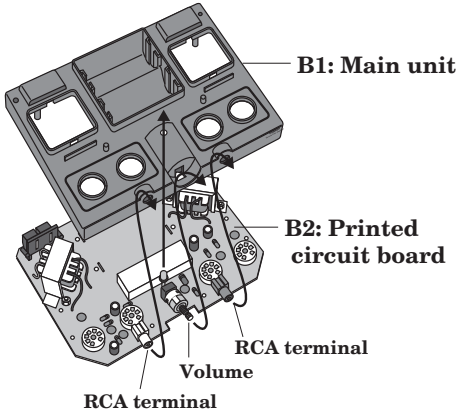
Figure-(4)
After installing the B2 printed circuit board into the B1 main unit, flip it upside down and secure it with eight screws on the back side.

How to tighten the screw

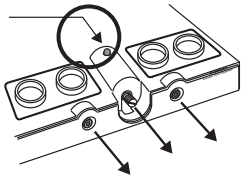
After temporarily tightening all the screws, gradually provide additional tightening diagonally.



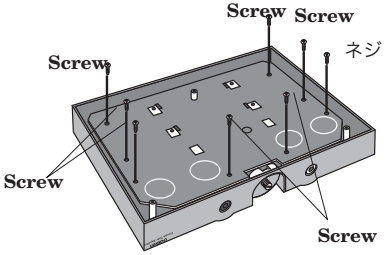
(3) Install the B2 printed circuit board into the B1 main unit.



CAUTION
While using caution not to crush the pilot light, push it in so that its head sticks out here.



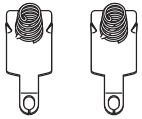
(4) Attach the B2 printed circuit board to the B1 main unit.



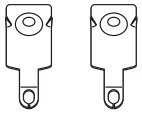
3 Mounting the Battery Contacts

Parts to be used *PARTS* Ⓒ

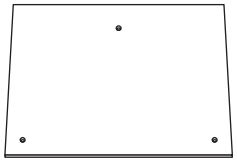
C1: Battery contacts (negative) (2)



C2: Battery contacts (positive) (2)

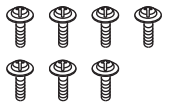


C3: Back cover



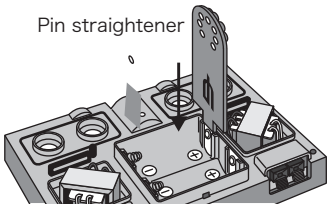
C4: Rubber pads (4)

Washer head screws (7)



Pin straightener

Figure-(5)
Mount the C1 and C2 battery contacts on the battery box. Push them in using the back of the pin straightener so that it will not protrude from the edge.



After mounting the battery contacts, flip the B1 main unit upside down. Bend and crease the C1 and C2 battery contacts that have protruded from the back, along the B2 printed circuit board, and secure them with washer head screws.

How to attach battery contacts

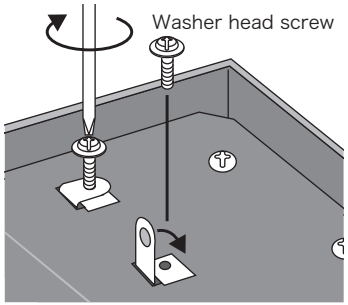
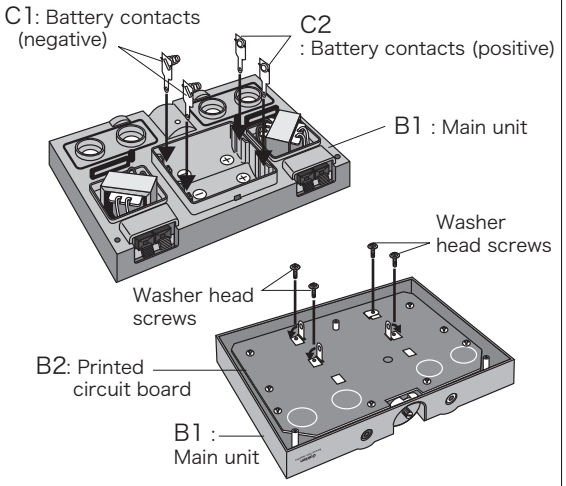
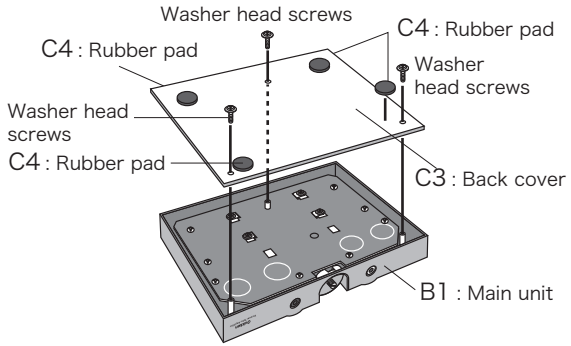


Figure-(6)
Attach the C4 rubber pads to the four corners of the C3 back cover. After that, using three washer head screws, attach the C3 back cover to the B1 main unit.

(5) Attach the C1 and C2 battery contacts to the battery box on the B1 main unit.



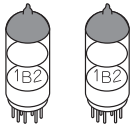
(6) Attach the C3 back cover to the B1 main unit.



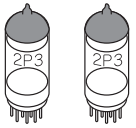
4 Setting the Vacuum Tubes

Parts to be used *PARTS* Ⓓ

D1 : Vacuum tubes] (blue) (2)

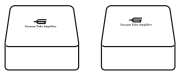


D2 : Vacuum tubes (yellow) (2)



D3 : Battery box cover

D4 : Output transformer covers (2)

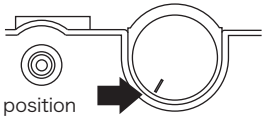


D5 Volume knob

Pin straightener

Figure-(7)
Attach the D3 battery box cover, D4 output transformer cover, and D5 volume knob to the B1 main unit.

D5 volume knob mounting position



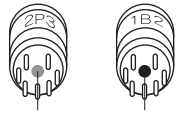
Mount the volume knob as shown in the figure.

Figure-(8)
Vertically insert the pins of the vacuum tubes into the holes on the pin straightener. If pins are bent, straighten them. (Use caution so that the pins are not broken.)

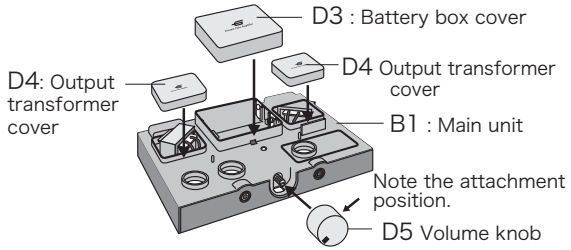
Figure-(9)
While carefully noting the positions into which they are inserted, set the D1 and D2 vacuum tubes on the B1 main unit.

How to identify a vacuum tube

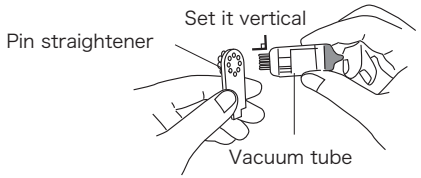
If the printed characters are too faint to read, go by the color on the bottom of the vacuum tube.



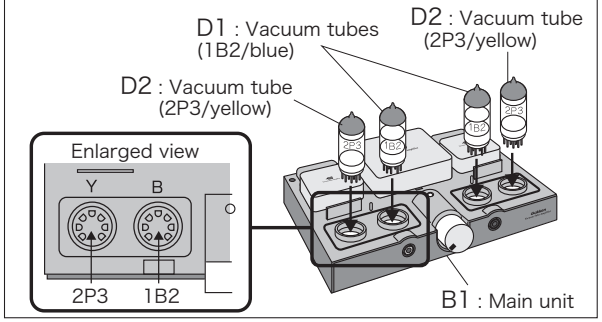
(7) Attach the D3 battery box cover, D4 output transformer cover, and D5 volume knob.



(8) Using the pin straightener, set the vacuum tube pins perpendicular.



(9) While noting the insertion positions, set the D1 and D2 vacuum tubes.



5 Assembling and Connecting the Speakers

Parts to be used *PARTS* Ⓔ

E1 : Support posts (2)

E2 : Tripods (2)

Figure-(10)
Set the E1 support post on the E2 tripod to make a base. Then, mount the speakers that were assembled in Figure-(2) to the base.

(10) Mount the speakers onto the base (make two sets).

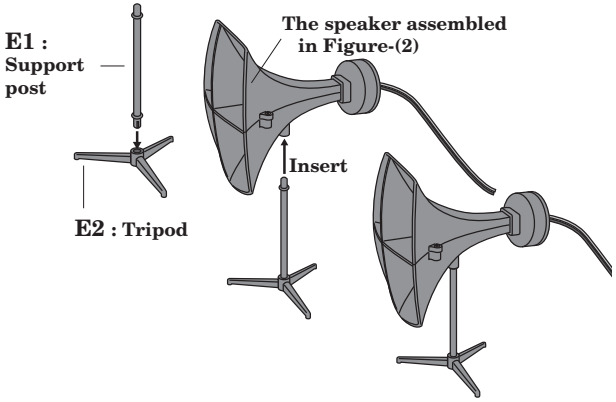
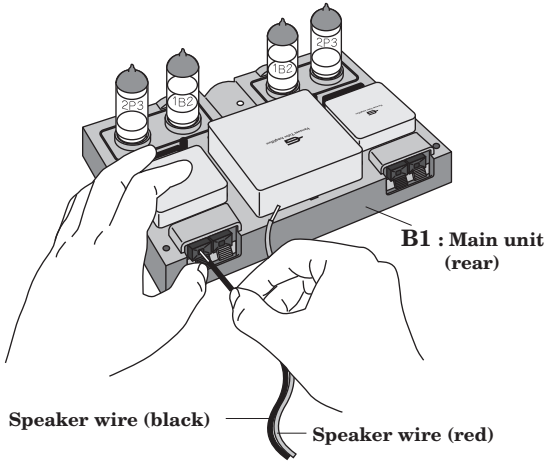


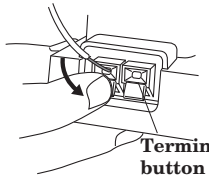
Figure-(11)
Connect the speaker wires to the speaker terminals on the back of the B1 main unit by matching the red and black colors.

(11) Connect the speakers to the back of the B1 main unit.



How to connect the speaker wires

Securely press the terminal button. Insert the conducting parts on the tips of the speaker wires into the open space.



6 Listening to Music

Parts to be used *PARTS* Ⓕ

F1 : Audio cable

D alkaline batteries (2) (sold separately)

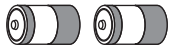


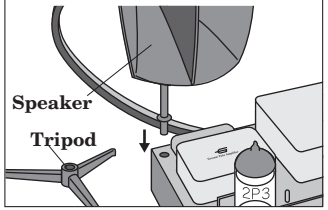
Figure-(12)
Set two D alkaline batteries (sold separately) in the battery box of the B1 main unit.

Figure-(13)
With the F1 audio cable, connect a digital audio device, etc., to the Vacuum Tube Amplifier.

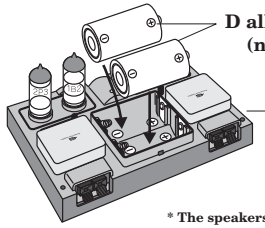
Figure-(14)
Turn on the digital audio device, etc.
*** For how to turn on the digital audio, etc., see the instructions that are supplied with the equipment.**

Turn on the switch (the D5 volume knob) for the Vacuum Tube Amplifier, and rotate the knob to adjust the sound volume.
*** The volume can also be adjusted on the digital audio device side (adjust it while listening to the sound).**

The speakers can be detached from the tripod and attached to the B1 main unit.

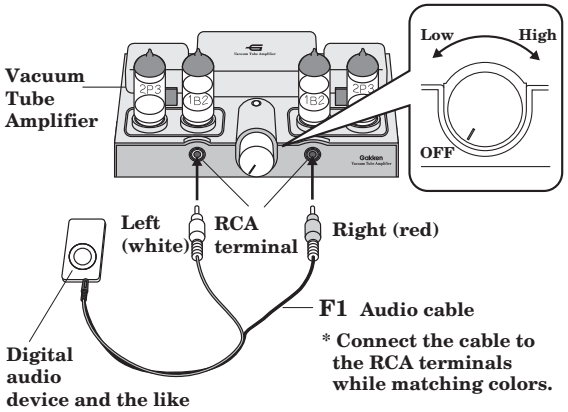


(12) Set two D alkaline batteries (sold separately).



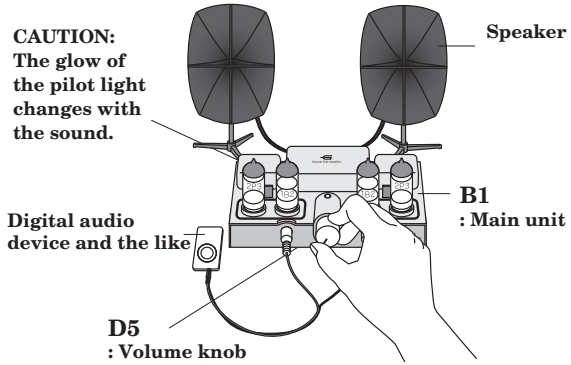
*** The speakers are not shown in the illustration.**

(13) Connect a digital audio device, etc., to the Vacuum Tube Amplifie



*** Connect the cable to the RCA terminals while matching colors.**

(14) Adjust the sound volume with the D5 volume knob.



7 Experimenting with the Speaker Sound

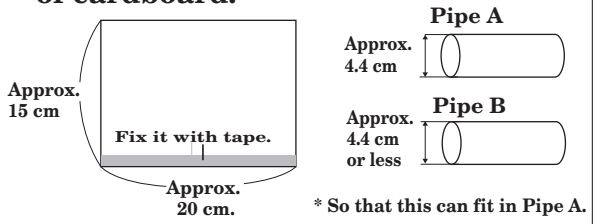
A. Backside pipe experiment

●**Required items**
· Cardboard · Ruler · Cellophane tape · Scissors

Figure-(1)
With a ruler, measure the sizes shown in the figure. Using scissors, cut a piece of cardboard. Roll up the cardboard to create Pipe A and Pipe B (secure them with cellophane tapes).

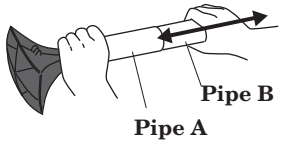
Figure-(2)
Set the Pipe A that was assembled in Figure-(1) in the Pipe B, and insert it into the back of the speaker. Slide the backside pipe to change its length, and check any change in sound that occurs.

(1) Make backside pipes with a piece of cardboard.



*** So that this can fit in Pipe A.**

(2) Insert the backside pipes into the back of the speaker. Change the length and check to see how the sound changes.



B. Frequency characteristics experiment (magic voice)

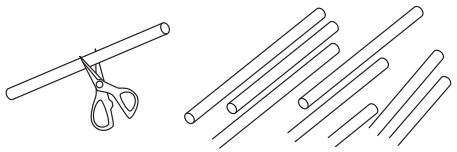
●**Required items**
· Straws (approx. 6 mm diameter) · Scissors

Figure-(1)
Cut the straws into varying lengths.

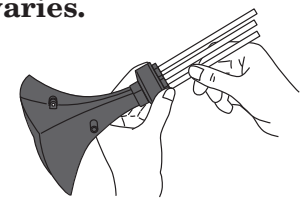
Figure-(2)
Insert the cut straws into the eight holes on the back of the speaker. Insert straws of different lengths, and also change the number of straws; check the resulting variation in sound.

*** For an explanation of "frequency characteristics," see page 20.**

(1) Cut the straws (approx. 6 mm diameter) in appropriate lengths.



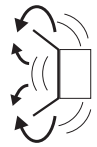
(2) Stick the straws to the back of the speaker. Check to see how the sound varies.



★ Explanation ★

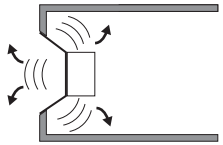
A. On the backside pipe experiment

What causes the change in sound when pipes are inserted into the back of the speaker?
The speaker generates sound when the vibrating plate (the corn, see page 19) vibrates the surrounding air. The sound, irrespective of the type of the sound source, is emitted from the rear of the speaker as well as the front side of it. For this reason, if the speaker is operated as a single unit, the sound from the back travels to the front side and becomes mixed (Fig. 1), creating a flat, monotone sound. In particular, in the low-pitched sound, the sound from the front side is canceled out by the sound from the back side.
Sound quality can be improved by reducing the amount of sound traveling from the back side. By reducing the area in which the backside is open, the amount of sound propagated can be minimized. Therefore, in this backside pipe experiment, the backside is elongated using the pipe to reduce the amount of open area on the backside (Fig. 2), and you check to see how the sound actually changes.



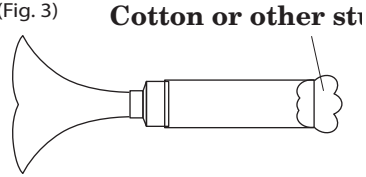
(Fig. 1)

(Fig. 2)



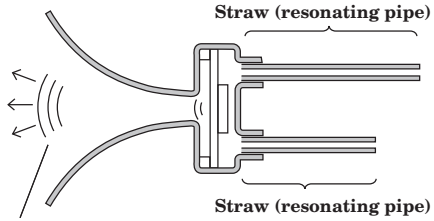
Changing the length of a pipe causes the pipe to "vibrate," or "resonate." As a result, the vibrating plate also vibrates extensively in a specific frequency in tune with the length. At the same time, the volume of the specific frequency that is emitted forward increases.
How does the sound change if the open state in the backside is blocked? It can be ascertained that the volume diminishes if the ends of the backside pipes are plugged with cotton or other materials (Fig. 3). The reason is that while the sound propagation is inhibited and sound quality is improved, the closed space impairs the motion of the vibrating plate, and this reduces the sound volume.

(Fig. 3)



B. On the frequency characteristics experiment (magic box)

The frequency characteristics experiment refers to an "experiment for verifying how the output changes when the frequency is varied while holding the input signal fixed." By attaching straws with varying lengths to the holes on the back of the speaker, you can vary the antiphase frequency (in this case, it means the vibration of the air in the back) (Fig. 4). With your own ears, check how the sound emanating from the speaker changes as the number and the length of the straws attached are changed. You can feel change in sound quality.



The resonating frequency is enhanced in the back.

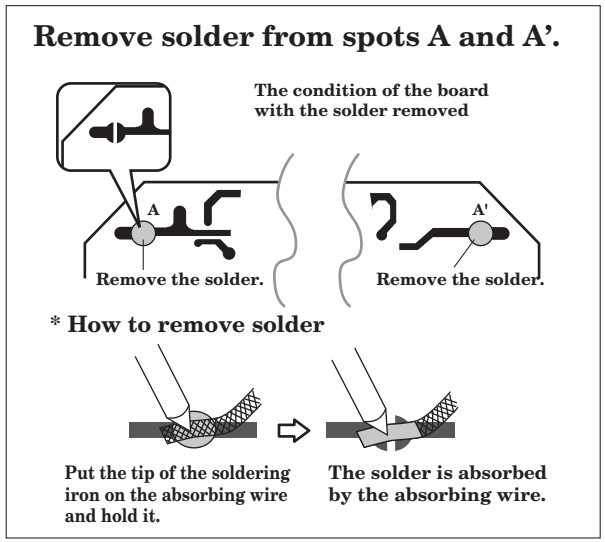
(Fig. 4)

8 Circuit Modification Experiment

A. Experiment on modification toward energy-saving mode

Required items
· Soldering iron · Solder · Absorbing wire

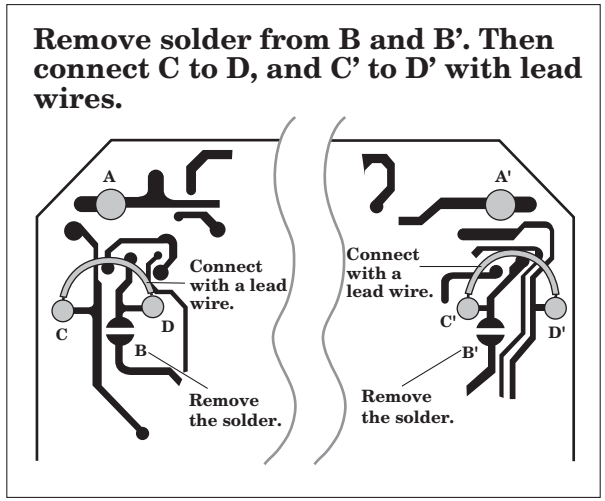
Remove the C3 back cover from the Vacuum Tube Amplifier. Take out the B2 printed circuit board. Setting the B2 printed circuit board upside down, from the printed parts, remove the solder in two spots, A and A', as shown in the figure. After removing the solder, re-assemble the Vacuum Tube Amplifier. Although the output will be somewhat lower, the resulting energy-saving mode makes the batteries last longer.



B. Experiment on modification from a pentode to a triode

Required items
· Soldering iron · Solder · Absorbing wire · Lead wire

Remove the C3 back cover from the Vacuum Tube Amplifier. Take out the B2 printed circuit board. Setting the B2 printed circuit board upside down, from the printed parts, remove the solder in two spots, B and B', as shown in the figure. Next, connect C to D, and C' to D', as shown in the figure, with lead wires. When finished with this operation, re-assemble the Vacuum Tube Amplifier. This turns the pentode circuit into a classical triode.



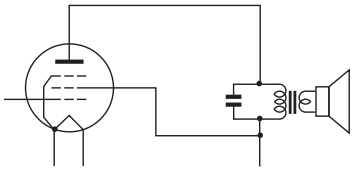
★ Explanation ★

A. On modification toward energy-saving mode
Removing the solder in the solder shorts (parts connected with solder) in A and A' from the printed circuit board reduces output to some extent, but it turns the Vacuum Tube Amplifier into a unit with an energy-saving mode (the batteries will last two times longer).
The reason is that only one of the two heaters will be used. (In the unlikely event that the heater on the operating side is blown, the remaining heater can be restored to its original condition by resodering the open in A.)

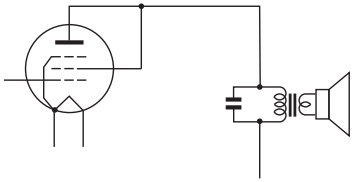
B. On modification from a pentode to a triode
By removing the solder at B and B' from the circuit board and jumpering two locations, C and D, and C' and D' with lead wires (lead wires are not supplied; they must be procured on your own), you can modify the circuit from a pentode to a triode.
The triode, which is a classical circuit, is lower in sound volume than the pentode, but it is said to produce a softer and smoother sound. (The "2P3" used for power amplification is a pentode tube, which can also be used in a triode.)

* Pentode and triode circuit diagrams

Pentode



Triode



*CAUTION: Any circuit modification using solder should be performed at your own risk. Some solder contains lead, so be careful when handling it.

Main specifications for this kit

- Output: 100 mW/ch
- Vacuum tube used (directly-heated, battery tube): Voltage amplification: 1B2 x 2 / Power amplification: 2P3 x 2
- Input terminal: RCA terminal
- Input sensitivity (input impedance): 1 Vp-p/100 k
- Load (output) impedance: 8 to 16
- Frequency characteristics: 100 to 10 kHz (+0, -6 dB)
- Distortion: 5% maximum (1 kHz)
- Accessories
  - Multicellular horn speaker: 250 mW/8 Ω, full-range style x 2
  - Audio cable: RCA pin plug x 2 and stereo mini-plug

★ About the Vacuum Tube Amplifier ★

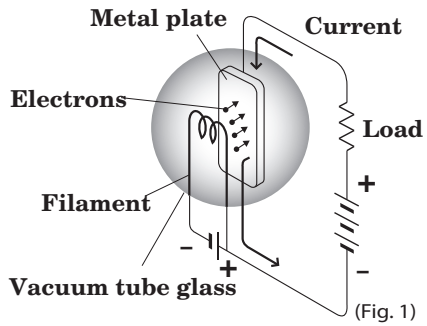
1 What is an "amp"?

The "amp" in the term "Vacuum Tube Amp" is an abbreviation for "amplifier," and it means changing the amplitude of an input electrical signal and producing an electrical signal with a larger amplitude. The process is referred to as "amplification."
If an electrical signal supplied from an external audio device, such as a digital audio unit, is simply fed as is to a speaker, it is not possible to produce sound with the same volume and quality in an audible form from the speaker. Therefore, an electrical process, such as "amplification," is needed. For this reason, a piece of equipment called an "amp" would be required. As a consequence, the most critical part of an audio system is the amplifier. In the case of this kit, it is a vacuum tube.
When compared with transistor-produced amplification, amplification by a vacuum tube is said to produce a "softer sound."

2 What is a "vacuum tube"?

The origins of the vacuum tube trace back to no less than Thomas Edison. Edison, who discovered the electric bulb, in conducting further research, found that when a metal is heated to high temperatures in a vacuum, electrons are emitted from its surface, and he took out a patent in 1885 for this discovery. This phenomenon is dubbed the "Edison effect" or the "thermionic emission phenomenon."
In 1904, British engineer J. A. Fleming created a unit that can change the voltage through the application of the Edison effect. The result is a "vacuum tube" (diode).
Heating the filament in an electric bulb by electricity causes the emission of electrons by the thermionic emission phenomenon. In addition, when a metal plate is placed near the filament and a positive voltage is applied to it, the emitted electrons are adsorbed onto the metal plate, causing a current to flow from the metal plate to the filament (Fig. 1).

* How a diode tube works

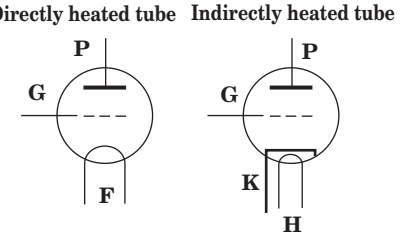


(Fig. 1)

In 1912, American electrical engineer Lee De Forest conceived the idea of regulating the current flowing between the filament and the metal plate by placing lattice-like electrodes (grid) between the metal plate and the filament and by applying a negative voltage, the same as the electrons, to it. This is the birth of the triode. When this device is used, the current changes significantly in reaction to a small change in voltage applied to the grid, and in this manner, electrical signals can be amplified. After a series of refinements that were made in the succeeding years, the device achieved a remarkable development in the form of an amplifier.
In the 1910s, the vacuum tube was a directly-heated tube in which electrons are directly emitted from the filament. In those times, AC power was not available in ordinary homes. Therefore, it is supposed that batteries (dry cells and storage batteries for cars, that is, car batteries) were used as a power source. In that era, directly-heated type battery tubes were standard.

In subsequent years, AC power made its way to homes to provide a power supply. It was found, however, that heating a directly-heated filament with AC power caused deterioration in sound quality. In order to prevent this phenomenon, the indirectly-heated tube was created in 1926. In this device, the heater (corresponding to the filament in a directly-heated tube) is wrapped in an oxide material and heated, causing the emission of electrons. When heated, the heater becomes so red that it begins to emit light (Fig. 2).

* How the directly-heated and the indirectly-heated tubes work



(Fig. 2)

3 Advantages of the battery tube

The popular conception that a vacuum tube "glows in red" is a characteristic of the indirectly-heated tube which became the mainstream during the 1930s and in subsequent years. Since this kit consists of directly-heated type battery tubes, in order to minimize power consumption and provide a high-efficiency amplification function, these tubes glow slightly, but not as much as indirectly-heated tubes do.
Battery tubes offer several advantages:

1. They are safe

Because they run on dry or storage batteries, so they basically have an energy-saving design. Compared with AC power, these batteries are low in both current and voltage, which means that there is very little chance for accidents resulting from electric shock. These tubes, as in the case of the supplied kit, are well-suited for use in hand-made kits.

2. They run on DC power

The ability to run on DC power provides a significant advantage. In the case of AC power, electrical vibrations are unavoidable (when turned on, the indirectly-heated tube emits a booming sound, which is a type of vibration), and this affects sound quality. For audio equipment, batteries are ideal power supplies.

3. They are quick acting

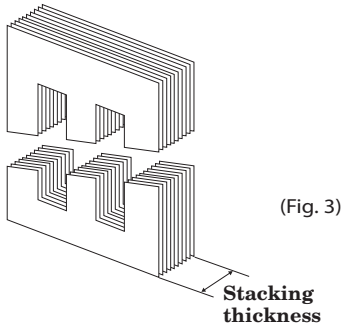
Indirectly-heated tubes that run on AC power require about 15 seconds until the heater warms up and the tube begins to operate. Unlike the indirectly-heated tube, because it does not require the heating of the filament, the battery tube begins to operate as soon as it is turned on.

4 In search of maximum efficiency

Battery tubes also have some disadvantages: the power supplied from the battery is necessarily low compared with AC power, and this places a limit on performance. In this respect, the supplied kit is designed using innovation for drawing out the maximum performance inherent in the battery tube.
1. Independently-Developed Output Transformer
A transformer is an electronic component made by combining two coils. A coil is an electronic component in which a conducting wire is wound in a helical form. Applying a current to the coil produces a magnetic field around it. The transformer generates a voltage from the magnetic field produced by the coil itself when the applied current is varied (electromagnetic induction). A transformer is an electronic component that changes voltage due to the number of windings of two coils being different.
The output transformer is a key component

that determines the sound quality produced by the amplifier. The impedance (a concept similar to “resistance” in direct current – see page 21) of the signal amplified by the vacuum tube must be reduced to the impedance used in the speakers. For the faithful reproduction of sound quality, the waveform should remain the same. Critical elements in achieving such a performance are the quality of the core material and the stacking thickness (a thickness attained by stacking slim core materials – the greater the thickness, the higher the performance level of the transformer). (Fig. 3)

* Shape of the core material used in an output transformer



(Fig. 3)

The supplied kit contains an irregular EE core type transformer. The code “EE” is associated with the shape of the core material. The supplied transformer was independently developed by Gakken, in search of an ideal output transformer. Also, a special steel plate, “silicon steel plate” is used in the core material.

2. Appropriate arrangement of electronic components

An amp always has input and output sections. In the supplied kit, the RCA terminal into which a signal from an external audio device is fed corresponds to an input part, and the speaker terminal corresponds to an output part. In arranging the electronic components, we designed the circuit board so that the input parts are located in the front and the output parts are in the back (rear), in progressing order of electrical processing. Consequently, the RCA terminal is located in the front, and the speaker terminals in the back. If these components are placed in proximity to one another, electrical coupling occurs, with an attendant decrease in sound quality.

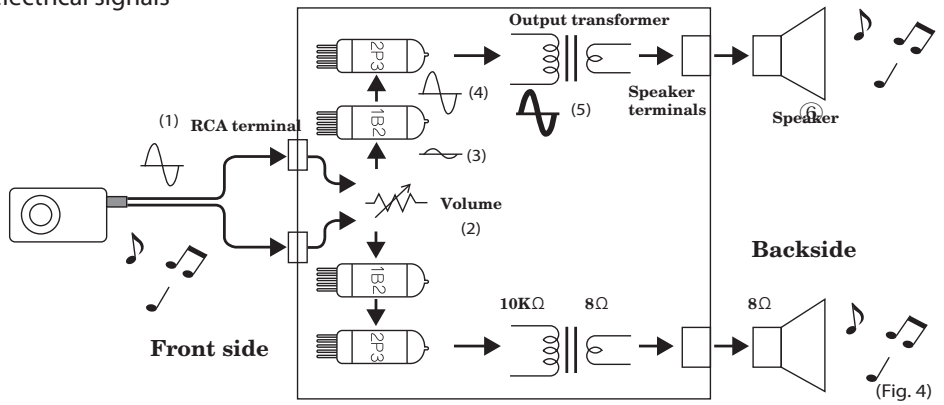
Electrical signals are processed as follows (Fig. 4):

(1) RCA terminal Electrical signal (sound source) is input from an external audio device.
(2) Volume Adjusts the overall volume of the input signal.
(3) Vacuum tube (1B2) Amplifies the voltage of the input signal.
(4) Vacuum tube (2P3) Amplifies the power (= voltage x current) of the input signal.
(5) Output transformer Matches the amplified signal to the speaker impedance.
(6) Speaker terminals Output the amplified electrical signal to the speaker.

5 Speakers that fully utilize the output

As a vacuum tube amplifier, the main unit is a self-contained unit. However, to listen to actual sound, speakers are required. Believing that speakers cannot be omitted from the kit, we decided to include speaker units that are capable of drawing out maximum sound from a low-power input in the kit.
A speaker is comprised of two elements: an integrated cone (vibrating plate) and coil, and independent magnets (Fig. 5). Each of the speakers supplied with this kit is equipped with a size 40-diameter mylar cone (plastic cone) and a coil, to which a neodymium class magnet is attached. As such, they are “full-range speakers” (with emphasis on the middle range while maintaining low and high range characteristics). An air chamber is provided on the front side, producing an increased sound volume and delivering an improved sound quality through an air suspension effect (an effect that physically changes the sound volume and quality by compressing air and

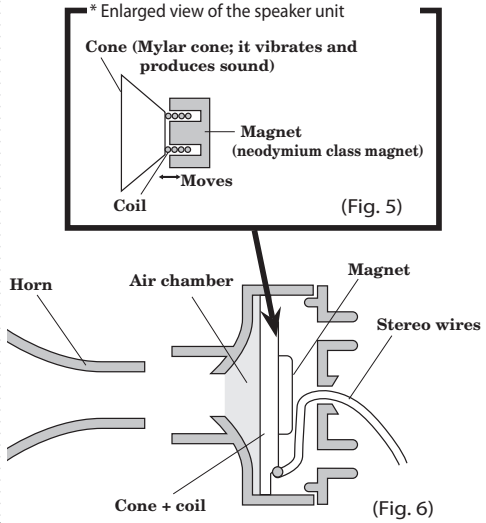
Steps for the processing of electrical signals



(Fig. 4)

then releasing it in a burst – a technique that was used in an early gramophone sound box). (Fig. 6)
The shape of the horn incorporates the classical “cellular type” (where a horn is partitioned into small compartments so that individual high range sounds are produced with great clarity). This method was originally developed for middle and high range sounds. However, since the supplied kit uses full-range speakers, the low range sound can also be covered. You can enjoy a sound different from high-powered speakers.

* How a speaker unit works



★ Glossary of Audio Terms ★

● Stereo amp
An amplifier that consists of right and left units. The separate right and left sound sources create a stereophonic effect.

● Alternating current
A current that flows in alternately in opposite directions at a fixed cycle.

● Power supply frequency
The electricity supplied to homes is an AC current, in which the direction of current flow changes every 0.02 second. The length of time for this repeated cycle, in which the amount of time that cycle completes itself, from the beginning to the end, is referred to as a period. The number of periods (the number of times cycles repeated) per second is called the power supply frequency (50 Hz in Eastern Japan, and 60 Hz in Western Japan).

● Audio band
This refers to the frequency band that is audible to humans. Normally it is 20 Hz to 20 kHz (20,000 Hz). A frequency band below 20 Hz is called the ultra low frequency; the frequency above 20 kHz is called the ultra high frequency, both of which are beyond the ability of humans to hear.

● Frequency characteristics
The term refers to the degree to which a frequency range of interest is amplified. In the case of an audio amp, the extent to which degree of amplification declines is indicated in terms of the range of the frequency to be amplified.

● Audio amp
A device that amplifies a weak signal to a high signal. An ideal audio amp is the one that faithfully amplifies a given sound source in a flat manner (= favorable frequency characteristics), ranging from the low range sound to the high range sound.

● Distortion factor
When the input and output signals are not similar in waveform, the characteristic is referred to as a "distortion." The distortion factor is a numerical value that indicates the extent of distortion: the smaller the value, the greater the quality of the amp. In practice, the limit is a few percentage points. Normally, sine waves (neat waves that are generated based upon a mathematical formula) at 400 or 1000 Hz are input, and the output waves are measured with a distortion factor meter. The distortion factor is an index for the extent to which signal is faithfully amplified.

● Amplifier output
In this kit, the expression "100 mW/ch" means a capacity to output 100 mW per channel. Normally this indicates the maximum output. However, in the field of audio equipment, it often indicates an output level with a 10% distortion. In terms of a measurement method, the output voltage is measured with a rated input of 400 or 1000 Hz. Normally, a fixed resistance (8 Ω) is used as a load.

● Rated input
The term refers to the voltage of input signal (sound source). Normally, the voltage is expressed as a potential difference between the peak and the trough of a wave, often based on 1 V. Because the rated output is used as a reference in the measurement of a distortion factor or the S/N ratio, the input signal level is lowered.

● S/N ratio
The term refers to a signal to noise ratio, and it represents the percentage of noise that is generated in the amplification or impedance transformation process. This is usually expressed in dB (decibel); the larger the number, the better the performance. For example, an amp with an S/N ratio of 60 dB produces a noise component that is only 1/1000 with respect to the signal. For the measurement method, with a sine wave input, the ratio between a state matching the rated output and the value of no-signal is measured.

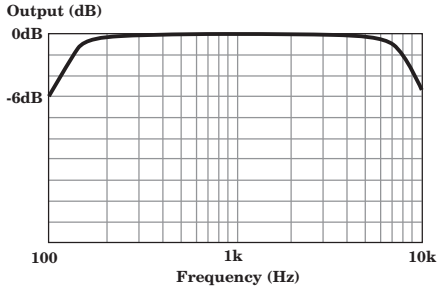
● dB (decibel)
The term refers to a unit of measure, expressed logarithmically, that represents the magnitude of voltage or power. In a normal comparison of voltages, 20 decibels = 20log10, and 20 dB means 10 times greater. 40 dB would mean 100 times greater; and 6 dB, 2 times greater.

● Crosstalk
The term refers to the condition in which the right and left signals are mixed. Even when they are completely separated on a circuit diagram, in an actual circuit, right and left signals often become mixed due to ground loop and electromagnetic coupling. Normally crosstalk is expressed in dB (decibel), such that the greater the number, the higher the performance. For the measurement method, with a sine wave input, the ratio between a state matching the rated output and the value of no-signal is measured. For example, a crosstalk level of 46 dB means that signals are mixed in a 1/200 ratio.

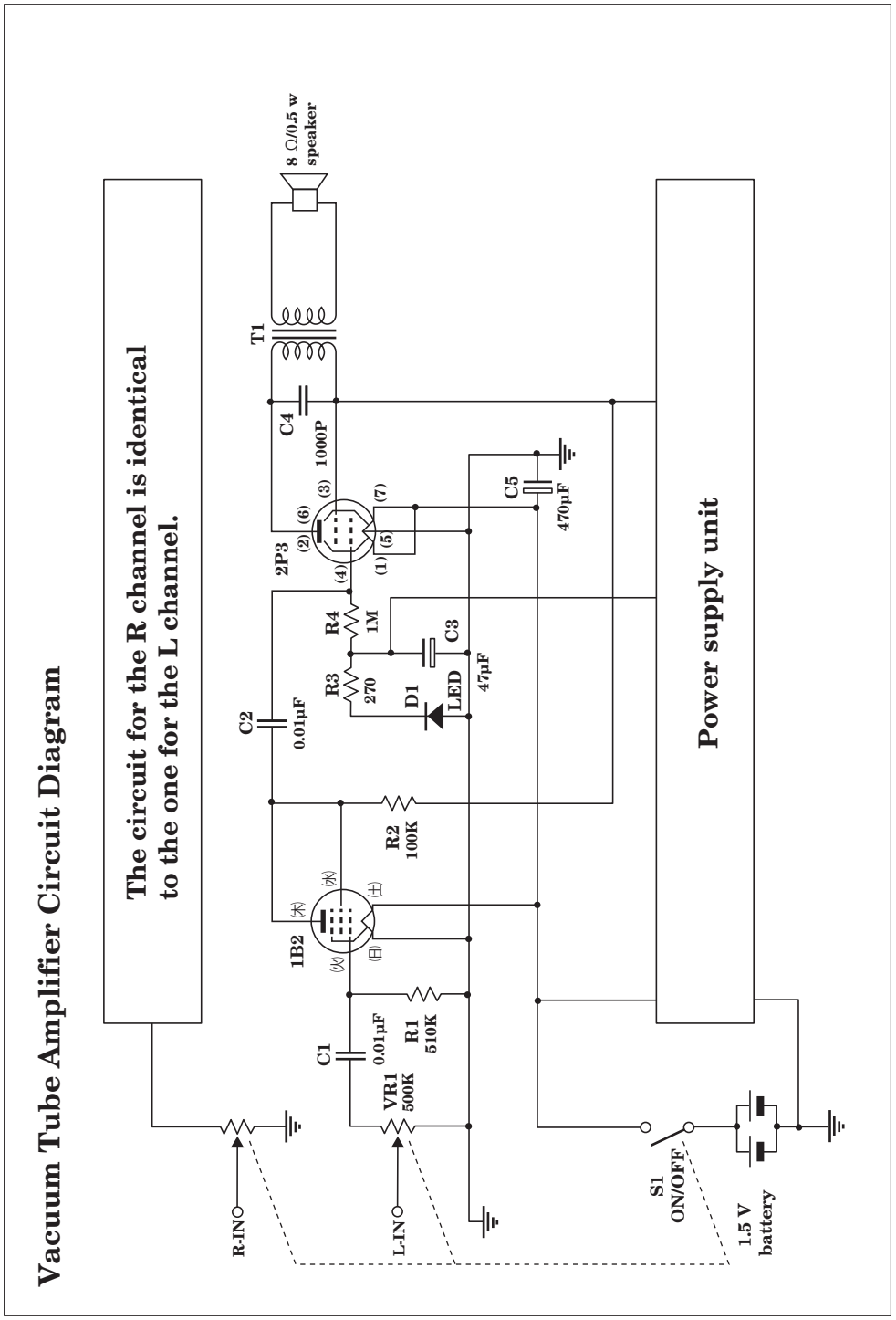
● Impedance
The term refers to an AC resistance level. In audio devices, the term normally means a resistance at 400 or 1000 Hz. Because the output from a vacuum tube has a high impedance value, directly driving an 8-Ω speaker produces a large drop in voltage, and inhibits output. An attendant increase in distortion could also reduce sound quality. In the supplied kit, an output transformer is provided between the vacuum tubes and the speakers to achieve impedance matching.

● Output transformer
The term refers to an electronic component in which two coils are used in combination. The functions of an output transformer used in an amplifier are to provide I/O impedance matching, to perform low-distortion transformation, and to perform the necessary and sufficient power transmission. The key is to wind a thick winding wire around a highly magnetic core a large number of times. The supplied kit includes a transformer with a 10 kΩ : 8 Ω output capacity.

● Meaning of "Frequency characteristics: 100 to 10 kHz (+0, -6 dB)" (see page15, "Main specifications for this kit")
It means an "output decrease of 0 to -6 dB at 100 Hz or 10 kHz ("-6 dB" indicates a 1/2 decrease in output)."



● Meaning of "Speakers: 250 mW/8 Ω" (see page15, "Main specifications for this kit")
The term refers to a maximum input of 250 mW; no greater signal input may be applied. The 8 represents the load impedance, meaning that the speaker can be connected to an amp with a maximum impedance of 8 Ω.



Q&A Vacuum Tube Amplifier

Q: No sound is produced.

A: Check the direction of the batteries, whether parts are in contact, and whether vacuum tubes have not been plugged in wrong.

Q: The LED on the pilot light does not light up.

A: Check the contact of the batteries. A loose screw on the printed circuit board can cause a contact failure. If this is the case, retighten it. Also, if a vacuum tube is plugged in incorrectly, the LED on the pilot light can dim.

Q: What is the function of the LED on the pilot lamp?

A: It is used to ensure an adequate bias voltage for the vacuum tube (2P3) (approx. 1.5V).

Q: The vacuum tubes don't get bright.

A: In this kit, in order to conserve battery power, only a minimum necessary current is applied to the vacuum tubes. Therefore, they glow to an extent that that they are barely visible in a dark place.

Q: The speakers feedback.

A: Sound from the speakers may be feeding back to the heaters on the vacuum tubes, etc., creating a feedback loop. Turn the power supply on again. The shock generated when the switch is turned on can cause feedback. Turn the switch knob gently.

Q: I want to test the vacuum tubes.

A: Use the multimeter resistance range (a range of ×10 Ω or more) to check for blown heaters. Never measure with a low range (×1 Ω). This could break the vacuum tube heater.

Q: What are the model numbers for equivalents of the vacuum tubes?

A: 1B2 corresponds to 1S5; 2P3 to 3A4.

Q: By mistake, I inserted a vacuum tube incorrectly.

A: This will not break it, but it should be inserted correctly. Note that removing it could bend the pins. If it does, straighten them with the provided pin straightener.

Q: How long will the batteries last?

A: At a usage rate of one hour per day, the batteries will last for approximately 20 days.

Q: What are the signs of a dying battery?

A: Volume gets steadily weaker.