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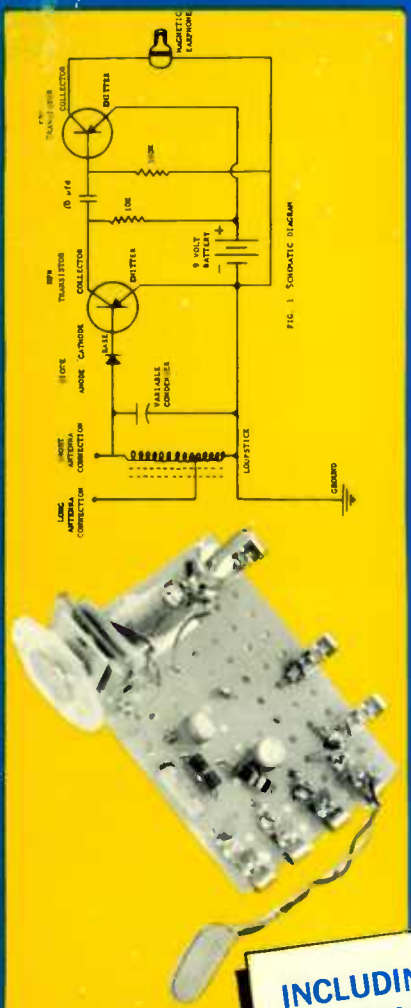

A MODERN Transistor WORKBOOK

Schematics and data for building 50 projects using latest solid state devices

INCLUDING INSTRUCTIONS AND MASTER PARTS LIST!

BUILD THESE 50 PROJECTS

- Audio Amplifier/Oscillator
- SSB Test Oscillator
- Wireless Microphone Broadcaster
- Wireless Phono Oscillator
- CB Channel Locator
- Microphone Booster
- Electroplater and Battery Charger
- AM Broadcast Tuner
- Battery Eliminator
- Supersonic Transceiver
- Electronic Organ
- Telephone Amplifier
- Clorox Powered AM Radio
- High Sensitivity Hearing Aid
- Two-transistor Receiver
- Audio Mixer
- The Key-Click Killer
- Cathode Modulator for CW Transmitters
- Carbon Mike Preamplifier
- Public Address System
- Noise Limiter
- High-to-Low-Impedance Mike Matcher
- Low-to-High-Impedance Mike Matcher
- "No Power" Receiver
- Receiver with Push-Pull Amplification
- AM Radio Booster
- Current Reverser
- World's Smallest Transmitter?
- Experimenter's Power Supply
- Headset Booster
- Light/Dark Music Maker
- VLF "Whistler" Receiver
- Interphone Amplifier
- Radio-TV Signal Tracer
- Supersonic Receiver
- World's Smallest Receiver?
- Theremin
- Power Supply for Tunnel Diodes
- VU Meters
- Square Wave Generator
- Headset/Loudspeaker Converter
- Modulation Monitor
- 15-Meter "Flea Watter" Transmitter
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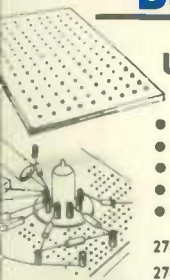

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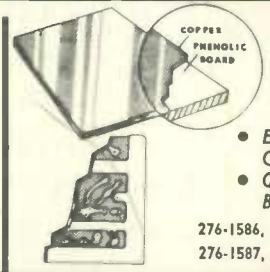

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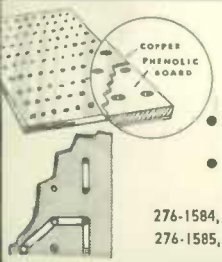

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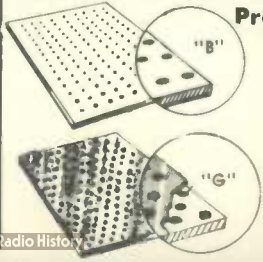

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FOREWORD

"A Modern Transistor Workbook" comprises 50 electronic projects entirely different from those included in Radio Shack's other book "50 Easy-to-Build Solid State Projects". It has been written expressly for the Amateur, the CB'er, the Audiophile, the Experimenter and the Photographer.

None of these experiments incorporate hard-to-get or costly parts—every part is available from any Radio Shack store. The Master Parts List (page 79) gives you the identifying Radio Shack stock number and price for ease in ordering. No guesswork involved! With the clean, easy-to-follow schematics included, you can build such fascinating transistorized units as an AM Broadcast Tuner; a Radio-TV Signal Tracer; a Square Wave Generator or an Audio Preamplifier. You'll find, too, that most of the circuits used in this book can be adapted to your own needs, and that the number of devices which can be constructed is multiplied accordingly.

All these projects are useful as well as educational and fun to make, and we have taken care to eliminate that major stumbling block for hobbyists and experimenters—the high cost of needed parts. All our parts are standard components designed for universal use and all of them are priced right. Simply check the Master Parts List and order by mail if, for any reason, you can't avail yourself of the personalized service obtainable at any one of our coast-to-coast Radio Shack stores.

RADIO SHACK CORPORATION
Boston, Mass. 02215 U.S.A.

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INTRODUCTION

Before you begin working on the first project, you should become familiar with transistors, and some of the more important electronic components, schematic diagram symbols, and the tools you will use.

TOOLS

Small tools for use in constructing electronic projects are inexpensive, and can be used over and over again.

For soldering, an iron with a pencil tip is the most appropriate. It should be rated at 37½ watts.

A coil of rosin-core solder (never use acid-core solder in electronics), and a roll of plastic-covered hookup wire.

5″ long-nose pliers for handling components and for twisting wires together; 5″ diagonal cutters for trimming.

A large screwdriver for general work; a small "set" screwdriver for attaching knobs.

A small hand drill, a set of drill bits, and a keyhole saw are very useful.

BOARDS AND CHASSIS

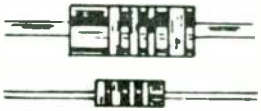
The base on which electronic parts are mounted is called a "chassis." Many everyday things can be used; a piece of plywood or pine, (waxed or shellacked for protection against moisture), pegboard, plastic boxes, cigar boxes, small paper cartons, aluminum boxes, and cake pans are just a few of the more common chassis bases that have been used successfully by hobbyists and experimenters. A thin nonconductive

board with tiny perforations called "vector board" has become popular in recent years. Our projects will use a widely varied assortment of boards, some you may find around the house, and other specifically intended for use in electronics.

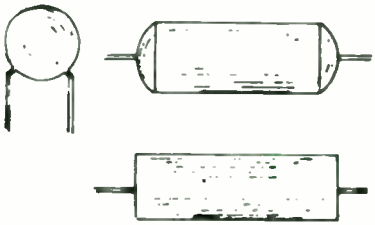
HOW TO RECOGNIZE ELECTRONIC PARTS

Your projects use electronic parts best suited to and most popular for transistor work. Here are some of those which are most often used:

Resistors — control voltage levels, limit currents in circuits, and separate circuit elements from each other.



Capacitors — store energy, or isolate certain circuit elements from each other. Larger value units are usually "electrolytic" types. There are also tubular (long and round), ceramic (flat discs), and variable capacitors for tuning antenna coils.

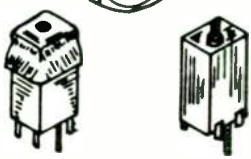


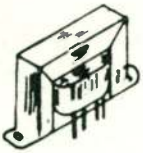
Antenna coils — when used with a variable capacitor, select and separate signals picked up by an antenna.

Earphones — small, low-power speakers which convert electrical energy to sound.

Loudspeakers—like earphones, but generally larger and more powerful.

IF (intermediate-frequency) transformers — interconnect sections in certain types of radios.





AF (audio-frequency) transformers — used to connect the output of one stage to the input of another. Power output types connect a stage to a loudspeaker.

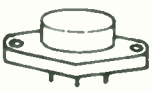
Volume controls—a "potentiometer" or variable resistor used to electrically vary the size of a signal and the loudness of sound.

Diodes and rectifiers — convert alternating currents to direct currents. In many radio applications diodes are used as signal "detectors."

Transistors

A small-signal transistor amplifies relatively "small" electrical signals into much bigger ones.

Power transistors amplify considerably larger signals, do heavy work.



Solder lugs — easily soldered terminals for securing the leads from wires and parts; small holes for wires, larger holes for screw mounts.

Fahnestock clips — spring-like grippers for the ends of wires; used when temporary connections are needed, such as to batteries, earphones, loudspeakers, and so on.

HOW TO SOLDER

A solder joint that "looks good" is usually electrically good. The soldering iron must be given time to get as hot as it can. If the tip of the iron melts solder instantly, it is hot enough for use. The joint to be soldered must be cleaned of any insulation, and the enamel wire coating scraped off. For best results, the joint must be heated by the iron so that the joint, not the iron, actually melts the solder.

Transistors, capacitors, and other small parts must be protected when the hot soldering iron is touched to their wire leads. With the tip of the long-nose pliers, grasp the wire lead close to the point where it enters the body of the component. This conducts the heat away from the delicate "insides" of the part, yet does not interfere with soldering.

Press the tip of the iron to the point you want to solder. Hold the end of the solder against the junction, not against the iron. If the junction is hot enough, the solder will flow like syrup onto the junction. Hold the pliers absolutely still while you lift the iron quickly away from the junction. The solder will cool and harden in a few seconds.

A good solder joint looks smooth and glossy. If too little heat is used or the wires are moved before the solder has hardened, the appearance is crystalline, dull. You can fix it by touching the iron to the joint again to liquefy the solder.

AN ANTENNA "PICKS UP" RADIO SIGNALS

The better the antenna, the stronger are the signals it provides. A good antenna is high up and clear of surrounding objects such as telephone and electric power lines, trees, and buildings.

A convenient and effective antenna for receiving commercial AM broadcast stations is a 50′ length of flexible copper wire running from the edge of a house roof, for example, to a clothes pole, or to the top of another high structure.

Insulators at the ends of the wire electrically insulate it from its supports. Insulated lead-in wire connects the antenna to the radio set. The lead-in wire itself must be insulated.

A cold water pipe (not a hot one) makes a good "ground." Use a metal hose clamp, tightened to the pipe with the bare end of the ground wire from the radio set placed between the clamp and the pipe. Radios often work without a "ground," but usually work better with one.

No. 1
AUDIO AMPLIFIER/OSCILLATOR

This device doubles as a code practice oscillator and an audio amplifier. It requires just a few standard parts and can be built in a small aluminum box or speaker cabinet.

If you have no use for a code practice oscillator and wish to use this only as an audio amplifier, you can eliminate the connection which runs between the base of the 2N104 to the collector of the 2N408. This, of course, also eliminates the key and the capacitor. The volume can be adjusted when used either way.

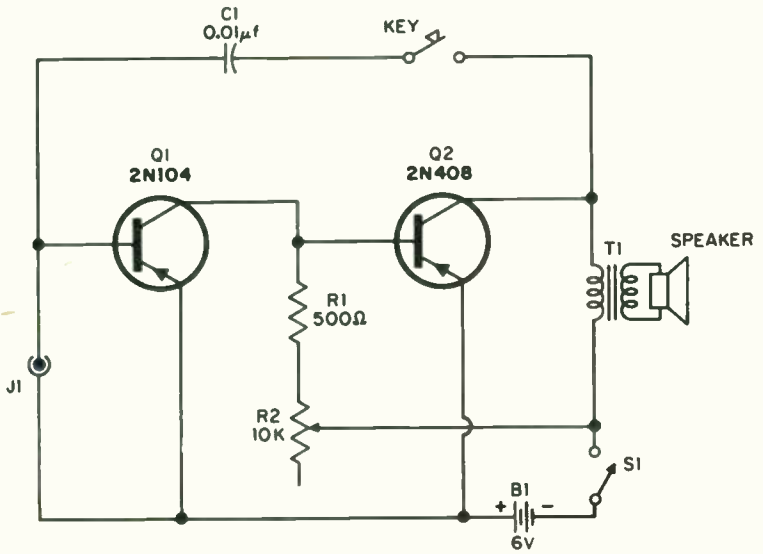


Fig. 1

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N104	276-403
Q2	transistor, 2N408	276-1702
R1	resistor, 470 ohms	70-0195
R2	potentionmeter, 10,000 ohms	271-1715
C1	capacitor, 0.01 mfd	71-5194
T1	AF output transformer: 500-ohm CT primary, 3.2-ohm secondary	273-1379
J1	standard phono jack	75-0966
S1	switch, SPST	275-602
B1	6 volts (4 "C" cells)	23-467
	6" PM speaker, 3.2-ohm	40-1207
	telegraph key	20-1085

No. 2 SSB TEST OSCILLATOR

This two-tone, SSB test oscillator may be constructed on a piece of board about the size of a deck of playing cards. The output of this unit may be applied to a SSB generator for two-tone linearity measurements.

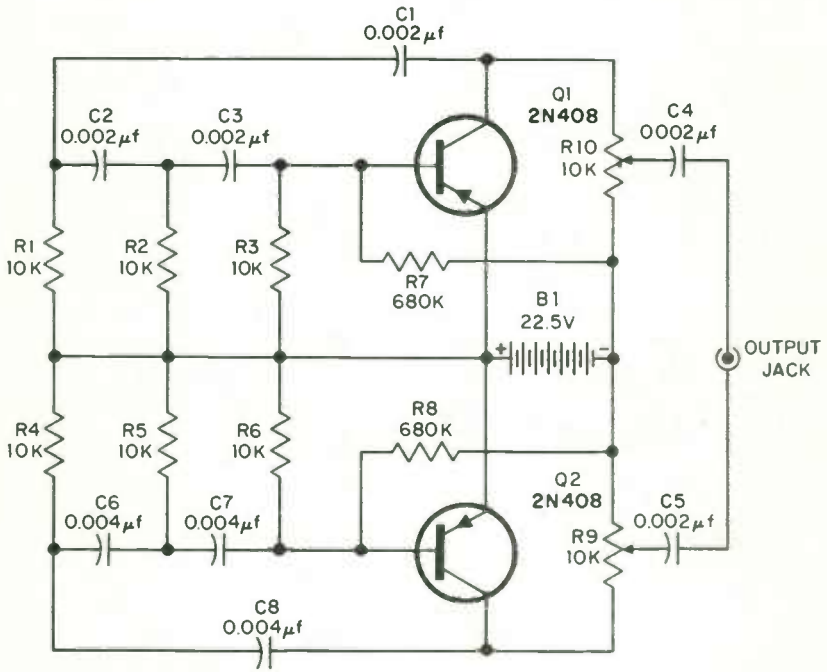


Fig. 2

Compoments may be mounted on top of the construction board and soldered together beneath.

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1, Q2	transistors, 2N408	276-403
R1, R2, R3, R4, R5, R6	resistors, 10,000 ohms	70-0195
R7, R8	resistors, 680,000 ohms	70-0195
R9, R10	potentiometers, 10,000 ohms	271-1915
C1, C2, C3, C4, C5	capacitors, 0.002 mfd.	71-5182
C6, C7, C8	capacitors, 0.0047 mfd.	71-5189
	output jack	75-3392
B1	battery, 22.5 volts	23-097

No. 3 WIRELESS MICROPHONE BROADCASTER

These circuits have always been popular for both utility and entertainment purposes (candid microphones are made of this).

Our wireless mike is built with a minimum of components to save space and cost (cost is an important factor in case the victim of the candid mike treatment doesn't see the humor of the device and decides to end its career).

The broadcasting frequency of the unit is determined by L1 and the 365-pf variable capacitor. L1 consists of No. 7/41 Belden litz wire wound in a single close-spaced layer on a 7-inch by 0.33-inch ferrite rod. Leave 1/4 inch at the end of the rod. L2 is about 35 turns of No. 24 enameled wire wound directly on top of L1.

Any piece of stiff wire will serve as the antenna and will give good coverage. FCC regulations prohibit the antenna length from exceeding 10 feet.

Try your unit out at any convenient dead spot on the low end of the broadcast band. If it fails to transmit, try reversing the connections on L2. A ground connection is optional; it often helps.

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N139	276-402
R1	resistor, 100,000 ohms	70-0195
C1	capacitor, 365-mmf, variable	272-1343
C2, C4	capacitors, 0.02 mfd	71-0424
C3	capacitors, 0.002 mfd	71-5182
B1	6 volts (4 "D" cells)	23-466
S1	switch, SPST	275-602
L1	No. 7/41 Belden litz wire wound on 7 in. x 0.33 in. ferrite rod, single layer	
L2	35 turns, No. 24 enameled wire, wound directly on L1 antenna: stiff wire	
	carbon mike	279-1425

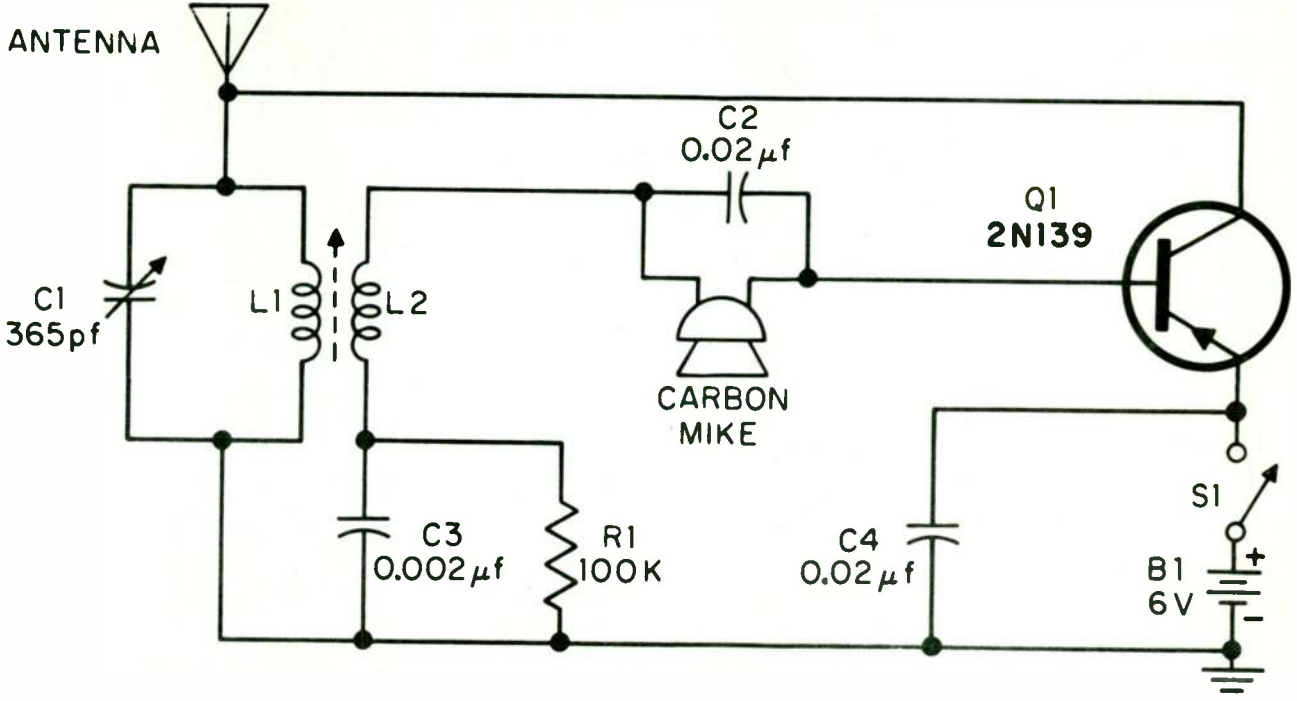


Fig. 3

No. 4 WIRELESS MICROPHONE BOOSTER

This little circuit was originally designed for use in CB transceivers, but it will also add zip to ham rigs. The entire assembly is small enough to be wired directly inside the microphone case! Yet, small as it is, it generally adds considerable audio gain to any unit into which it is wired.

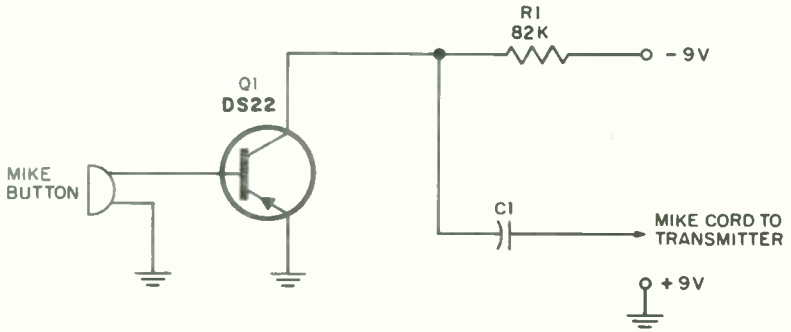


Fig. 4

The 5-mfd capacitor will give you good base-boost; however if you do not desire this feature you can replace the component with a 0.05-mfd capacitor.

Should oscillations occur after the booster has been added try inserting a filter capacitor (about 0.01-mfd) at the mike plug on the transmitter. Do not put this on the audio output lead. If this does not cure the oscillation, use a 100K resistor at the mike plug where the lead from the mike enters the set. If all else fails, reduce the size of R1 to the point where the oscillations cease but do not exceed 200,000 ohms.

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, DS22	276-401
R1	resistor, 82,000 ohms	70-0195
C1	capacitor, 5-mfd or 0.05-mfd (see text)	
	mike button	

No. 5 WIRELESS PHONO OSCILLATOR

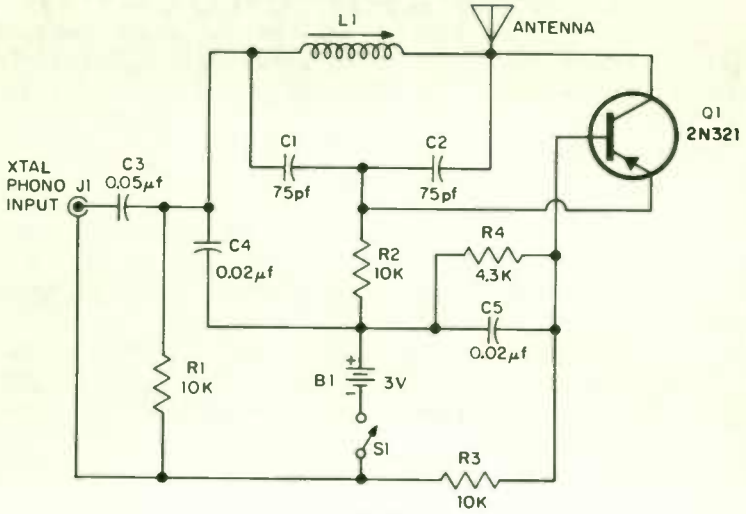


Fig. 5

This is a form of wireless mike, except that it is specifically designed to enable you to use the amplifier of a better quality AM receiver instead of the relatively poor quality of an inexpensive phonograph.

The unit attaches to the phonograph cartridge and actually broadcasts the recording in the immediate vicinity of the phonograph. The device will also permit you to hear your recordings over any pocket portable receiver as long as you don't stray too far from the phono oscillator's antenna.

The transmitting frequency is controlled by L1, a vari-loopstick, and the two 82 pf capacitors. J1 is a phono jack to receive output of phonograph's crystal cartridge.

The two 82 pf capacitors should be ceramic units.

The antenna should not be longer than 10 feet to comply with FCC regulations.

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N321	276-403
R1, R2, R3	resistors, 10,000 ohms	70-0195
R4	resistor, 4,700 ohms	70-0195
C1, C2	capacitors, 82 pf	71-5105
C3	capacitor, 0.05 mfd.	71-0407
C4, C5	capacitor, 0.02 mfd.	71-0424
L1	vari-loopstick	270-1430
J1	phono jack	75-0966
S1	switch, SPST	275-602
B1	3 volts (2 "D" cells)	23-466

No. 6 CB CHANNEL LOCATOR

This gadget will permit a CB'er to rapidly locate any CB channel on his receiver by mere insertion of a 3rd overtone CB transmitting crystal in the circuit.

The unit is housed in a 4-1/2 in. x 2-1/2 in. x 2 in. aluminum box. When constructing it, keep the leads as short as possible.

To operate the channel locator, start with the 1-megohm variable resistor set at its point of highest resistance. Gradually back down on the resistor until the circuit (without a crystal installed) pulls about 0.2 ma on a milliameter connected in series with one of the battery leads.

Then, insert a crystal (3rd overtone *only*) and peak the circuit using the 50-pf variable capacitor, listening on your receiver for maximum signal reading. This capacitor should be peaked on each crystal used for maximum signal radiation.

This CB Channel Locator is also helpful as an aid in determining the radiation pattern of a base or mobile CB antenna. A short walk around the antenna, unit in hand, will show you peaks and nulls.

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N372	276-412
R1	potentiometer, 1 megohm	271-211
C1	capacitor, 5 pf	71-5087
C2	capacitor, 47 pf	71-5101
C3	capacitor, 50 pf variable	71-4031
C4	capacitor, 0.01 mfd	71-5194
S1	toggle switch, SPST	275-602
B1	9-volt battery	23-464
L1	coil, B&W 3003	
	crystal 3rd overtone (standard)	
	crystal socket	75-9131

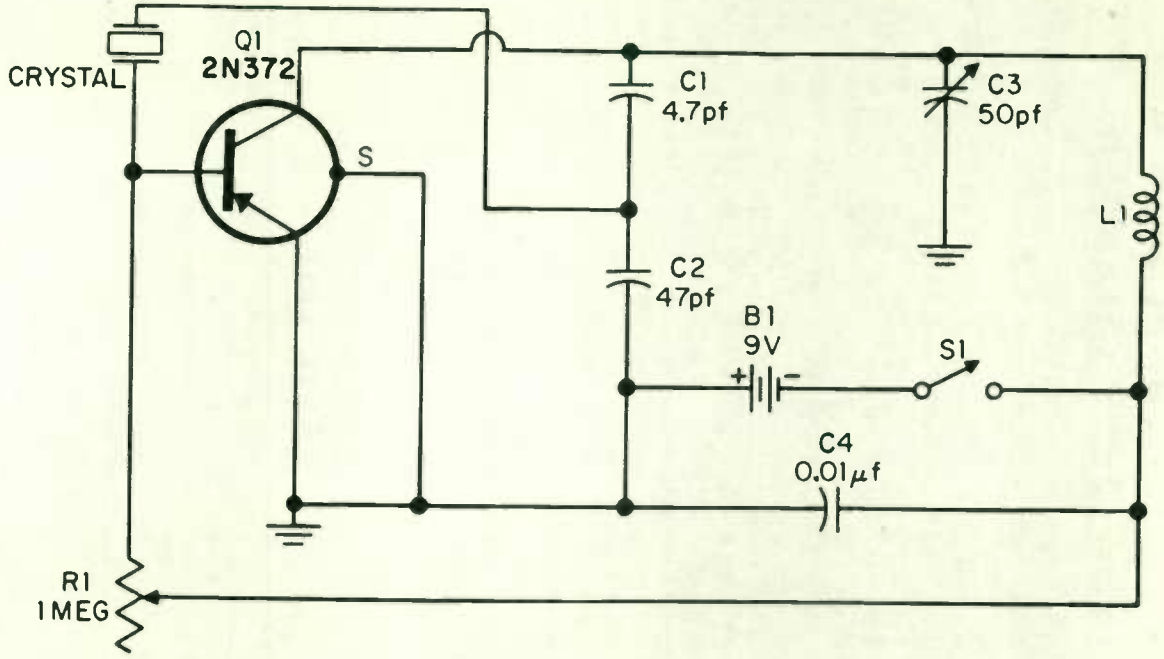


Fig. 6

No. 7 ELECTROPLATER AND BATTERY CHARGER

As an electroplater, this device should find many uses around any household. As a battery charger it will be of genuine value to all experimenters.

The unit is built in an aluminum chassis 5 in. x 9-1/2 in. x 2 in. The transistor should be mounted outside, on top of the aluminum chassis, so that it can have a heat sink—use a power transistor mounting kit as the transistor holder, so the case of the transistor will be insulated from the chassis.

T1 is a filament transformer which happens to be well-suited for stepping down house current to transistor-operating current. D1 and D2 are rectifiers connected for full-wave rectification. The transistor is protected from overload by a 1.5-ampere, 250-volt fuse F1, which is mounted in a fuse holder.

The output of this unit is 0 to 14 volts dc at 1 ampere. Controlling factor for the output is the 500-ohm wire wound resistor R1. The output can be measured by an external ammeter connected between J1 and the load.

For electroplating stainless steel, nickel, bronze, copper, brass, tin, and other metals, check any of the several inexpensive books on the subject for instructions on handling the necessary acids and other materials which are part of this interesting art.

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N1291	276-406
R1	resistor, 500 ohm, 10-watt, wirewound, with sliding contact	80-0101
T1	transformer, filament, 24-volt, 1 ampere	273-1480
F1	fuse, 1.5-ampere, 250-volt	77-2764
S1	switch, SPST	275-602
J1, J2	nylon binding post (set of 2)	274-736
D1, D2	rectifiers, 100 PIV, 1 ampere	276-1708
	fuse holder	270-739
	aluminum chassis	77-0347

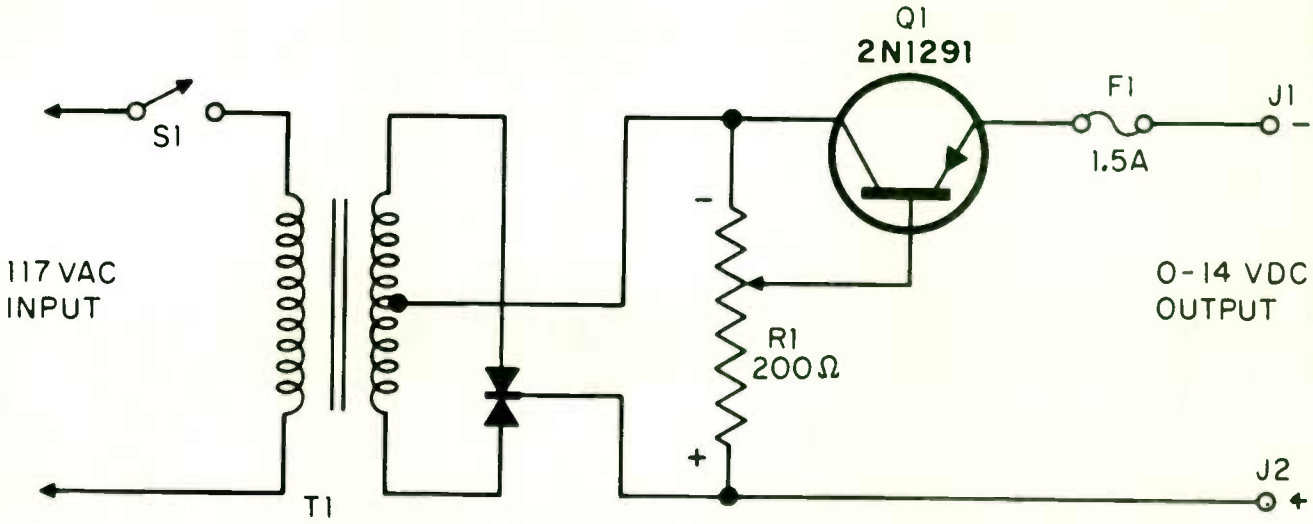


Fig. 7

No. 8 AM BROADCAST TUNER

This AM broadcast tuner will convert a phonograph or audio amplifier into a household radio. It has a high-impedance output.

The unit may be built in a small case about 1-1/2 in. x 2 in. x 2-1/2 in., either plastic or fiber.

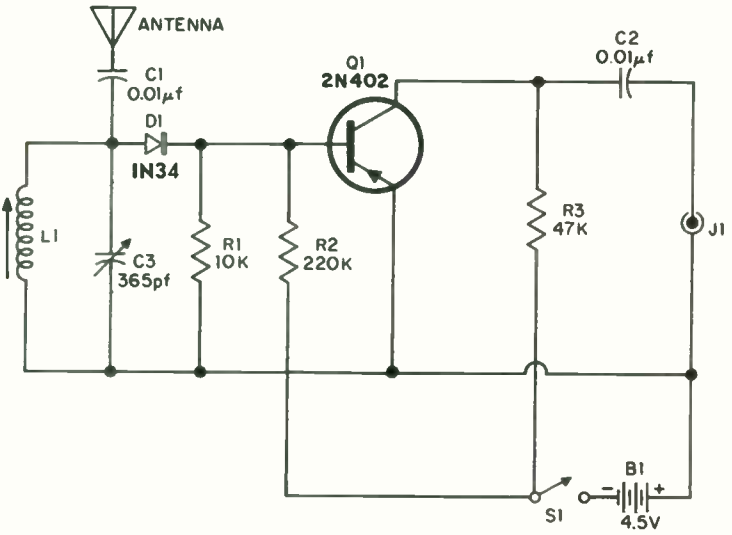


Fig. 8

S1 is the power switch. L1 is a ferrite antenna-tuning coil The output of the tuner is at J1, which is a standard phono jack.

The antenna does not have to be of any particular length—a random length of wire will suffice, the longer the better.

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N402	276-403
R1	resistor, 10,000 ohms	70-0195
R2	resistor, 220,000 ohms	70-0195
R3	resistor, 47,000 ohms	70-0195
C1, C2	capacitor, 0.01 mfd.	71-5194
C3	capacitor, 365 pf, variable	272-1343
D1	diode, 1N34	276-1709
S1	switch, SPST	275-602
J1	standard phono jack	75-0966
L1	ferrite coil (standard broadcast)	270-1430
B1	power supply, 4.5 volts (3 "D" cells)	23-466

No. 9 BATTERY ELIMINATOR

If you have constructed and experimented with transistor circuits, you may be getting weary of working with batteries. This device plugs into your household current and converts it to a supply of almost zero to 9 volts at 20 ma.

The circuit can be constructed in a 2-3/4 in. x 2-1/8 in. x 1-5/8 in. box. The transformer is a power transformer.

To protect the transistor, the current output requirement should not go over 20 ma. This can be checked with a 0–25 milliameter in the circuit at the output.

When working with a new circuit, start with the output all the way down (control knob fully counterclockwise), then slowly advance it (turn it clockwise) until the unit functions properly. It might be wise to insert the meter in the unit while testing all new circuits.

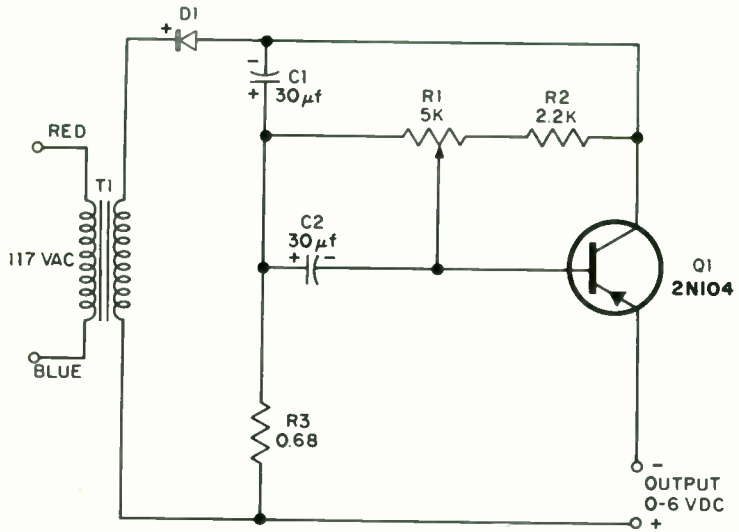


Fig. 9

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N104	276-403
R1	potentiometer, 5,000 ohms	271-1714
R2	resistor, 2,200 ohms	70-0195
R3	resistor, 10 ohms	70-0195
C1, C2	capacitor, 30 mfd	272-961
T1	transformer, power, 110-volt 60 cycle primary, 12.6-volt secondary, 1.2 amp.	273-1505
D1	rectifier, 1 ampere, 100 PIV.	276-1708
	aluminum box	77-0677

No. 10 SUPERSONIC TRANSCEIVER

Here's an experiment in supersonic communications—even though the unit described has a very short range. The transmission range of the unit can be greatly increased by the addition of a transistor audio amplifier to the circuit.

Heart of the circuit is a type SQ7 transistor. The headphones are 2,000 ohms impedance.

Coil L1 consists of exactly 5 turns of No. 12 wire wound on an 18-in. diameter by 5/8-in. high form (try the top of a basket). Turns should be spaced 1/8 in. on centers. L2 is one turn. Both transceivers must have exactly the same coils for communications.

To test the units, place them two feet apart on a wooden table-top. Press the key on one of the units—a click should be heard in the headphones of both units. Try this with the other unit. If all is well with both units, leave both keys closed and manipulate the spacing of the coils until a pure tone is heard.

For receiving—one transceiver should have its key held closed while someone keys the other unit.

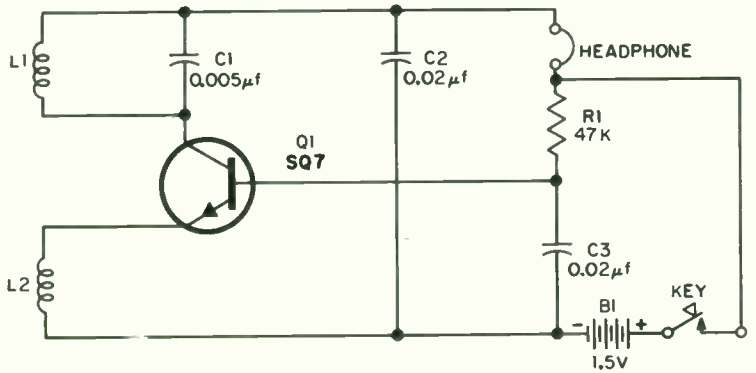


Fig. 10

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, SQ7	276-409
R1	resistor, 47,000 ohms	70-0195
C1	capacitor, 0.005 mfd	71-5190
C2, C3	capacitors, 0.02 mfd	71-0452
B1	1.5 volts (1 "D" cell)	23-466
L1	coil, 5 turns No. 12 on 18-in. D. x 5/8-in. high form	
L2	coil, 1 turn	
	headphones, 2,000 ohms impedance	33-180
	telegraph key	20-1085

No. 11 ELECTRONIC ORGAN

Here is an interesting experiment in audio which would make a nice toy for a child.

Our electronic organ will play but one note at a time—its keys being made of spring-return pushbuttons (like doorbell buttons) mounted on a board.

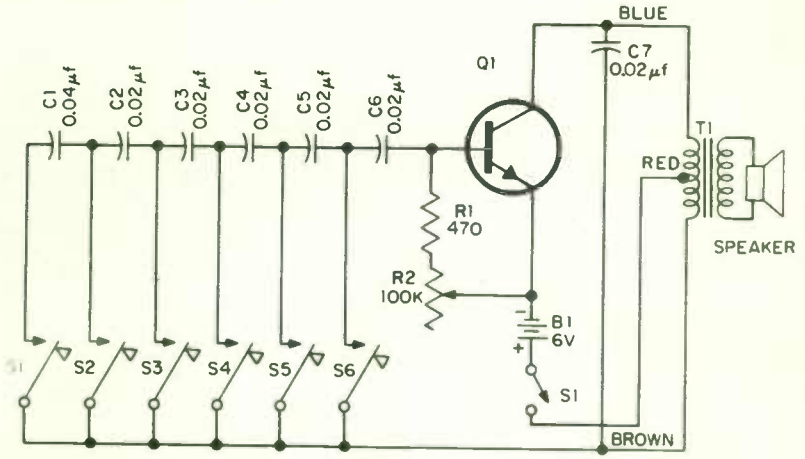


Fig. 11

The best loudspeaker to use in this circuit is an 8-ohm unit, 2-3/4 inches in diameter (see parts list). Connect the speaker to the secondary winding terminals No. 1 and No. 2 of T1, an AF output transformer, with a 1000-ohm CT primary and an 8-ohm secondary.

To raise the tonal range of the unit, change the value of the 0.05 mfd. capacitor, C1, to 0.02 mfd. The 100,000 ohm potentiometer controls the frequency range.

The unit is turned on and off by means of S7, a SPST switch.

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N1291	276-406
R1	resistor, 470 ohms	70-0195
R2	potentiometer, 100,000 ohms	271-092
C1	capacitor, 0.05 mfd.	71-0407
C2, C3, C4, C5, C6, C7	capacitor, 0.02 mfd.	71-0452
S1, S2, S3, S4, S5, S6	switch, pushbutton, spring-return, SPSR	275-1385
S7	switch, SPST	275-602
T1	transformer, AF output, 1000-ohm CT. prim., 8-ohm sec.	273-1380
SPKR	speaker: 8-ohm, 2¾ in.	40-262
B1	power supply, 6 volts (4 "D" cells)	23-466

No. 12 TELEPHONE AMPLIFIER

The telephone amplifier described here will enable you to play a telephone conversation for a group of people, or it can be used for the hard of hearing.

The transformer is a transistor audio output type with a 500-ohm primary impedance. L1 is an induction coil designed for telephone pickup. When this coil is placed in proximity to a telephone line, the magnetic flux created by the voltage in the line will induce a voltage in the coil and an input will be coupled into the amplifier through capacitor C1. Each transistor provides a stage of amplification which is coupled to the speaker by output transformer T1.

Be careful not to place the amplifier's loudspeaker too close to the telephone's transmitter, or you'll have feedback problems. The 5,000 ohm potentiometer is the volume control and may be helpful in controlling feedback.

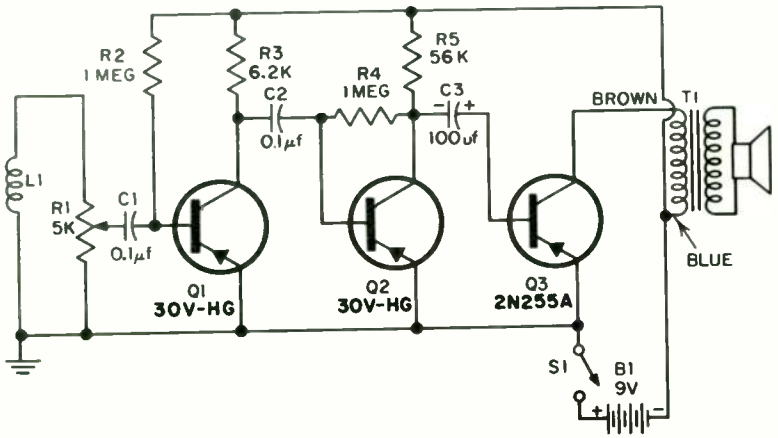


Fig. 12

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1, Q2	transistors	276-404
Q3	transistor, 2N255A	276-406
R1	potentiometer, 5,000 ohms	271-1714
R2, R4	resistors, 1,000,000 ohms	70-0195
R3	resistor, 6,800 ohms	70-0195
R5	resistor, 5,600 ohms	70-0195
C1, C2	capacitors, 0.1 mfd.	71-0409
C3	capacitor, 100 mfd.	272-963
T1	transformer, transistor audio output type, with 500-ohm primary impedance	273-1380
L1	induction coil for telephone pickup	44-533
B1	9-volt battery	23-464
S1	switch, SPST	275-602
	miniature speaker, 8-10 ohms, 2¾ in.	40-262

No. 13 HIGH SENSITIVITY HEARING AID

This unit was designed to fit in a tiny plastic box. With it you will be able to increase your hearing range so that you can hear a whisper from across a large room.

Construction is not difficult. Use a miniature microphone, and a hearing-aid or magnetic transistor-portable type earphone.

The volume control is the 10,000-ohm potentiometer R1. The tone control is the 50,000-ohm potentiometer R3. R1 is also the on-off switch. The headphone plugs into J1, which is a miniature phono jack.

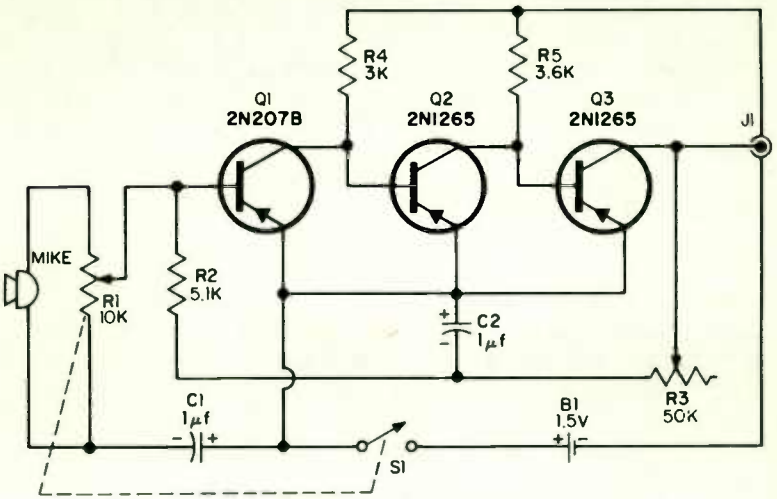


Fig. 13

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N207B	276-405
Q2, Q3	transistors, 2N1265	276-403
R1	potentiometer, 10,000 ohms, with switch	271-1443
R2	resistor, 4,700 ohms	70-0195
R3	potentiometer, 50,000 ohms	271-1716
R4	resistor, 3,300 ohms	70-0195
R5	resistor, 3,900 ohms	70-0195
C1, C2	capacitors, 1 mfd.	71-0416
S1	switch, part of R1	
J1	miniature phono jack	75-3392
B1	1.5 volts (1 "D" cell)	23-466
	microphone: miniature, 1850 ohms, 400-3500 cps	

No. 14 CLOROX POWERED AM RADIO

This little crystal receiver has a transistor amplifier and a *Clorox* laundry bleach power supply.

L1 and L2 are standard ferrite loopsticks.

The electrodes consist of a 3-in. strip of zinc and a 3-in. copper rod. For operation of the receiver, place both in a glass of *Clorox* laundry bleach.

String up a long antenna, ground the set to a cold water pipe or other good ground, and you have a receiver which will never need battery replacement (except as the *Clorox* evaporates or the zinc eventually disintegrates).

The 365-pf variable capacitor will enable you to tune across the standard AM broadcasting band.

Stations can be heard on any low-impedance headset.

To adjust the set for proper operation, move the L2 slug all the way in, and tune with the variable capacitor until a station is heard. Then adjust L1 for maximum volume. L2 should then be adjusted so that the widest possible segment of the broadcast band can be tuned with the variable capacitor.

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N1097	276-405
C1	capacitor, 100 mfd.	272-963
C2	capacitor, 365-pf variable	272-1341
L1, L2	standard ferrite loopstick	270-1430
D1	diode, 1N34	276-1709
	electrodes: 3-in. strip of copper; 3-in. strip of zinc	
	Clorox	
	headphone—low impedance	33-175

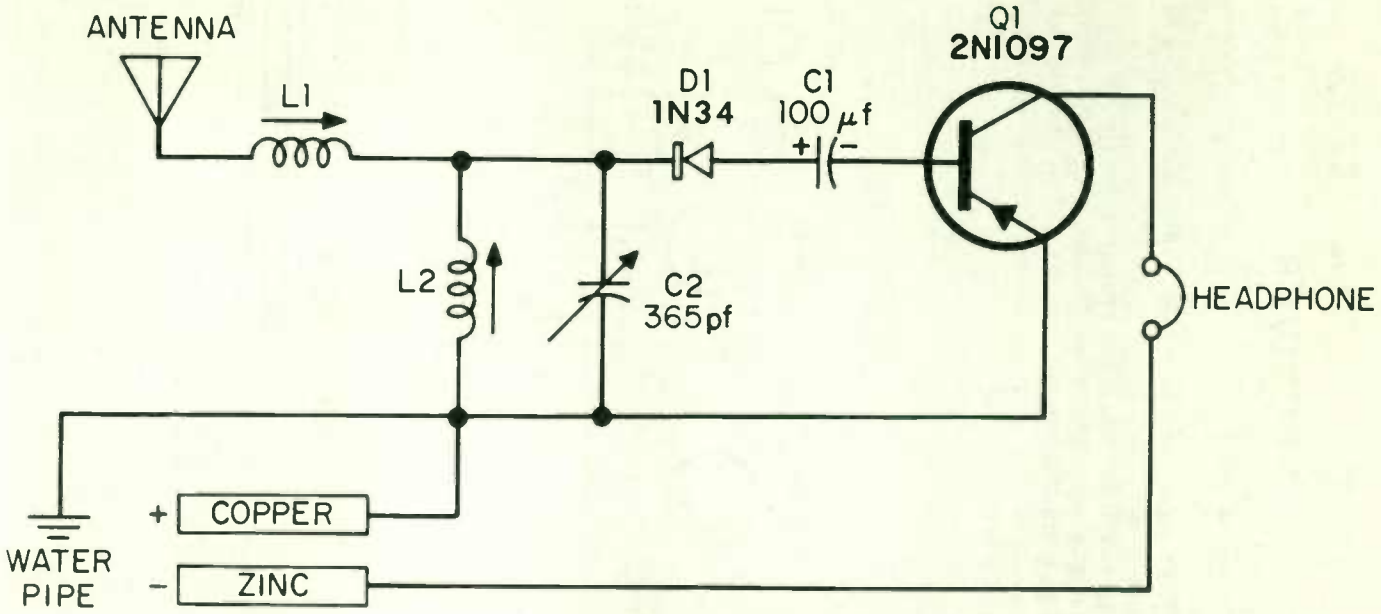


Fig. 14

No. 15 TWO-TRANSISTOR RECEIVER

This receiver was designed for use with an inexpensive crystal earphone.

The coil, L1, is a regular vari-loopstick. Tuning is accomplished by the 365-pf variable capacitor.

To adjust the circuit for maximum operation, set the variable capacitor for minimum capacity and tune the coil's slug so that the highest frequency local broadcast station in your area can be heard well.

A 32-in. antenna will give good results for portable use; for fixed use, the longer the better.

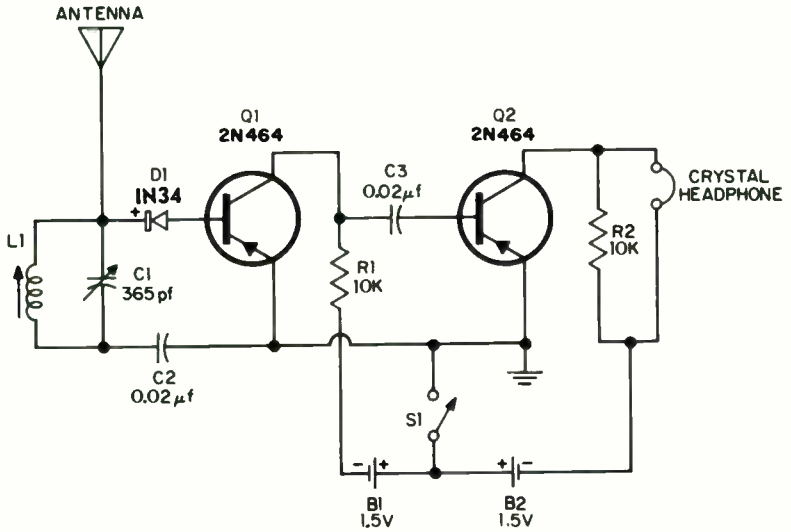


Fig. 15

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1, Q2	transistors, 2N464	276-403
R1, R2	resistors, 10,000 ohms	70-0195
C1	capacitor, 365-pf variable	272-1343
C2, C3	capacitors, 0.02 mfd.	71-0424
D1	diode, 1N34	276-1709
L1	vari-loopstick	270-1430
	antenna, 32 in.	
	crystal headphone	
B1, B2	power supply, 1.5 volts each (1 "D" cell each)	23-466

No. 16 AUDIO MIXER

The Audio Mixer permits two-microphone operation for audio and recording applications or for mixing microphone and radio signals into a recording machine.

The three jacks can be any type which is compatible with your existing equipment.

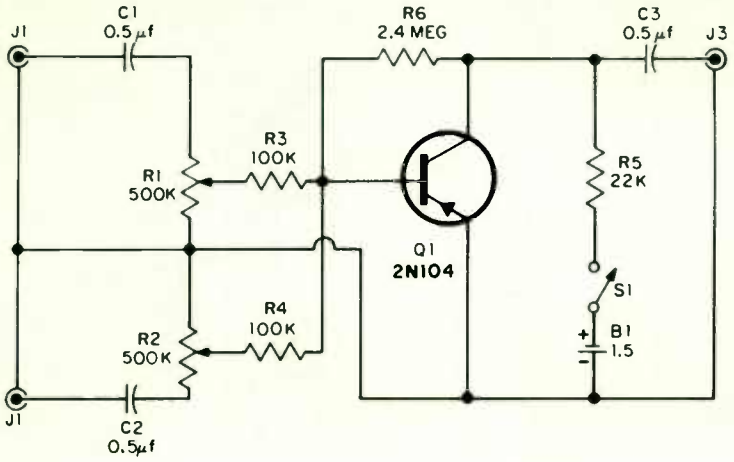


Fig. 16

Signals coming through J1 and J2 are mixed by the two 500,000 ohm potentiometers, fed into the 2N104, and the mixed signal at the output of transistor Q1 is available for use at J3.

It is suggested that this circuit be housed in a metal box and that all wiring be shielded wire to eliminate the possibility of hum.

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N104	276-403
R1, R2	potentiometers, 500,000 ohms	271-210
R3, R4	resistors, 100,000 ohms	70-0195
R5	resistor, 22,000 ohms	70-0195
R6	resistor, 2.2 megohms	70-0195
C1, C2, C3	capacitors, 0.5 mfd.	71-0468
J1, J2, J3	standard phono jacks	75-0966
S1	switch, SPST	275-602
B1	power supply, 1.5 volts (1 "D" cell)	23-466

No. 17 THE KEY-CLICK KILLER

This circuit was developed to eliminate those annoying clicks and thumps which plague the transmissions of many CW operators.

The key plug is inserted in jack J1, and plug J2 is inserted in the transmitter key-jack, thereby placing the whole circuit between the key and the transmitter. *Do not leave the key pressed down* when this device is in the circuit.

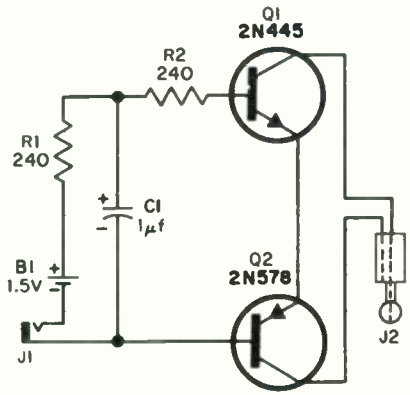


Fig. 17

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N445	276-410
Q2	transistor, 2N578	276-401
R1, R2	resistors, 220 ohms	70-0195
C1	capacitor, 1 mfd.	71-0416
J1	jack	75-3392
J2	plug	75-3394

No. 18 CATHODE MODULATOR FOR CW TRANSMITTERS

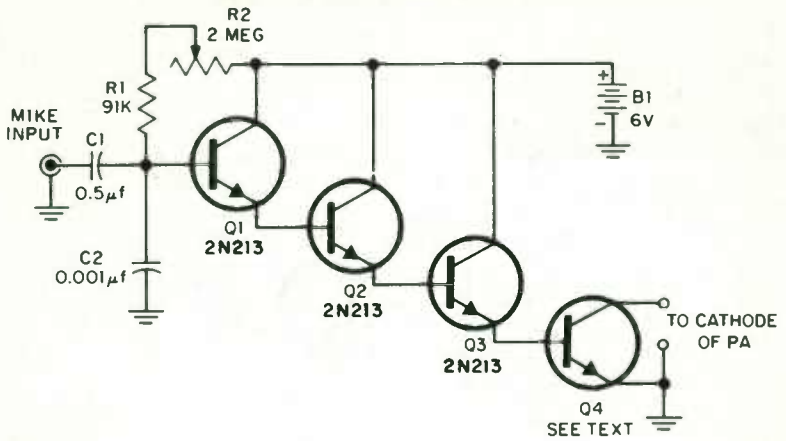


Fig. 18

If your low-power ham CW transmitter is set up for cathode keying, this unit plugs directly into the key jack (instead of the key) and converts the transmitter from CW operation to phone operation with about 75% modulation. The circuit also acts as a clamp and will limit the amount of cathode current should the final amplifier stage lose drive.

Q4 should be chosen to suit your individual transmitter. The amount of cathode current which will flow through it will be the determining factor. It is an n-p-n type.

Use a crystal lapel microphone at the input of the device.

To use the modulator, tune up as you would for normal CW operation. Adjust R2 until you get a reading of maximum change in cathode current as you modulate.

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1, Q2, Q3	transistors, 2N213	276-410
Q4	transistor, (see text)	
R1	resistor, 100,000 ohms	70-0195
R2	potentiometer, 2 megohms	271-093
C1	capacitor, .5 mfd.	71-468
C2	capacitor, 0.001 mfd.	71-5123
B1	4"D" cell batteries	23-466
	lapel microphone, crystal	33-100

No. 19 CARBON MIKE PREAMPLIFIER

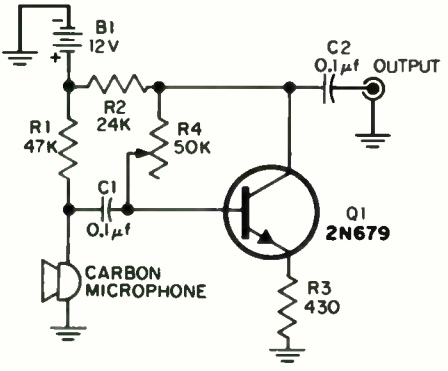


Fig. 19

Boosting the normally low output of a carbon microphone is a simple task with this preamp.

The quality of the audio output will vary as the volume control is varied. A satisfactory level of volume with good audio quality can be achieved by proper adjustment.

Construct the preamplifier in an aluminum minibox, with all ground points to the box. Keep leads as short as possible.

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N679	276-411
R1	resistor, 47,000 ohms	70-0195
R2	resistor, 22,000 ohms	70-0195
R3	resistor, 470 ohms	70-0195
R4	potentiometer, 50,000 ohms	271-1716
C1, C2	capacitor, 0.1 mfd.	71-0409
	carbon microphone	279-1425
B1	8 "D" cells	23-466

No. 20 PUBLIC ADDRESS SYSTEM

This miniature PA system can be built right into the speaker enclosure, power supply and all.

The unit is supplied with audio from any carbon mike having *good sensitivity*.

The 2N174 transistor is a rugged power transistor connected directly to the 6-volt battery supply and whose output drives the speaker directly.

It operates when microphone input is supplied at J1, and the power switch S1 is on.

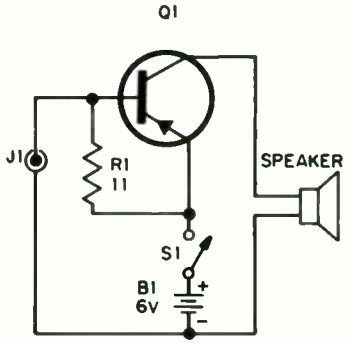


Fig. 20

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N174	276-407
R1	resistor, 10 ohms	70-0195
J1	phono input jack	75-0966
S1	toggle switch, SPST	275-602
B1	4 "D" cells	23-466
	speaker, heavy magnet	40-262

No. 21 NOISE LIMITER

This is a straightforward design utilizing 2 diodes functioning in the manner of a 6AL5 vacuum tube.

The unit can be built in a small metal box and mounted near the mobile rig. The only operating control is switch S1, which simply cuts the limiter in and out of the receiver's circuit.

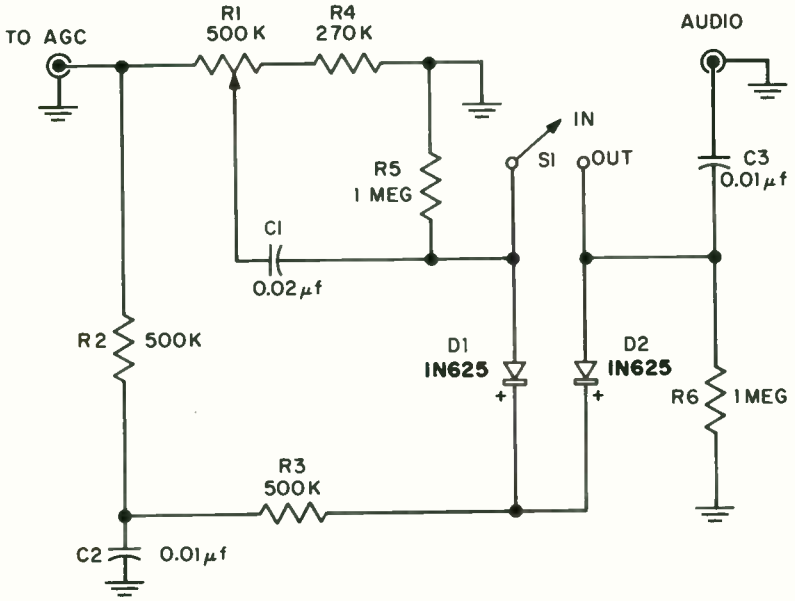


Fig. 21

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
R1	potentiometer, 500,000 ohms	271-210
R2, R3	resistors, 560,000 ohms	70-0195
R4	resistor, 270,000 ohms	70-0195
R5, R6	resistors, 1 megohm	70-0195
C1	capacitor, 0.02 mfd.	71-0424
C2, C3	capacitor, 0.01 mfd.	71-5194
D1, D2	diodes, 1N625	276-418
S1	switch, SPST	275-602

No. 22 HIGH-TO-LOW-IMPEDANCE MIKE MATCHER

This device enables you to match high-impedance microphones into low-impedance inputs.

Build the mike matcher in a metal box, hooking all ground leads to the box to prevent hum. Use shielded wire for hookup purposes.

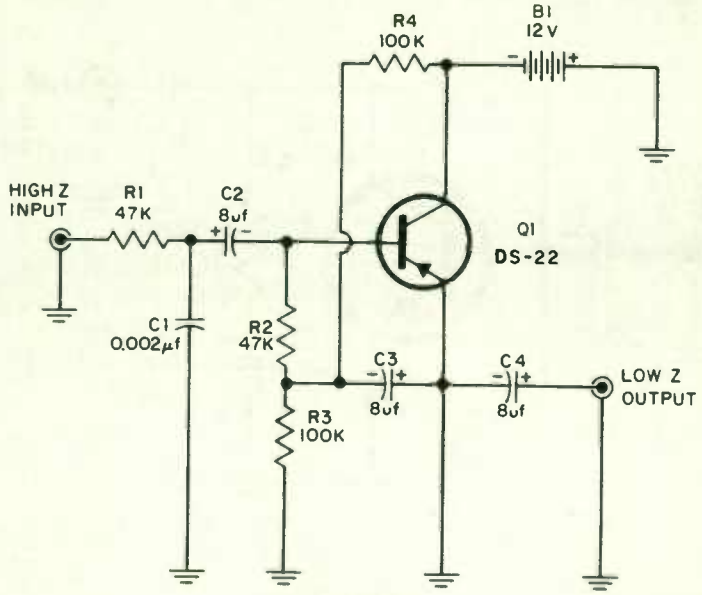


Fig. 22

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, DS-22	276-401
R1, R2	resistors, 47,000 ohms	70-0195
R3, R4	resistors, 100,000 ohms	70-0195
C1	capacitor, 0.002 mfd.	71-5182
C2, C3, C4	capacitors, 10 mfd.	272-960
B1	12 volts, 8 "D" cell batteries	23-466

No. 23 LOW-TO-HIGH-IMPEDANCE MIKE MATCHER

This device enables you to match low-impedance microphones into high-impedance inputs.

The transistor is a PNP type audio transistor.

Build the mike matcher in an aluminum minibox with all ground connections made to the box to prevent hum. Use shielded wire for hookup purposes.

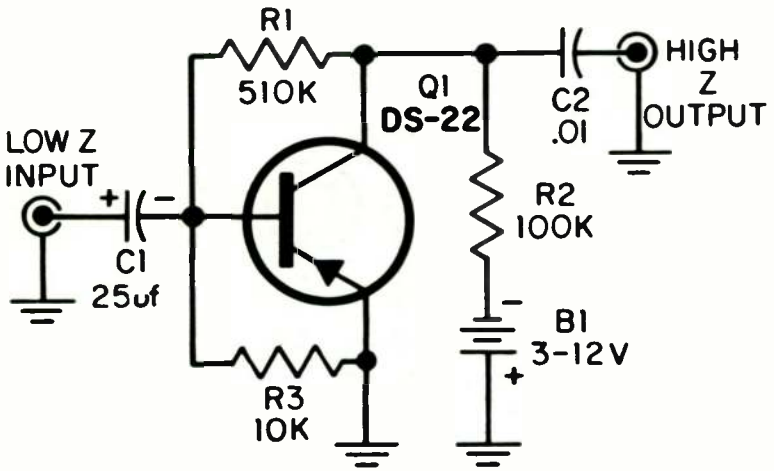


Fig. 23

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 9-volt audio	276-405
R1	resistor, 560,000 ohms	70-0195
R2	resistor, 100,000 ohms	70-0195
R3	resistor, 10,000 ohms	70-0195
C1	capacitor, 30 mfd.	272-961
C2	capacitor, 0.01 mfd.	71-5197
B1	9-volt battery	23-464

No. 24 "NO-POWER" RECEIVER

Here's a receiver which requires no power supply, and it's *not* a crystal set.

The stations are tuned with the 365-pf variable capacitor in the antenna and are heard best over high-impedance magnetic headphones.

A long wire antenna will give good results, and the set should be grounded to a cold water pipe.

L1 is a vari-loopstick. L2 consists of 6 turns of No. 22 wire wound over the loopstick's coil. Experiment with L2's connections; the set might work better with them reversed.

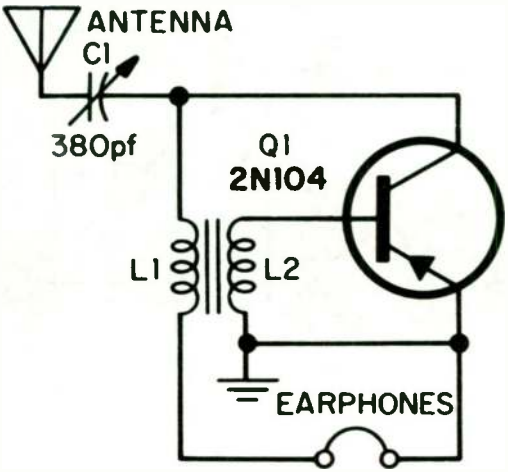


Fig. 24

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N104	276-403
C1	capacitor, 365-pf variable	272-1341
L1	vari-loopstick	270-1430
L2	6 turns No. 22 wire on loopstick's coil	
	antenna—see text	
	earphones, high impedance magnetic	33-180

No. 25 RECEIVER WITH PUSH-PULL AMPLIFICATION AND DETECTION

This interesting circuit is rather unique in that it uses a bridge type detector which provides a push-pull output signal which, in turn, drives a push-pull amplifier circuit.

The antenna coil L1 is a ferri-loopstick. The transformer drives a miniature 8-10-ohm speaker.

The antenna should be a long wire, and best results will be obtained when the unit is connected to a good ground such as a cold water pipe.

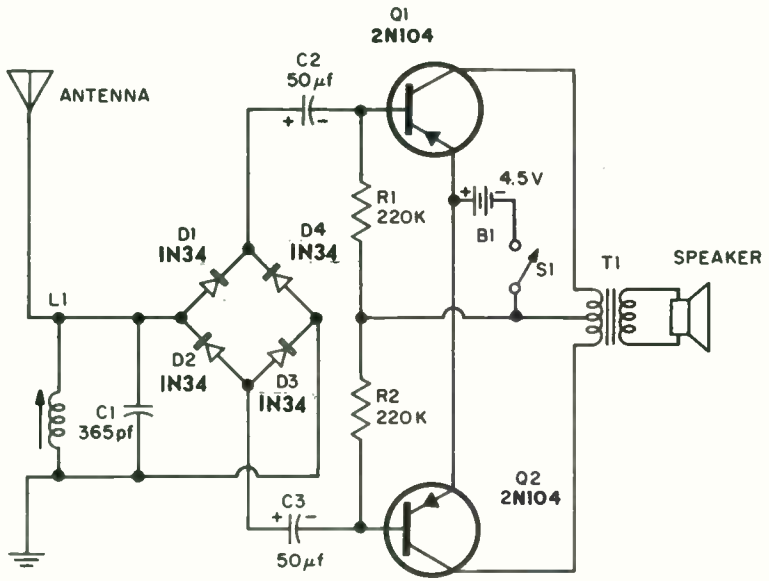


Fig. 25

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1, Q2	transistors, 2N104	276-407
R1, R2	resistors, 220,000 ohms	70-0195
C1	capacitor, 365-pf, variable	272-1343
C2, C3	capacitor, 50 mfd.	272-962
L1	ferri-loopstick	270-1430
T1	transformer	273-1380
D1, D2, D3, D4	diodes, 1N34	276-1709
S1	switch, SPST	275-602
B1	3 "D" cell batteries	23-466
	speaker, 8-10 ohms	40-262
	antenna, long wire	

No. 26 AM RADIO BOOSTER

If your small AM radio does not seem to be able to bring in distant stations clearly, or if your BCB DX receiver can use a little more "zip," this circuit should be immediately put to use.

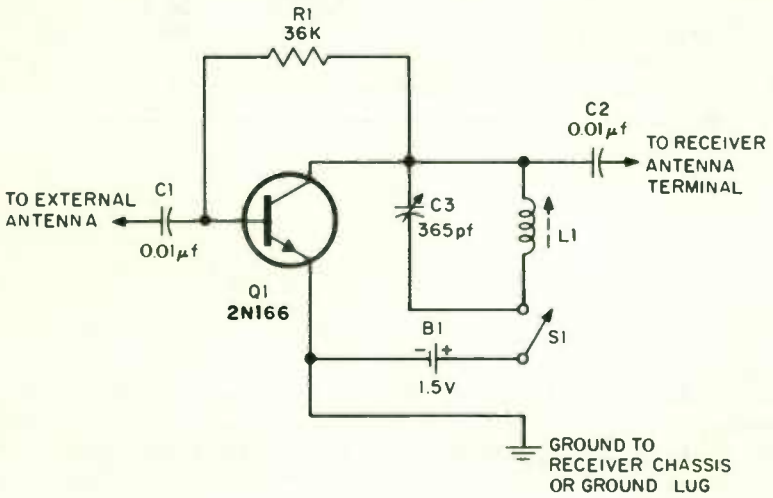


Fig. 26

L1 is a regular ferri-loopstick. The unit can be built in an aluminum minibox and mounted in the rear of the receiver cabinet. The loopstick and the 365-pf capacitor should be peaked to the center of the band for regular listening (1080 kc) or to any particular frequency you wish to bring in better than the others.

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N166	276-409
R1	resistor, 39,000 ohms	70-0195
C1, C2	capacitors, 0.01 mfd.	71-5194
C3	capacitor, 365-pf variable	272-1343
L1	ferri-loopstick	270-1430
S1	switch, SPST	275-602
B1	1.5 volts, (1 "D" cell battery)	23-466

No. 27 CURRENT REVERSER

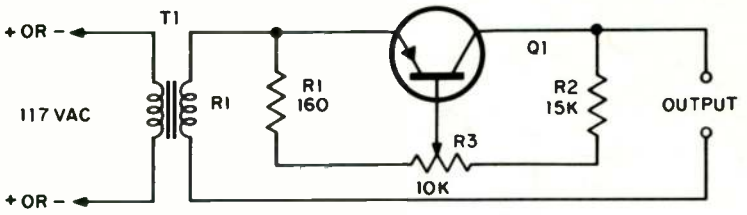


Fig. 27

This is an interesting experiment in electrical polarity. The device puts out a few volts of pulsating dc and you can reverse the polarity of the circuit, resulting in changing the operation of anything which is being powered by the device. For instance, if you connect a 1.5-volt d-c motor to the output of the reverser, it will run in one direction. By rotating the potentiometer slowly, the motor will slow down, then stop, slowly start up in the opposite direction, increasing in speed as you go. The center of the potentiometer is zero volts.

A filament transformer is used to operate from house current and supply the six volts required to operate the transistor.

The unit can also be used as a dimmer for small bulbs and other lighting devices.

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N301	276-406
R1	resistor, 150 ohms	70-0195
R2	resistor, 15,000 ohms	70-0195
R3	potentiometer, 10,000 ohms	271-1715
T1	filament transformer, 6.3 volts @ 1.2A	273-050

No. 28 WORLD'S SMALLEST TRANSMITTER?

This is a real low-power "spy" type transmitter which can be used at transmitter hunts when you are not engaged in spying activities.

Designed for operation on a relatively wide range of frequencies, operation on 80 meters is simple with a 17-inch whip antenna doing the honors.

The 1-meg potentiometer controls the bias to the transistor; it may be omitted from the circuit, but will often improve operation of the transmitter.

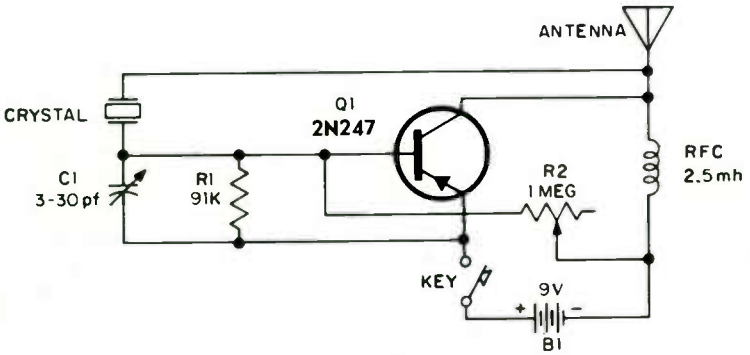


Fig. 28

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N247	276-412
R1	resistor, 100,000 ohms	70-0195
R2	potentiometer, 1 megohm	271-211
C1	capacitor, 4-40 pf, variable	71-4030
L1	r-f choke: 2.5 mh	270-1713
B1	battery, 9 volts	23-464
	telegraph key	20-1085
	antenna: 17-inch whip	
	crystal socket	75-9131

No. 29 VLF "WHISTLER" RECEIVER

The VLF portion of the RF spectrum runs from 4 to 16 kc. If you monitor this portion of the radio spectrum, you are liable to hear the strange sounds which mother nature makes in the RF spectrum. These are called "whistlers," long descending screams caused by lightning. You can also hear sounds called "the dawn chorus," "clicks," "chirps," "chinks," and other phenomena which science has yet to explain. Atomic blasts and the ionized air trails from rising missiles can also be heard. The device described here will permit you to monitor these strange signals. By the way, if you should hear some CW, it is probably the U.S. Navy's 2-million-watt radio station in Cutler, Maine. They operate on 14.8 kc.

The unit may be built on a small piece of punched board, and can be enclosed in a metal box if you desire. Parts layout is not critical.

The loop antenna consists of 200 turns of No. 25 enameled wire wound in a square loop on a wooden frame. The frame should consist of two 48-in. pieces of wood formed into an "X". The loop is joined to the unit by a length of lamp cord. Mount the loop so that it may be rotated. The rotation is necessary because of the fact that it will pick up considerable power-line hum. The loop should be rotated to a point where the hum is at it's minimum, or "null," point—where it should be permanently located.

With the antenna properly located, and the output of your unit fed into the high-impedance input of a hi-fi amplifier, you should be able to hear the clicks and pops of atmospheric noise. Early morning should bring you the dawn chorus; summertime, the whistlers; launching time, the missiles. Look for anything that differs from the normal background noise as being something worth studying.

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N64	276-404
Q2	transistor, 2N104	276-403
R1	resistor, 470 ohms	70-0195
R2	resistor, 10,000 ohms	70-0195
R3	resistor, 330,000 ohms	70-0195
R4	resistor, 5,600 ohms	70-0195
C1	capacitor, 10 mfd.	271-953
C2	capacitor, 5 mfd.	271-952
C3, C4	capacitor, 0.02 mfd.	71-0452
L1	loop antenna (see text)	
S1	switch, SPST	275-602
B1	6 volts (4 "D" cell batteries)	23-466

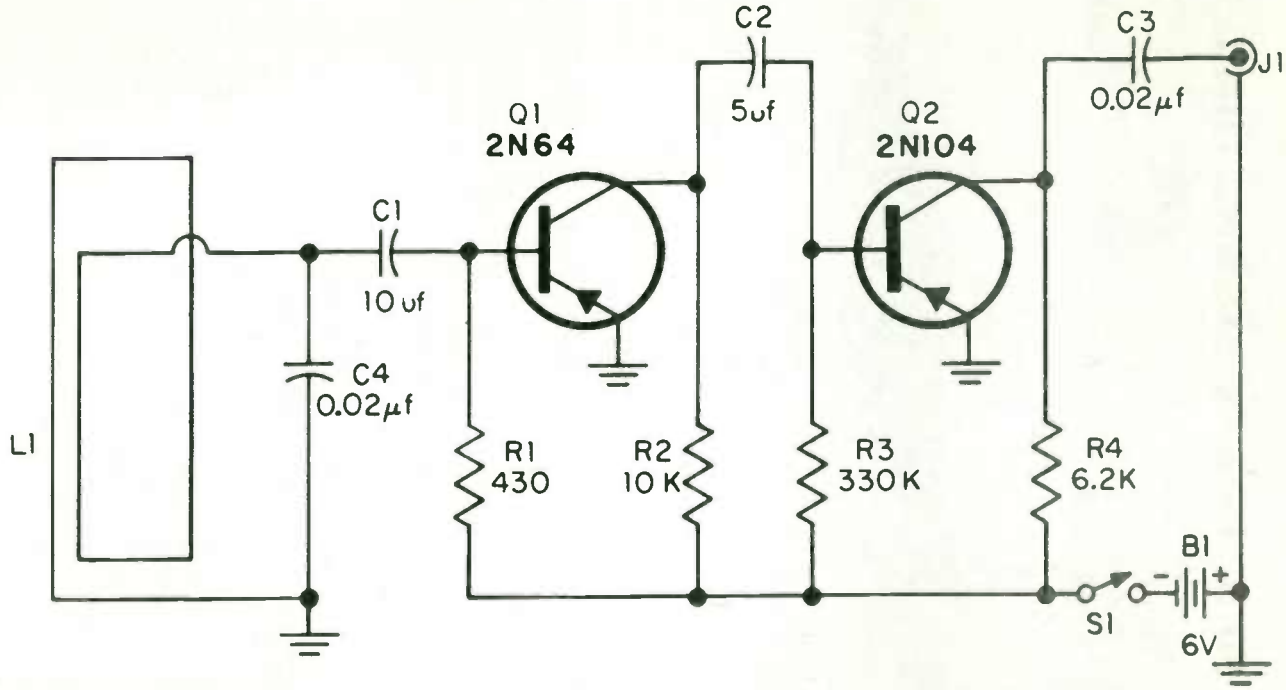


Fig. 29

No. 30 RADIO-TV SIGNAL TRACER

This device can be used to follow a signal through its course in the circuit of a radio or TV set, or an audio amplifier.

The device can be constructed in a small plastic case. Use a midget audio transformer to drive the midget PM type speaker. A DPDT slide switch is used as a selector for use with af or rf circuits. Volume control is provided by the 25,000 ohm potentiometer at the input to transistor Q1. Any short, stiff piece of wire can be used as the probe—a nail will suffice.

The unit is designed to be grounded to the chassis of the equipment being serviced. This is accomplished by a short length of wire and an alligator clip. The ground lead and all but the tip of the alligator clip should be insulated to prevent the tracer from grounding to components within the equipment.

When testing audio equipment, S1 should be turned towards *af;* when testing radios and TV sets, towards *rf.*

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N707	276-407
Q2	transistor, 2N104	276-403
R1	resistor, 100,000 ohms	70-0195
R2	potentiometer, 25,000 ohms	271-094
R3, R4	resistors, 270,000 ohms	70-0195
R5	resistor, 4,700 ohms	70-0195
R6	resistor, 100 ohms	70-0195
C1	capacitor, 0.05 mfd.	71-0407
C2	capacitor, 100 pf	272-963
C3, C4	capacitor, 3 mfd.	272-958
C5	capacitor, 10 mfd.	272-960
T1	transformer, primary: 1000 ohms C.T., secondary: 8 ohms	273-1380
S1	switch, DPDT	275-067
S2	switch (part of R2)	
D1	rectifier, 1N34	276-1709
B1	9 volt battery	23-464
	speaker, miniature PM	40-262

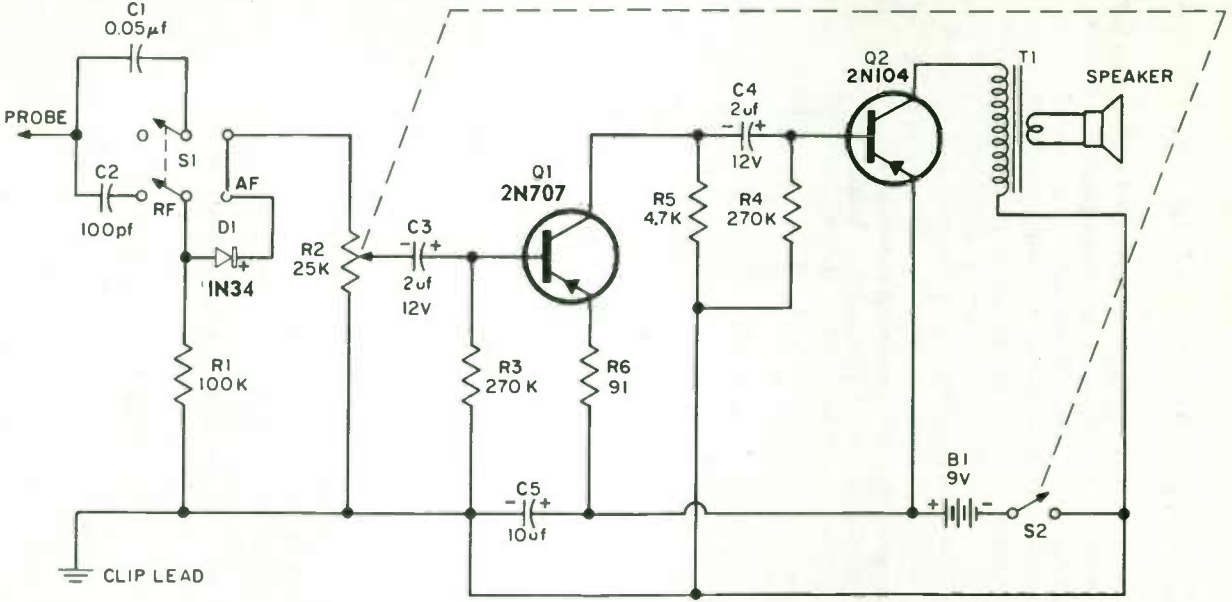


Fig. 30

No. 31 HEADSET BOOSTER

If you have used magnetic earphones, you have probably wondered what could be done to pep them up, or completely replace them. Here's the answer—for a small sum and very little effort you can build a booster which will substantially increase the sensitivity of the magnetic headset.

This unit is to be constructed in an aluminum minibox.

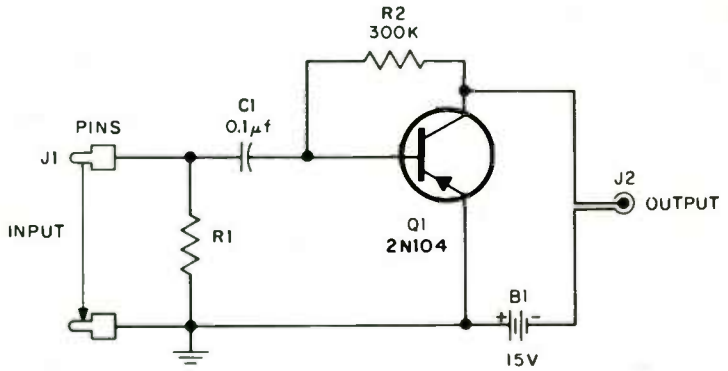


Fig. 31

Resistor R1 will vary depending upon the receiver and the output impedance of the receiver with which it will be used. Typical values are: vacuum tube sets—100,000 ohms, crystal sets—47,000 ohms, transistor sets—470 ohms.

The set turns on and off as the earphones are inserted into J2. This means that when you wire the unit, the battery should be hooked up last, and when you use it, the earphones should be removed from the unit at the end of usage. The earphones used with the booster can be anywhere from 500 ohms to 6,000 ohms.

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N104	276-403
R1	resistor (see text)	
R2	resistor, 330,000 ohms	70-0195
C1	capacitor, 0.1 mfd.	71-0409
B1	15-volt battery	23-509

No. 32 LIGHT/DARK MUSIC MAKER

The next time someone tells you that they like "light music," you can build this gadget and give them a serenade in the world's only *true* "light music." Yes, this device actually produces musical tones by changes in light and dark falling upon it.

The sun battery is a type B2M selenium photovoltaic cell, which delivers about 0.25 volts when operated under sunlight. The sensitive circuit described here, however, does not operate in full sunlight, but will sense differences in light, such as those caused by shadows.

The output transformer T1, drives a miniature speaker.

As the shadow of your hand passes over the photocell, different musical tones will be produced. (Do not expect the unit to be workable in a dark, or even almost-dark, room, and not in bright sunlight.)

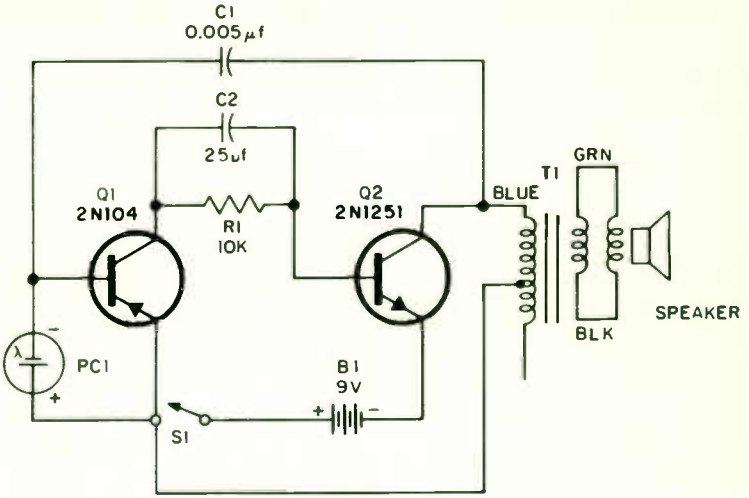


Fig. 32

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N104	276-403
Q2	transistor, 2N1251	276-410
R1	resistor, 10,000 ohms	70-0195
C1	capacitor, 0.005 mfd.	71-5190
C2	capacitor, 30 mfd.	272-961
T1	AF output transformer: 500-ohm CT primary, 3.2-ohm secondary	273-1379
PC1	selenium photovoltaic cell, type B2M	276-1025
S1	switch, SPST	275-602
B1	9-volt battery	23-464
	speaker, miniature, 2¾ in.	40-262

No. 33 THEREMIN

Perhaps you've heard recordings of this eerie musical instrument, or maybe you've heard its wailing sound in science fiction movies. At any rate you can construct your own Theremin without too much trouble—enjoy some strange "outer space" music and experiment with the effect capacitance can have on an oscillator circuit's frequency.

Our Theremin is constructed in a 7-in. x 5-in. x 2-in. metal box with a punched board as the chassis.

Parts are standard: two whip antennas are connected to 5-way binding posts J1 and J2. Vari-loopsticks are used as antenna tuning coils. The leads should be as short as possible, the shield connections on the two 2N1264 transistors should be cut off, and care should be taken not to let the circuit wiring come in contact with the cabinet box. The loopsticks should be in the center of the chassis. J1 and J2 mount on opposite sides of the 7-in. length of the chassis.

When the unit is constructed, the two whip antennas are placed in the binding posts in a vertical position. The unit is then placed near the back of an AM broadcast radio. The loopstick slugs are set about halfway in. Now adjust the 200-pf capacitor at J1 until a hissing noise is heard over the radio, at about the center of the band. Next adjust the 200-pf capacitor at J2 until you hear a very loud whistle. The AM radio's dial setting should not be changed.

Go back to the 200-pf capacitor at J1 and readjust it for the lowest pitch. You are now ready for playing the instrument.

To play the Theremin just move your hands around in the air a few inches away from the antennas. It is not necessary to touch the antennas. With a little practice you might be able to play a recognizable melody.

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N1097	276-405
Q2, Q3	transistor, 2N1264	276-412
R1	resistor, 180,000 ohms	70-0195
R2, R3	resistors, 56,000 ohms	70-0195
C1, C2	capacitors, 220 pf	71-5111
C3, C4	capacitors, 200 pf, variable	71-4035
C5, C6	capacitors, 0.01 mfd.	71-5194
L1, L2	vari-loopstick	270-1430
J1, J2	5-way binding post	274-333
S1	switch, SPST	275-602
B1	9-volt battery	23-464
	antenna: miniature whip, 38" long	-

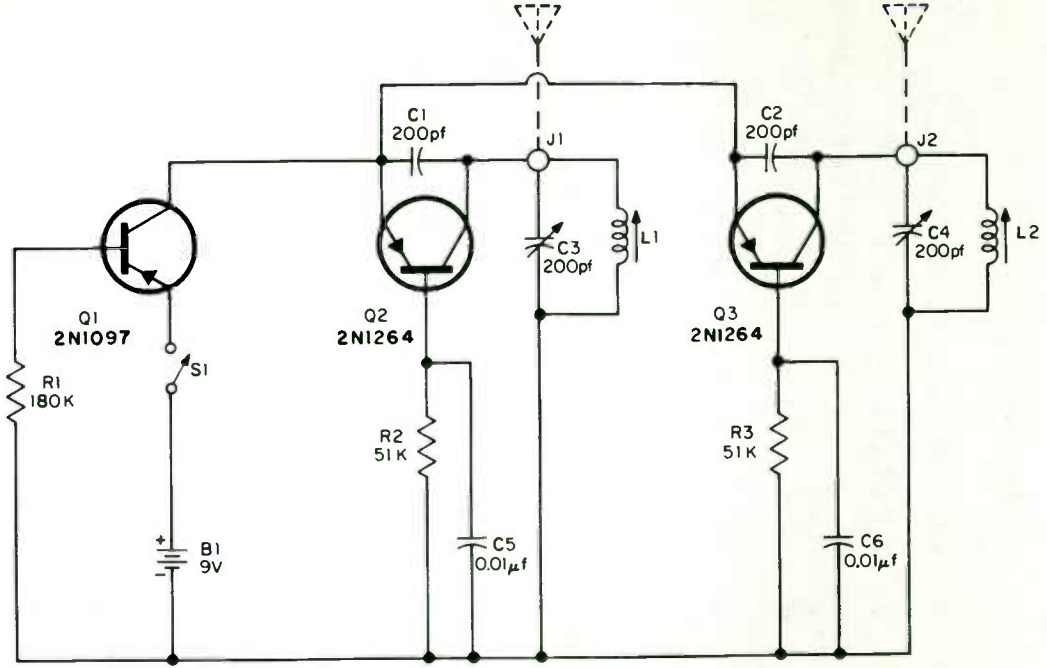


Fig. 33

No. 34 INTERPHONE AMPLIFIER

This circuit can be put to use as an inter-office or factory telephone amplifier.

Use a crystal microphone for the input, and a headset with 1,000 to 4,000 ohms impedance as the output. The 100,000 ohm potentiometer is the volume control.

This unit can be built into a relatively small space, even inside a telephone type handset. Two handsets, two units, the right kinds of transmitter and headset buttons, and you have an intercom system.

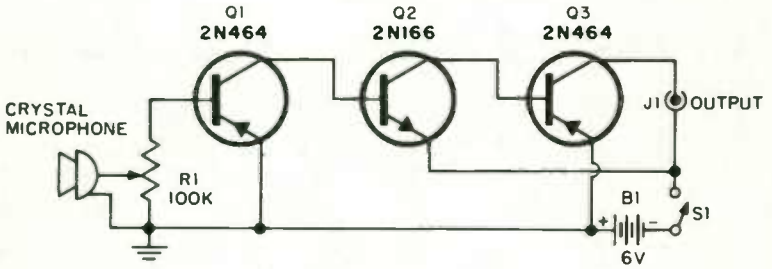


Fig. 34

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1, Q3	transistors, 2N464	276-403
Q2	transistor, 2N166	276-409
R1	potentiometer, 100,000 ohms	271-092
S1	switch, SPST	275-602
B1	6 volts, (4 "D" cell batteries)	23-466
	Microphone: crystal	33-100

No. 35 SUPERSONIC RECEIVER

Here's an interesting experiment in supersonic sound. This receiver acts like a radio receiver; any radio receiver or an audio amplifier can be the transmitter.

The receiver circuit may be constructed on a small piece of unclad perf-board. The sensing device which picks up the signal from the transmitting loop is a telephone pickup unit. The volume is controlled by the 5,000 ohm potentiometer which also contains the on-off switch. Spaghetti tubing should be used to cover the lead from the pickup coil to the 0.1-mfd. capacitor C1.

The transmitting antenna is a loop of wire strung around the room or area in which the reception will take place. The loop of wire is connected at each of its ends to the speaker connections of a radio or amplifier. The loop's impedance must match up with that of the receiving unit.

Use insulated wire of the thinnest gauge available for the loop. You should have a 10-ohm resistor of the same wattage rating as the amplifier inserted in series with the loop.

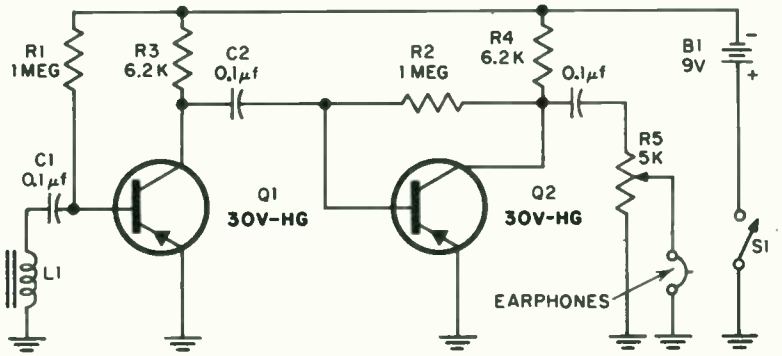


Fig. 35

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1, Q2	transistors, 30V-HG	276-405
R1, R2	resistors, 1 megohm	70-0195
R3, R4	resistors, 5,600 ohms	70-0195
R5	potentiometer, 5,000 ohms with switch	271-1620
C1, C2	capacitor, 0.1 mfd.	71-0409
L1	telephone pickup	44-533
S1	switch (part of R5)	
B1	9 volt battery	23-464
	earphones	33-180

No. 36 EXPERIMENTER'S POWER SUPPLY

This is more or less a battery eliminator to give your transistor circuits a little versatility and to save you the trouble of working with batteries of various sizes and shapes. It will deliver zero to 12 volts dc at half an ampere.

The unit can be constructed in an aluminum minibox with the transistor mounted on the box as a heat sink. An insulated power transistor socket is necessary for this circuit so that the 2N307A transistor does not ground to the chassis.

The bridge rectifier circuit consists of four silicon rectifiers whose balanced output is adjusted to drive the 2N307A transistor. It operates from a 117-volt, 60-cycle primary source through a 24-volt power transformer. A dc voltmeter is connected across the output as an aid in adjusting to the desired output voltage.

To operate, turn the unit on by plugging it into a 117-volt outlet, with the 500-ohm potentiometer set at its minimum position, and the desired load across terminals N and P. Slowly increase the potentiometer by turning it clockwise until a voltage can be read on the meter. Set the potentiometer at the desired reading of the dc voltmeter. This power supply will be very useful in the experimenter's lab.

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N307A	276-1706
R1	potentiometer, 500 ohms	271-066
R2	resistor, 150 ohms	70-0195
R3	resistor, 100 ohms	70-0195
C1, C2	capacitor, 1000 mfd., 25 V	272-1718
T1	transformer, 117-v primary, 60 cy., secondary, 24 VAC at 1.2 amperes	273-1480
D1, D2, D3, D4	rectifiers, 100 PIV, 1 ampere	276-1708
	socket for TO-3 case transistor	75-4969

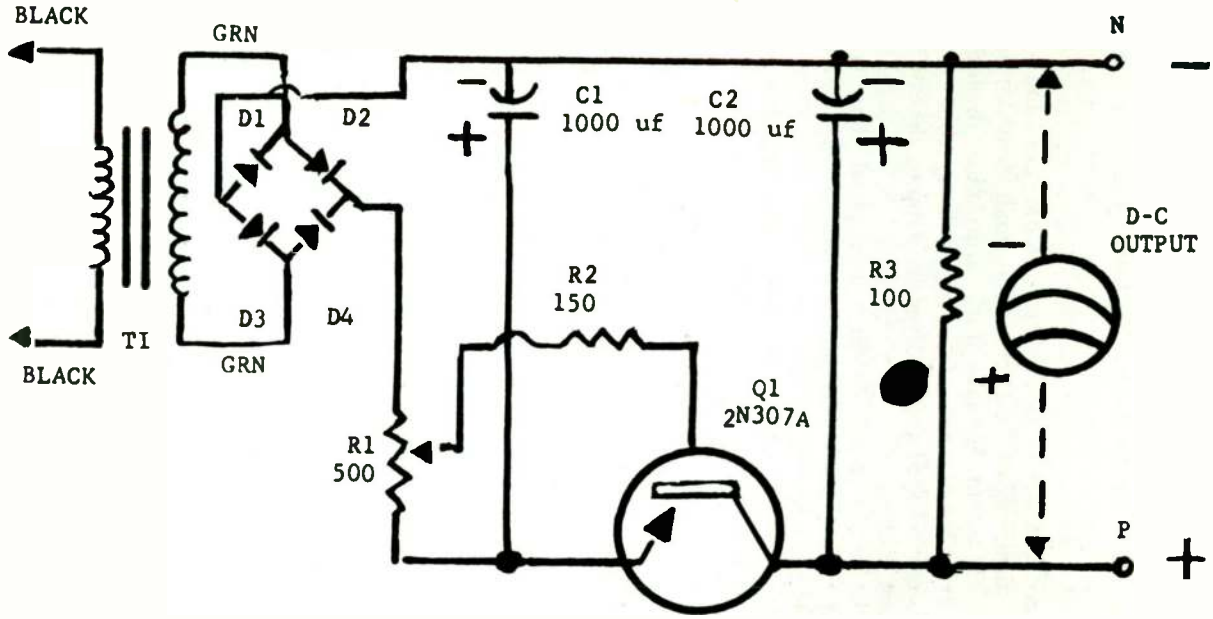


Fig. 36

No. 37 WORLD'S SMALLEST RECEIVER?

This may or may not be the world's smallest receiver. However, it's probably the smallest you'll be able to build with standard components.

A vari-loopstick is used as the antenna tuning coil, and a miniature 2,000 ohm earphone, of the type used in small transistor radios provides the audio output. For sake of miniaturization, the loopstick can be cut off about 2/3 of the way from the end away from the coil; however, this is complicated and involves unwrapping the coil, wrapping it back again, etc.

The radio should fit into a 1-in. x 1-in. plastic box, with a hole drilled in the side to accommodate the loopstick. The receiver is tuned by adjusting the loopstick's slug.

The battery is a mercury cell of the type used in hearing aids.

Any long length of wire may be used for an antenna.

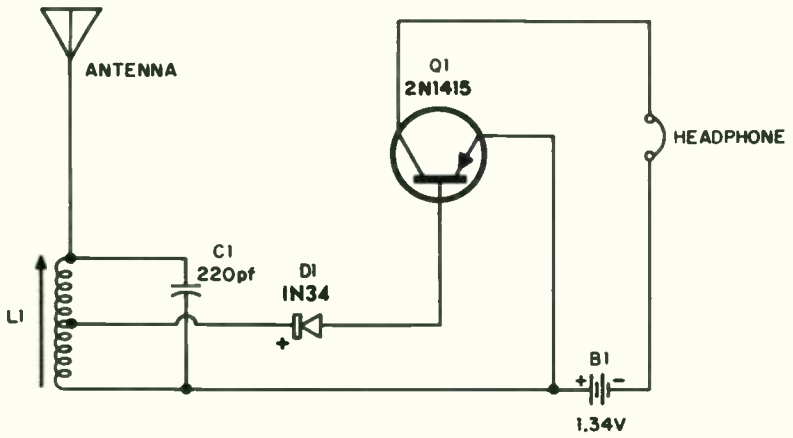


Fig. 37

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N1415	276-404
C1	capacitor, 220 pf	71-5111
L1	vari-loopstick	270-1430
D1	rectifier, 1N34	276-1709
B1	1.35-volt, type RM-400 mercury cell	23-592
	headphone: 2,000-ohm miniature	
	antenna: long wire	

No. 38 POWER SUPPLY FOR TUNNEL DIODES

Here's a power supply which delivers between 10 and 500 d-c millivolts, ideal for experimenting with tunnel diodes.

The circuit can be constructed in a small aluminum box, with parts layout not critical. Do not attempt to use the metal box as a heat sink for the transistor—it is not needed here, and the circuit will not function if the case of the transistor is grounded to the box.

The 10,000-ohm output control potentiometer should be mounted where it is readily accessible.

To use the unit, start with the output control set to minimum output. Then slowly advance the control until the tunnel diode begins to function.

Place bypass capacitors at the tunnel diode rather than at the output of the power supply.

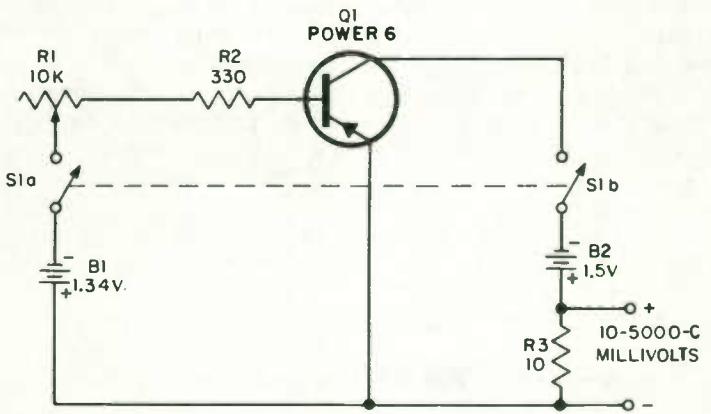


Fig 38

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor	276-406
R1	potentiometer, 10,000 ohms	271-1715
R2	resistor, 330 ohms	70-0195
R3	resistor, 10 ohms	70-0195
S1	switch, DPDT	270-067
B1	1.35-volt mercury cell	23-592
B2	1.5 volts (1 "D" cell)	23-466

No. 39 VU METER

Many audiophiles can never seem to attain a "perfect" recording. One of the reasons for this is overmodulation, together with its inherent distortion. Another reason is undermodulation with hum and noises. A VU meter will enable you to keep a watchful eye on your recording level at all times so that you can "ride the gain" control of the recorder to keep your sound level constant and at the proper setting for maximum quality.

The VU meter can be constructed in a small metal box, using the box itself as the chassis. The meter is calibrated in standard Volume Units, -20 to $+3$ VU and 0–100% range. It is connected by shielded cable to the grid of the last stage in the recorder's voice amplifier.

If you cannot get adequate signal from this point in your recorder, the unit should be tried at other spots in the circuit, taking care to avoid connecting it where a high d-c voltage exists. If you can obtain a signal only at a high d-c voltage source, remember that the electrolytic capacitor at the VU meter's input is only rated for 25 volts. A 0.5-mfd capacitor with at least a 400-volt rating should, therefore, be placed in series with the existing 25-volt capacitor.

To calibrate the unit for your equipment, play a recording into the unit at various recording levels. Make a note of the recording level at each of the test levels. Pick the maximum-quality level on the meter and mark it on the face. This is the point where your recordings should average (do not calibrate the meter for loud sound-peaks).

The input level of the meter is controlled by the 500,000-ohm potentiometer.

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N407	276-403
R1	potentiometer, 500,000 ohms	271-210
R2	resistor, 1 megohm	70-0195
R3	resistor, 3,900 ohms	70-0195
C1	capacitor, 3 mfd, 25 volts	271-958
C2	capacitor, 1 mfd. 200 VDCW	71-0416
M1	VU meter	22-019
S1	switch, SPST	275-602
B1	22.5 volts, bantamweight "B" battery	23-097

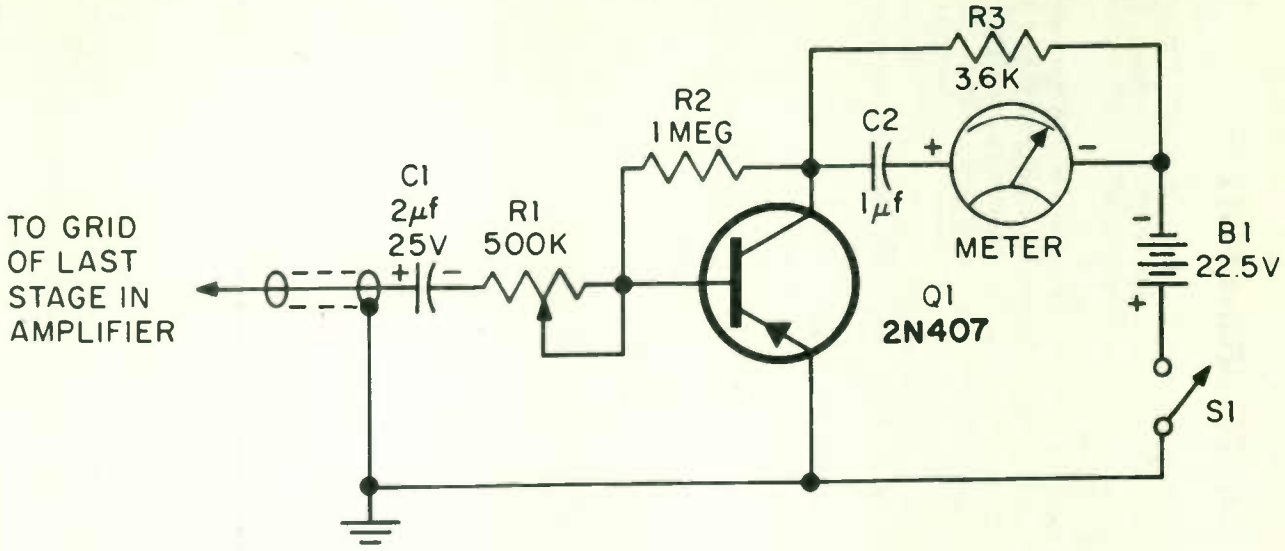


Fig. 39

No. 40 SQUARE WAVE GENERATOR

If you're interested in doing some servicing on your hi-fi equipment, you will undoubtedly find this square wave generator to be a handy item. It can feed from the output of a sine wave generator and puts out about 1 volt, or its own 60-cps signal.

The unit is constructed in a small aluminum box. A filament transformer is used to step down the line voltage to operate the transistors. S1 is the power on-off switch, connecting both the line voltage and battery voltage at the same time. Switch S2 permits selection of 117-volt input or an external input from a sine wave generator. The output level is controlled by potentiometer R4.

If you use the generator with an external signal source, do not plug in the 117-volt a-c line cord. The signal source is inserted in J1; the circuit under test in J2. Place S2 in the EXT position.

To use the internal signal, plug in the unit, place S2 in the INT position.

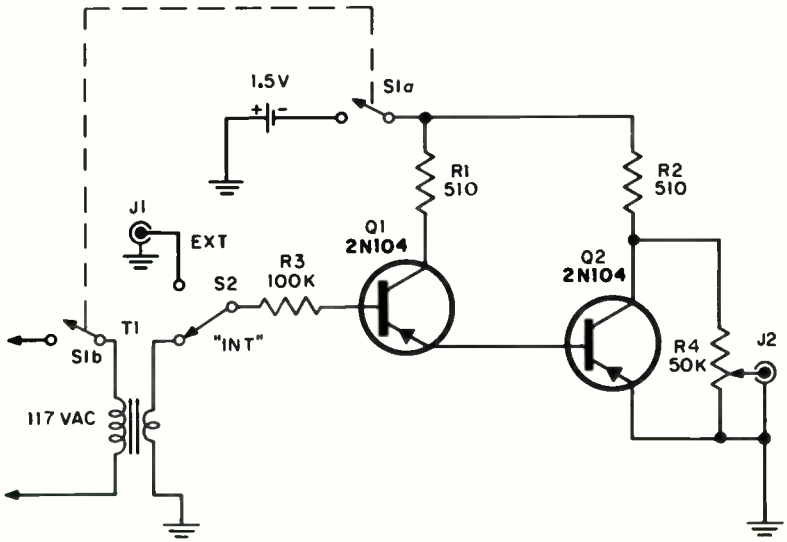


Fig. 40

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1, Q2	transistors, 2N104	276-403
R1, R2	resistors, 470 ohms	70-0195
R3	resistor, 100,000 ohms	70-0195
R4	potentiometer, 50,000 ohms	271-1716
S1, S2	switch, DPDT	275-062
T1	filament transformer, 6.3 volts at 1.2 amps	273-050
B1	1.5 volts (one "D" cell)	23-466

No. 41 HEADSET/LOUDSPEAKER CONVERTER

This gadget permits you to have loudspeaker volume on a set designed for headset reception.

The speaker is driven with an AF output transformer with the center-tap not connected. A PM type speaker is used.

Potentiometer R1 should be adjusted for maximum undistorted volume. The standard phone plug is plugged into the jack where a headset would normally be connected.

If results with this circuit are less than desired, try connecting a resistor between the base of the 2N464 and the positive terminal of the battery. Values between 100K and 2 megohms should be tried.

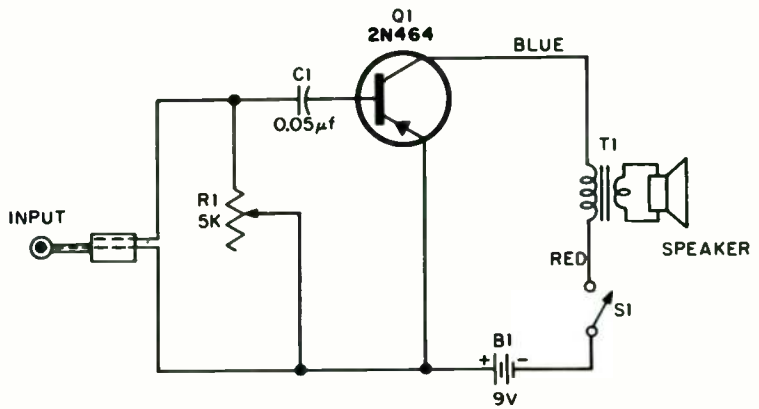


Fig. 41

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N464	276-403
R1	potentiometer, 5,000 ohms	271-1714
C1	capacitor, 0.05 mfd.	71-0407
T1	AF output transformer: 500-ohm CT primary, 3.2-ohm secondary	273-1379
S1	switch, SPST	275-602
B1	9-volt battery	23-464
	speaker, 2¾-inch PM type	40-262

No. 42 MODULATION MONITOR

Possibly the most basic circuit in this volume, the modulation monitor can be one of the most useful around a ham or CB station. This device enables you to hear your own transmissions to check your modulation.

Four components make up the entire unit. The only critical one is the earphone which must be a magnetic or dynamic type.

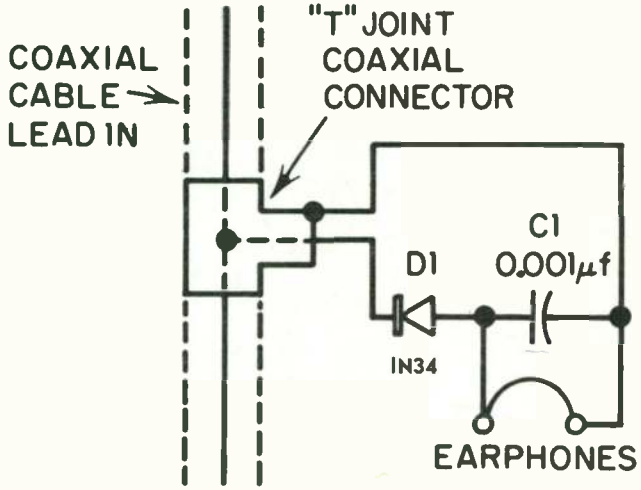


Fig. 42

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
C1	capacitor, 0.001 mfd	71-5123
D1	rectifier, 1N34	276-1709
	T-Adapter	42-2439
	Headphones, 2000 ohms	33-180

No. 43 15-METER "FLEA WATTER" TRANSMITTER

The transmitter discussed here may be built in a tiny plastic box, using a punched board as the chassis.

The unit is powered by a carbon mike. The final output coil L1 consists of 17 turns of B&W type No. 3007 coil tapped 8 turns from the 4700-pf capacitor. The crystal is a 21-mc third overtone type. This can be operated on a CB base station beam.

To tune the transmitter, turn on your receiver and set it to the "Flea Watter's" frequency. Peak the 3-30-pf trimmer in conjunction with the receiver's S-meter. That's all there is to it.

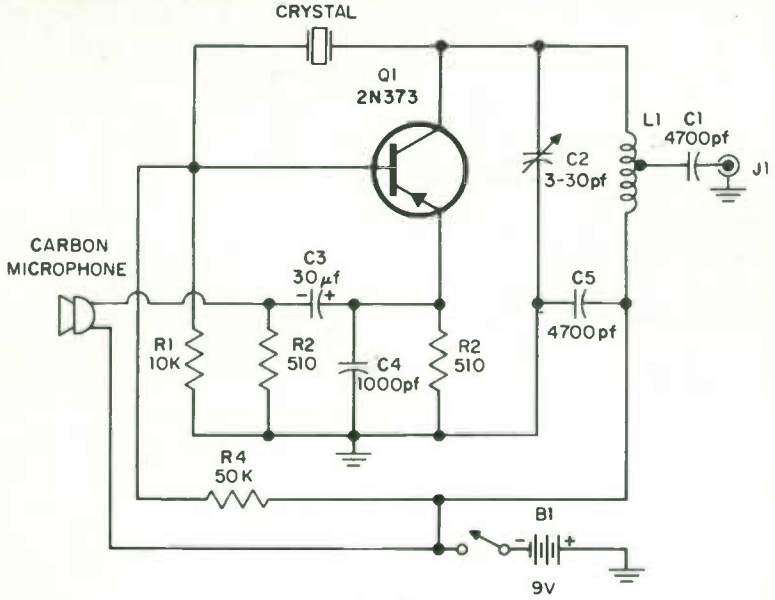


Fig. 43

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N373	276-412
R1	resistor, 10,000 ohms	70-0195
R2, R3	resistor, 470 ohms	70-0195
R4	resistor, 47,000 ohms	70-0195
C1, C5	capacitor, 4700 pf	71-5189
C2	capacitor, 4-40-pf, variable	71-4030
C3	capacitor, 30 mfd	272-961
C4	capacitor, 1000-pf	71-5123
L1	17 turns of B&W No. 3007	
J1	CB coax cable connector, S0239	278-201
B1	9-volt battery	23-464
	crystal: 21-mc 3rd overtone	
	microphone: carbon	279-1425

No. 44 AUDIO PREAMPLIFIER

If you've ever tried to run a long cable on a low-impedance microphone you will probably have a need for this device. It permits the use of low-impedance mikes and phono cartridges at reasonable distances from high-impedance inputs on recorders and amplifiers.

The unit is easily constructed on a small chassis, and can be inserted anywhere in your mike cable.

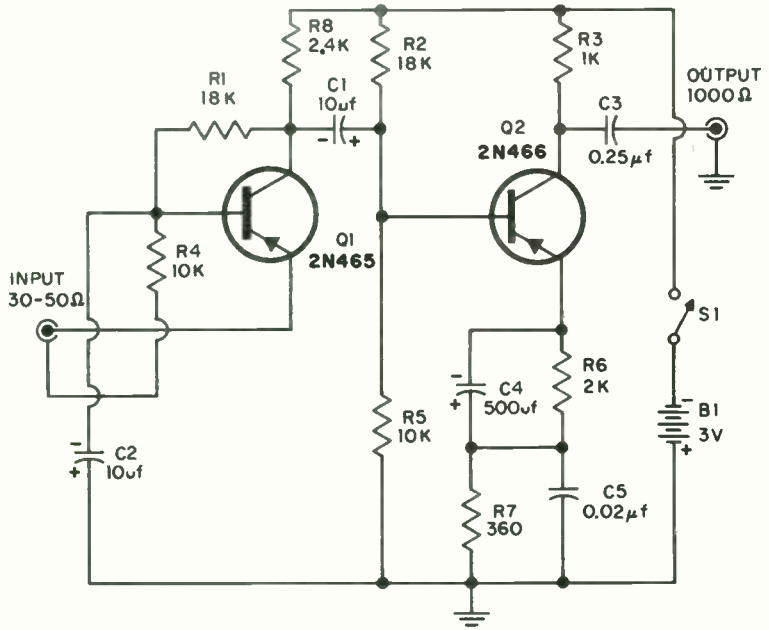


Fig. 44

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N465	276-403
Q2	transistor, 2N466	276-403
R1, R2	resistors, 18,000 ohms	70-0195
R3	resistor, 1,000 ohms	70-0195
R4, R5	resistor, 10,000 ohms	70-0195
R6	resistor, 2,000 ohms	70-0195
R7	resistor, 330 ohms	70-0195
C1, C2	capacitors, 10 mfd.	272-960
C3	capacitors, 0.25 mfd.	71-0412
C4	capacitor, 500 mfd, 25-volt electrolytic	272-986
C5	capacitor, 0.02 mfd.	71-452
B1	3 volts (2 "D" cells)	23-466
S1	switch, SPST	275-602

No. 45 DYNAMIC MICROPHONE

Did you know that a small dynamic loudspeaker can be made into a high output dynamic microphone? It can, and here's how to do it.

Using a 2-3/4-inch speaker for the microphone, you can easily construct this circuit in a 7-inch x 5-inch x 3-inch aluminum box.

The circuit contains two batteries which are controlled by a DPDT on-off switch.

For better quality, larger speakers may be used; however, the larger the loudspeaker used, the more cumbersome the microphone.

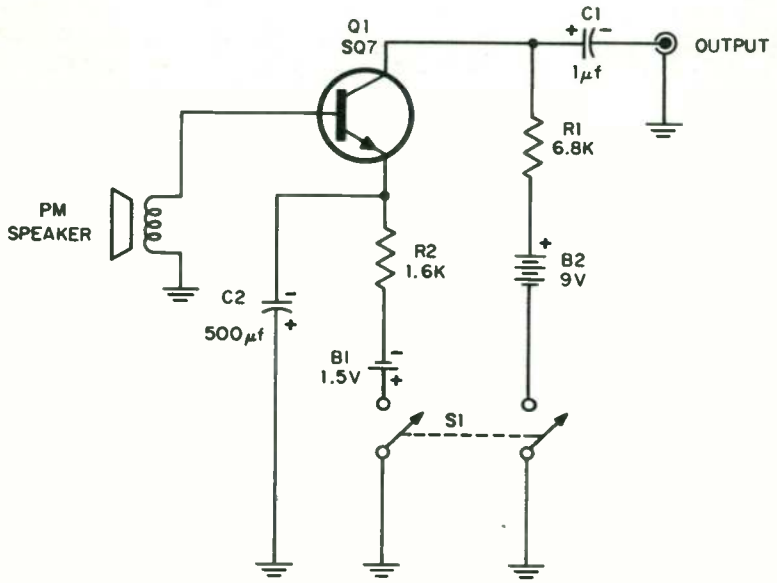


Fig. 45

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, SQ7	276-409
R1	resistor, 6,800 ohms	70-0195
R2	resistor, 1,600 ohms	70-0195
C1	capacitor, 1 mfd.	71-0416
C2	capacitor, 500 mfd, 25 volts, electrolytic	272-986
S1	switch, DPDT	275-666
B1	1.5 volts (1 "D" cell)	23-466
B2	9-volt battery	23-464
	speaker: 2¾ inch PM type	40-262

No. 46 FLASHING LIGHT

This is an experimenter's delight, and also useful to keep in the car for emergency use. Around the ham shack, it's a nice light for atop the tower to ward off low flying planes and high flying butterflies.

The light will flash about once a second, and can be varied in intensity by varying the value of the capacitor.

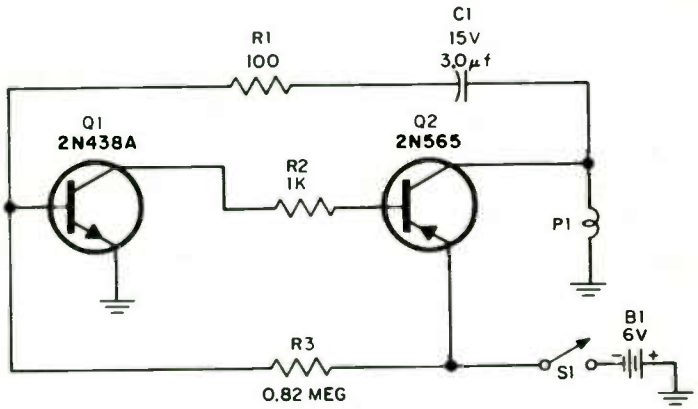


Fig. 46

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N438A	276-408
Q2	transistor, 2N565	276-404
R1	resistor, 100 ohms	70-0195
R2	resistor, 1000 ohms	70-0195
R3	resistor, 0.82 megohms	70-0195
C1	capacitor, 3.0 mfd, 25 volts	272-958
P1	No. 47 lamp	77-3396
S1	switch, SPST	275-602
B1	6 volts (4 "D" cells)	23-466

No. 47 BROADCAST BAND CW TRANSMITTER

Here's a handy device for use as a code practice oscillator or for short distance communications as it can be operated without a license under Part 15 of the FCC's Rules. It will transmit CW on any frequency which you select throughout the entire range of the AM broadcasting band.

The antenna tuning coil L1 is a standard ferri-loopstick. L2 consists of 12 turns of plastic covered hookup wire over the coils of L1.

The antenna length is limited by FCC regulations to 10 feet so that the transmitter will not radiate over too large an area.

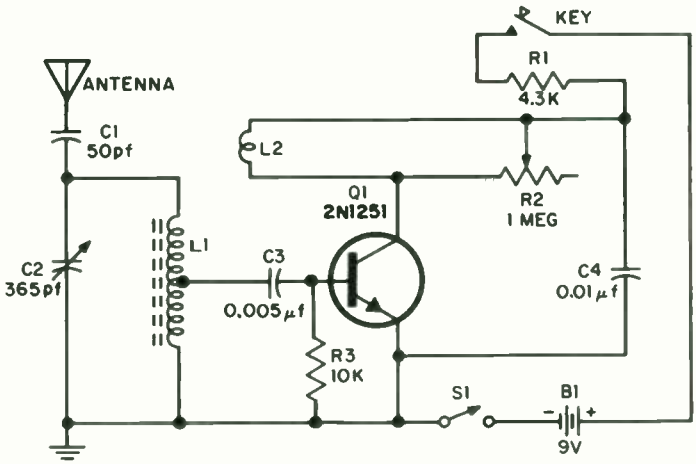


Fig. 47

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, 2N1251	276-410
R1	resistor, 4,700 ohms	70-0195
R2	potentiometer, 1 megohm	271-211
R3	resistor, 10,000 ohms	70-0195
C1	capacitor, 47 pf	71-5101
C2	capacitor, 365 pf, variable	272-1343
C3	capacitor, 0.005 mfd.	71-5190
C4	capacitor, 0.01	71-5194
L1	ferri-loopstick	270-1430
L2	12 turns plastic covered hookup over L1	
S1	switch, SPST	275-602
B1	9-volt battery	23-464
	antenna (see text)	
	telegraph key	20-1085

No. 48 CODE PRACTICE OSCILLATOR

Here is an audio code practice oscillator that is good for "fun and learning." It produces a variable tone which may be keyed for practicing the Morse Code. It will be useful to young men interested in radio communications, such as radio hams and boy scouts.

For fun and entertainment, simple musical tunes may be played with only a little practice by varying the tone control knob.

The unit can be built in a standard cabinet in a style of your own choice, with the speaker, control knob, and switch mounted on the front panel; and the binding post and battery holder at the rear.

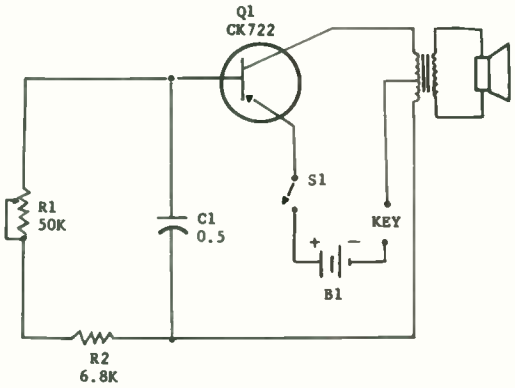


Fig. 48

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
Q1	transistor, CK-722	276-1034
R1	potentiometer, 50,000 ohms	271-1716
R2	resistor, 6,800 ohms, ½ watt	70-0195
C1	capacitor, 0.5 mfd.	71-0468
T1	AF output transformer, 500-ohm CT primary, 10,000-ohm secondary	273-1379
S1	switch, SPST	275-602
	5-way binding posts	274-333
	PM speaker, 2¾ inch	40-262

No. 49 HI-LO SWITCH (500 watts max.)

This relatively simple device has been proven to be very useful in the home. It has many uses. Wherever a lamp or motor of less than 500 watts is used, this device is applicable. It can be used to reduce the output of incandescent lamps, resistance heaters and most motors. It is NOT to be used on TRANSFORMER TYPE LOADS such as FLUORESCENT LAMPS or INSTANT-HEATING SOLDERING GUNS.

This device has two settings, a high and a low—it is not variable in between—and the low output is obtained by blocking part of the current from the source by using the diode. A diode in an AC circuit only passes current on the half-cycle of the source. The load therefore sees 70% of the source voltage and the remaining 30% is blocked. When used on 120-volt house current, the output on the high setting is 120 volts and on the low setting is 84 volts.

Mount the switch, diode, and space-saver socket in a small aluminum chassis. Attach a lamp-cord to one side of the plug and one terminal of the switch. Complete the other connections as shown in the diagram.

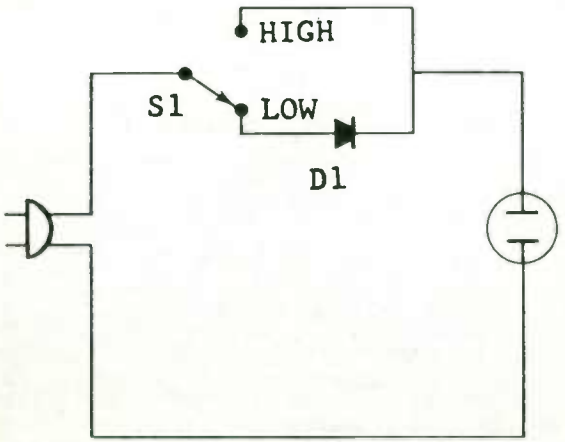


Fig. 49

PARTS LIST

SYMBOL	OESCRIPTION	RADIO SHACK NO.
D1	silicon rectifier 12 amps @ 400 PIV	276-1063
S1	slide switch, SPDT	275-125
	space-saver socket	270-640
	lamp cord, 6-foot with molded plug	278-1255

No. 50 VARIABLE AC CONTROL

In Project No. 49, a two-level AC control was described. In this circuit we have a means of controlling the output of an AC device from zero to its full-load capacity.

This is a full wave circuit which gives symmetrical control from zero to 100 percent over an AC load. It does a complete job of dimming incandescent lamps, and controlling AC motors. During the positive half-cycle of the supply voltage, the arm on the 100,000-ohm control samples the AC voltage and compares it with the back voltage of the motor through the gate of SCR. When the potentiometer voltage rises above the armature, diode D2 triggers the SCR which applies the remainder of that half cycle voltage to the motor at the controlled level.

D1 is used to suppress the inductive spikes that would be created when this circuit is used to control a motor. When application of this circuit is limited to controlling incandescent lamps, D1 can be eliminated.

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK NO.
SCR	silicon controlled rectifier, 6 amps, 200 PIV	276-1132
D1, D2, D3, D4	silicon rectifiers, 1 amp, 100 PIV	276-1709
R1	resistor, 33,000 ohms, 1W	70-0196
R2	potentiometer, 100,000 ohms	271-092
C1	capacitor, 1.0 mfd.	71-0416
S1	switch, SPST	275-315
	space-saver socket	270-640
	fuse holder	270-739
	box of 5-amp fuses	77-2768
	lamp cord, 6-foot with molded plug	278-1255

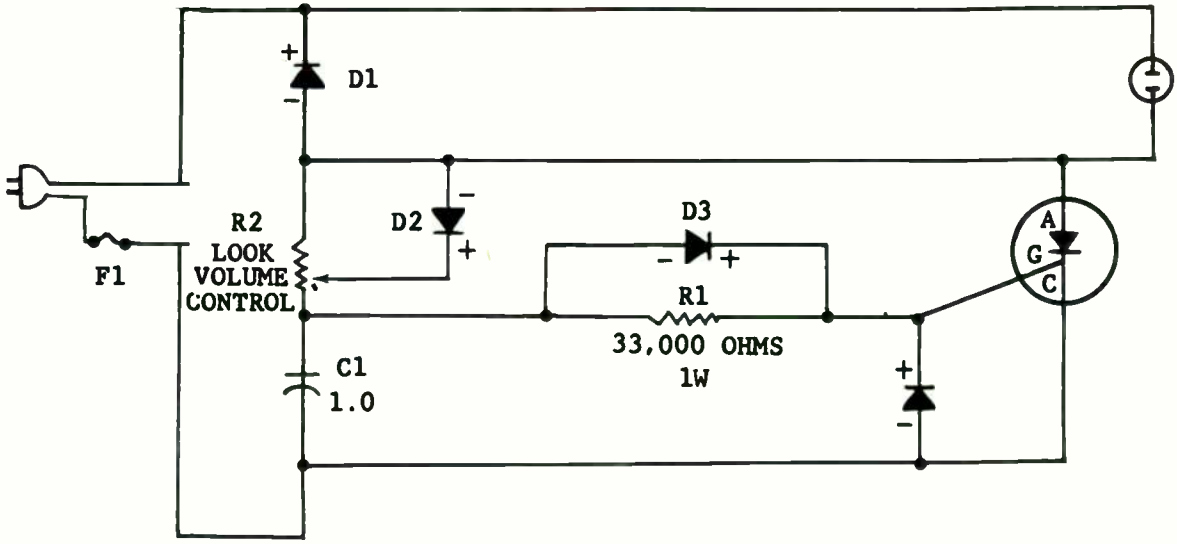


Fig. 50

RADIO SHACK HANDBOOK

- SCHEMATIC DIAGRAMS
- ELECTRONIC SYMBOLS
- SPECIFICATIONS
- FORMULAS

USEFUL DATA FOR STUDENTS AND EXPERIMENTERS. The data and specifications presented in this section will be an invaluable aid in the solution of electronic problems. The Ham, Hi-Fi enthusiast and the hobbyist will find that this section will add to their knowledge and enjoyment.

CAPACITANCE

$$C_T = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \ldots \text{etc.}}$$

$$C_T = C_1 + C_2 + C_3 \ldots \text{etc.}$$

$$C_T = \frac{C_1 C_2}{C_1 + C_2}$$

SELF-INDUCTANCE

$$L_T = L_1 + L_2 + L_3 \ldots \text{etc.}$$

$$L_T = \frac{1}{\frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} \ldots \text{etc.}}$$

$$L_T = \frac{L_1 L_2}{L_1 + L_2}$$

RESISTANCE

SERIES $R_T = R_1 + R_2 + R_3 \ldots \text{etc.}$

PARALLEL $R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \ldots \text{etc.}}$

TWO IN PARALLEL $R_T = \frac{R_1 R_2}{R_1 + R_2}$

MUTUAL INDUCTANCE

TWO R-F COILS WITH FIELDS INTERACTING $M = \frac{L_A - L_O}{4}$

- M = Mutual Inductance expressed in same units as L_A and L_O
- L_A = Total Inductance of coils L_1 and L_2 with fields aiding
- L_O = Total Inductance of coils L_1 and L_2 with fields opposing

REACTANCE

INDUCTIVE $X_L = 2\pi f L$

CAPACITIVE $X_C = \frac{1}{2\pi f C}$

- X_L = Inductive reactance in ohms (Positive reactance)
- X_C = Capacitive reactance in ohms (Negative reactance)
- f = Frequency in cps
- L = Inductance in henrys
- C = Capacitance in farads
- 2π = 6.28

IMPEDANCE

SERIES CIRCUITS $Z_T = \sqrt{R_T^2 + X_T^2}$

PARALLEL CIRCUITS $Z_T = \frac{1}{\sqrt{G_T^2 + B_T^2}}$

- Z_T = Magnitude of Impedance (Ohms)
- R_T = Total Resistance in Ohms
- X_T = Total Reactance in Ohms
- G_T = Total Conductance in Mhos
- B_T = Total Susceptance in Mhos

R AND X IN TERMS OF G AND B

$$R = \frac{G}{G^2 + B^2} \qquad X = \frac{B}{G^2 + B^2}$$

Q OR FIGURE OF MERIT

Simple Reactor $Q = \frac{X_L}{R_L}$ Single Capacitor $Q = \frac{X_C}{R_C}$

- Q = A Ratio Expressing the Figure of Merit
- X_L = Inductive Reactance (Ohms)
- X_C = Capacitive Reactance (Ohms)
- R_L = Resistance in ohms acting in series with inductance
- R_C = Resistance in ohms acting in series with capacitance

USEFUL FORMULAS

COUPLED INDUCTANCE

SERIES WITH FIELDS AIDING	$L_T = L_1 + L_2 + 2M$
SERIES WITH FIELDS OPPOSING	$L_T = L_1 + L_2 - 2M$
PARALLEL WITH FIELDS AIDING	$L_T = \frac{1}{\frac{1}{L_1 + M} + \frac{1}{L_2 + M}}$
PARALLEL WITH FIELDS OPPOSING	$L_T = \frac{1}{\frac{1}{L_1 - M} \quad \frac{1}{L_2 - M}}$

L_T = Total Inductance
M = Mutual Inductance
L_1 and L_2 = Self-inductance of individual coils

RESONANCE

The resonant frequency, or frequency, at which inductive reactance X_1 equals capacitive reactance X_C is found by:

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$\text{Also } L = \frac{1}{4\pi^2 f_r^2 C}$$

$$\text{Also } C = \frac{1}{4\pi^2 f_r^2 L}$$

f_r = Resonant frequency in cps
L = Inductance in henrys
C = Capacitance in farads
2π = 6.28
$4\pi^2$ = 39.5

WAVELENGTH FROM FREQUENCY

$$\lambda = \frac{3 \times 10^4}{f} \text{ (Centimeters)}$$

f = Frequency in megacycles

$$\lambda = \frac{3 \times 10^5}{f} \text{ (Meters)}$$

f = Frequency in kilocycles

FREQUENCY FROM WAVELENGTH

$$f = \frac{3 \times 10^4}{\lambda} \text{ (Megacycles)}$$

λ = Wavelength in centimeters

$$f = \frac{3 \times 10^5}{\lambda} \text{ (Kilocycles)}$$

λ = Wavelength in meters

VACUUM TUBE FORMULAS

AMPLIFICATION FACTOR (Mu or μ)	$M_U = \frac{\triangle E_P}{\triangle E_G}$
DYNAMIC PLATE RESISTANCE (Ohms)	$r_p = \frac{\triangle E_P}{\triangle I_P}$
MUTUAL CONDUCTANCE (Mhos)	$G_M = \frac{\triangle I_P}{\triangle E_G}$
GAIN PER STAGE	$\mu\left(\frac{R_L}{R_L + r_p}\right)$
VOLTAGE OUTPUT IN R_1	$\mu\left(\frac{E_S R_L}{r_p + R_L}\right)$
POWER OUTPUT IN R_1	$R_L\left(\frac{\mu E_S}{r_p + R_L}\right)^2$

M_U = Amplification Factor
R_P = Dynamic Plate Resistance (Ohms)
G_M = Mutual Conductance (Mhos)
E_P = Plate Voltage (Volts)
E_G = Grid Voltage (Volts)
I_P = Plate Current (Amperes)
R_1 = Plate Load Resistance (Ohms)
I_K = Total Cathode Current (Amperes)
E_S = Signal Voltage (Volts)
$\triangle$ = Change or variation in any value, may be an increase or decrease

PEAK, R.M.S. AND AVERAGE A-C VALUES OF E & I

Given Value	To Find Peak	R.M.S.	Av.
Peak		0.707 X Peak	0.637 X Peak
R.M.S.	1.41 X R.M.S.		0.9 X R.M.S.
Av.	1.57 X Av.	1.11 X Av.	

ELECTRICAL QUANTITIES

Multiply	By	To Obtain
Amperes	0.1	Abamperes
Ampere-hours	3,600	Coulombs
Ampere-hours	0.03731	Faradays
Coulombs	0.1	Abcoulombs
Coulombs	$1.037 / 10^5$	Faradays
Faradays	26.80	Ampere-hours
Farads	$1 / 10^9$	Abfarads
Farads	1×10^6	Microfarads
Gausses	1	Maxwells / sq cm
Gausses	6.452	Lines / sq inch
Henries	1×10^9	Abhenries
Ohm-cm	6.015×10^4	circ mil-ohms / ft
Ohm-cm	0.3937	Ohm-inches
Volts	1×10^8	Abvolts

COMMON ELECTRONIC ABBREVIATIONS AND LETTER SYMBOLS

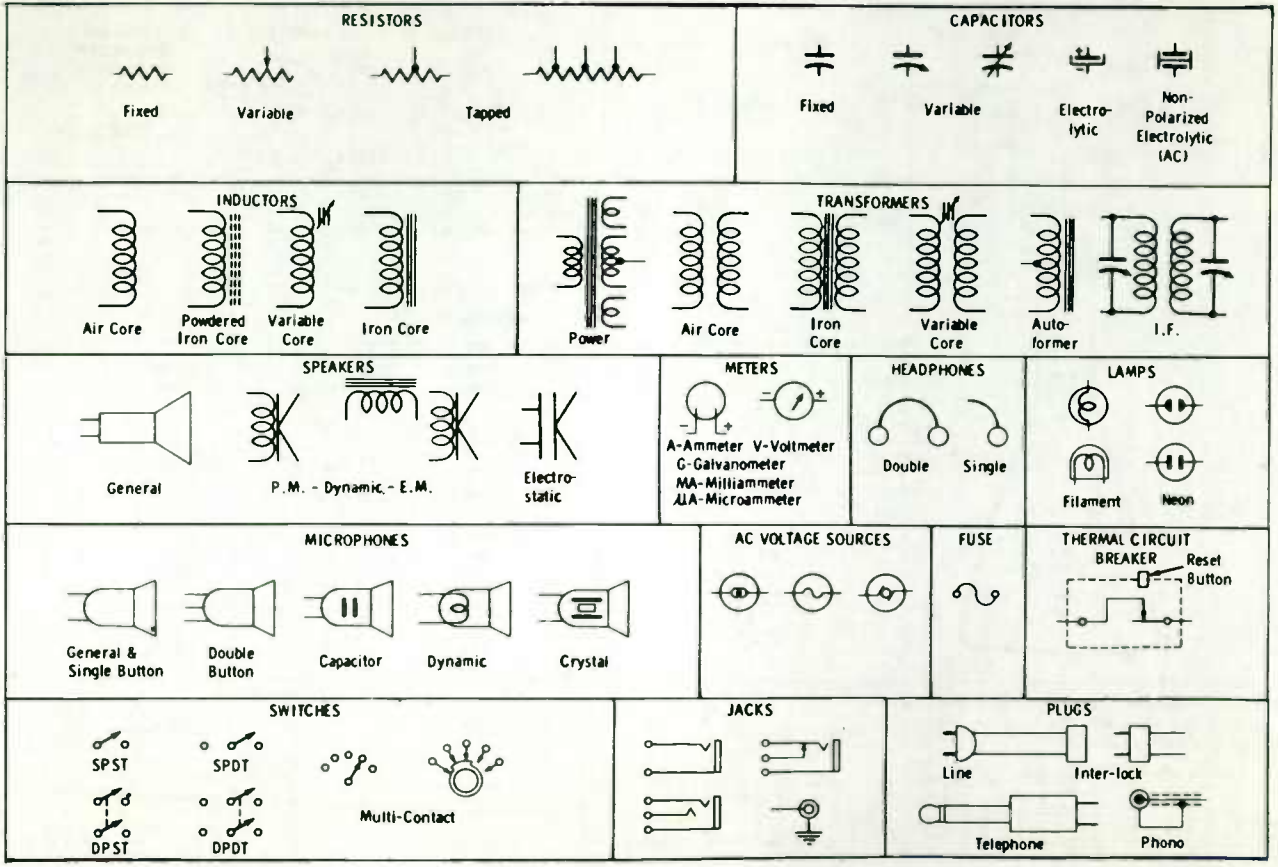
TERM	ABBREVIATION
Admittance	Y
Alternating-current (Adj.)	A-C
Alternating Current	AC
Ampere	A
Angular Velocity ($2\pi f$)	ω
Antenna	ANT
Audio-frequency	A-F
Audio Frequency	AF
Automatic Phase Control	APC
Automatic Volume Control	AVC
Automatic Volume Expansion	AVE
Band Pass	BP
Broadcast	BC
Capacitance	C
Capacitive Reactance	X_C
Centimeter	CM
Conductance	G
Continuous Waves	CW
Crystal Oscillator	CO
Current	I
Cycles per Second	CPS
Decibel	DB
Direct-current (Adj.)	D-C
Direct Current	DC
Double Cotton Covered	DCC
Double Pole, Double Throw	DPDT
Double Pole, Single Throw	DPST
Double Side Bond	DSB
Double Silk Covered	DSC
Electric Field Intensity	E
Electromotive Force	EMF
Frequency	f
Frequency Modulation	FM
Frequency Shift Keying	FSK
Ground	GND
Henry	h
High-frequency (Adj.)	H-F
High Frequency	HF
High Pass	HP
Impedance	Z
Inductance	L
Inductive Reactance	XI
Intermediate-frequency (Adj.)	I-F
Intermediate Frequency	IF
Interrupted Continuous Waves	ICW
Kilocycle	KC
Kilohm	KΩ
Kilovolt	KV
Kilovolt Ampere	KVA
Kilowatt	KW
Low-frequency (Adj.)	L-F
Low Frequency	LF
Low Pass	LP
Magnetic Field Intensity	H
Megacycle	MC
Megohm	MΩ
Meter	M
Microampere	μA
Microfarad (mfd)	μF
Microhenry	μH
Micromicrofarad (mmfd)	$\mu\mu$F
Microvolt	μV
Microvolt per Meter	μV/M

TERM	ABBREVIATION
Microwatt	μW
Milliampere	MA
Millihenry	MH
millivolt	MV
Millivolt per Meter	MV/M
Milliwatt	MW
Modulated Continuous Waves	MCW
Multiplex	MX
Multivibrator	MVB
Mutual Inducatance	M
Ohm	Ω
Peak to Peak	PP
Phase Modulation	PM
Power	P
Power Factor	PF
Radio-frequency (Adj.)	R-F
Radio Frequency	RF
Reactance	X
Resistance	R
Root Mean Square	RMS
Self-inducatance	L
Short Wave	SW
Single Cotton Covered	SCC
Single Cotton Enamel	SCE
Single Pole, Double Throw	SPDT
Single Pole, Single Throw	SPST
Single Silk Covered	SSC
Signal to Noise Ratio	SNR
Tuned Radio Frequency	TRF
Single Side Bond	SSB
Ultra High Frequency	UHF
Vacuum Tube Voltmeter	VTVM
Video	VID
Volt	V
Voltage	E
Volt-Ohm-Milliammeter	VOM
Watt	W

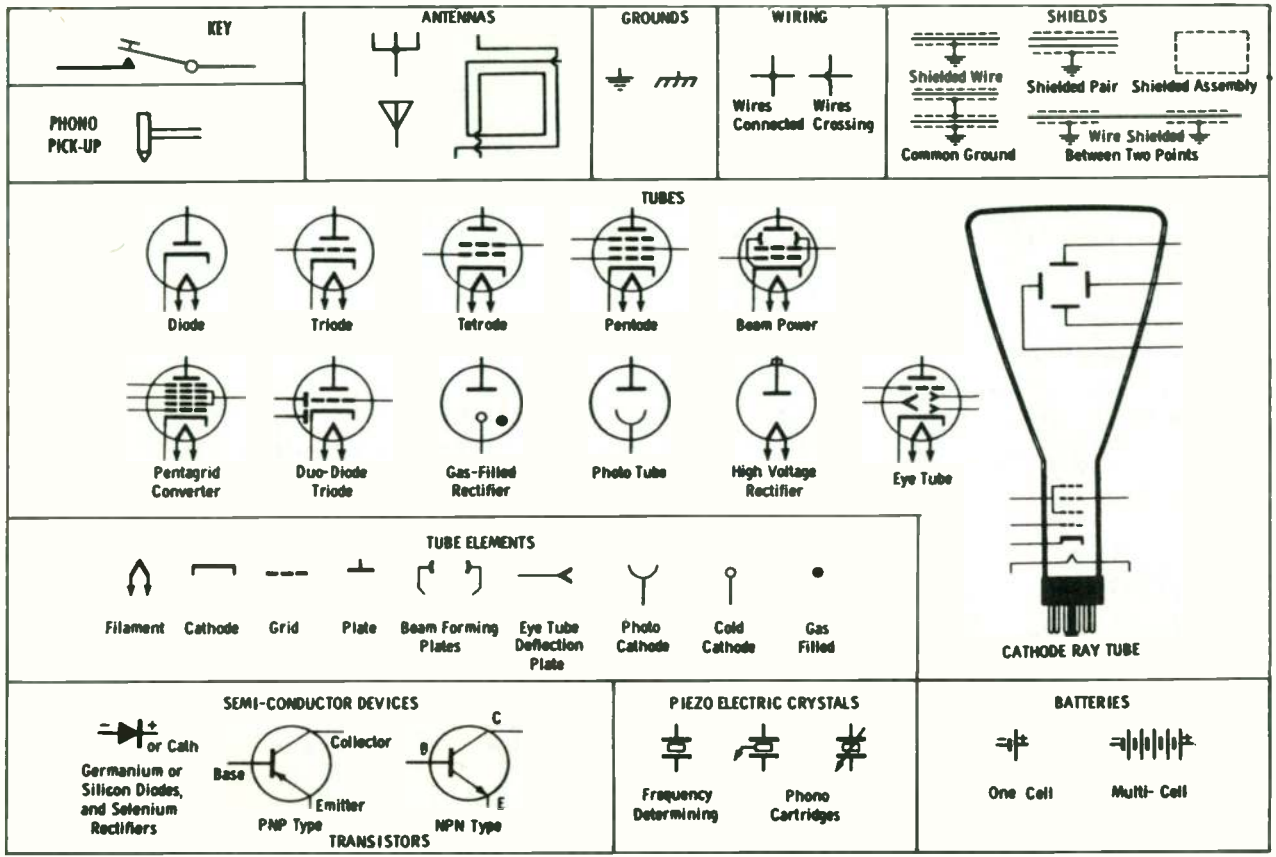
TRANSMISSION-LINE DATA

Type	Description or Type Number	Characteristic Impedance	Velocity Factor	Capacitance Per Foot; $\mu\mu$f
Coaxial	Air-Insulated	50-100	0.85[1]	
	RG-8/U	53	0.66	29.5
	RG-58/U	53	0.66	28.5
	RG-11/U	75	0.66	20.5
	RG-59/U	73	0.66	21.0
Parallel	Air-Insulated	200-600	0.975[2]	
Conductor	214-080[3]	75	0.68	19.0
	214-023[3]	75	0.71	20.0
	214-079[3]	150	0.77	10.0
	214-056[3]	300	0.82	5.8
	214-076[3]	300	0.84	3.9
	214-022[3]	300	0.85	3.0

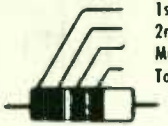
ELECTRONIC SYMBOLS



TUBE BASE DIAGRAMS



COLOR BAND SYSTEM



Resistors with black body color are composition, non-insulated. Resistors with colored bodies are composition, insulated. Wire-wound resistors have the 1st digit color band double width.

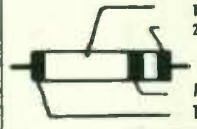
RESISTOR CODES (RESISTANCE GIVEN IN OHMS)

COLOR	DIGIT	MULTIPLIER	TOLERANCE
BLACK	0	1	20%
BROWN	1	10	1%
RED	2	100	2%
ORANGE	3	1000	3%*
YELLOW	4	10000	GMV*
GREEN	5	100000	5% (RETMA Alternate)
BLUE	6	1000000	6%*
VIOLET	7	10000000	12½%*
GRAY	8	.01 (RETMA Alternate)	30%*
WHITE	9	.1 (RETMA Alternate)	10% (RETMA Alternate)
GOLD		.1 (JAN and RETMA Preferred)	5% (JAN and RETMA Preferred)
SILVER		.01 (JAN and RETMA Preferred)	10% (JAN and RETMA Preferred)
NO COLOR			20%

*GMV — guaranteed minimum value, or −0 + 100% tolerance
*ASA 40, 20, 10 and 5 step tolerances

BODY END DOT SYSTEM

BODY END BAND SYSTEM



MOLDED MICA CAPACITOR CODES
(Capacity given in MMF)

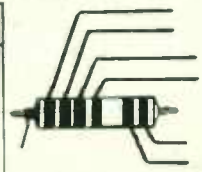
COLOR	DIGIT	MULTIPLIER	TOLERANCE*	CLASS OR CHARACTERISTIC
BLACK	0	1	20%	A
BROWN	1	10	1%	B
RED	2	100	2%	C
ORANGE	3	1000	3%	D
YELLOW	4	10000		E
GREEN	5		5% (RETMA)	F (JAN)
BLUE	6			G (JAN)
VIOLET	7			
GRAY	8			I (RETMA)
WHITE	9			J (RETMA)
GOLD		.1	5% (JAN)	
SILVER		.01	10%	

Class or characteristic denotes specifications of design involving Q factors, temperature coefficients and production test requirements.
All axial lead mica capacitors have a voltage rating of 300, 500 or 1000 volts.
*or 1.0 MMF whichever is greater.

MOLDED PAPER CAPACITOR CODES
(Capacity given in MMF)

COLOR	DIGIT	MULTIPLIER	TOLERANCE
BLACK	0	1	20%
BROWN	1	10	
RED	2	100	
ORANGE	3	1000	
YELLOW	4	10000	
GREEN	5	100000	5%
BLUE	6	1000000	
VIOLET	7		
GRAY	8		
WHITE	9		10%
GOLD			5%
SILVER			10%
NO COLOR			20%

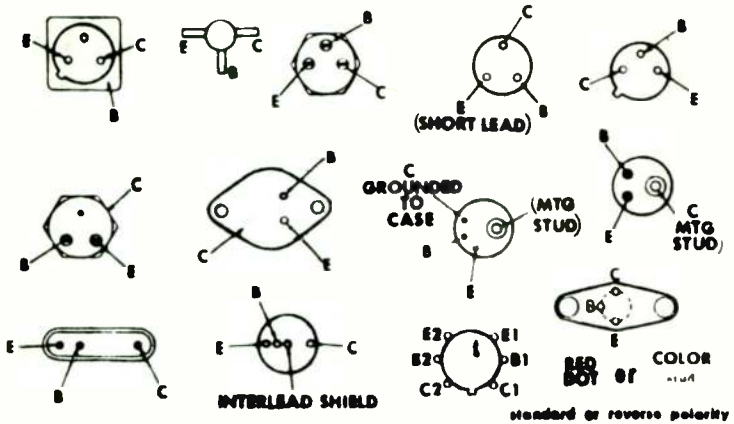
MOLDED PAPER TUBULAR

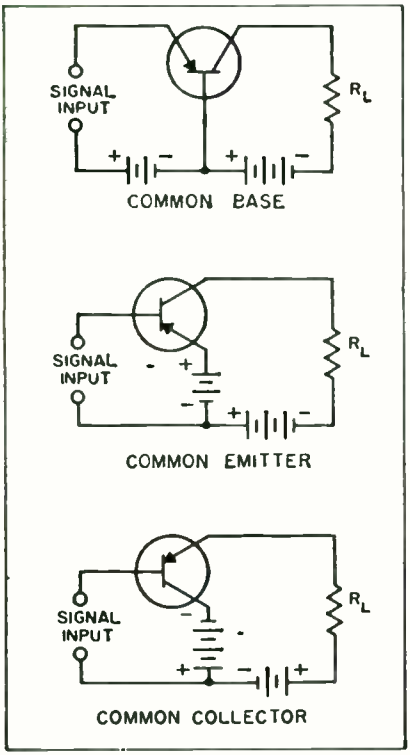


Indicates outer foil may be on either end. May also be indicated by typographical markings or black stripe

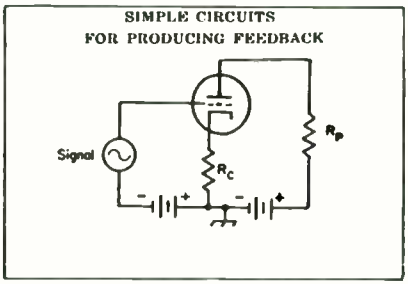
Add two zeros to significant voltage figures. One band indicates voltage rating under 1000 volts.

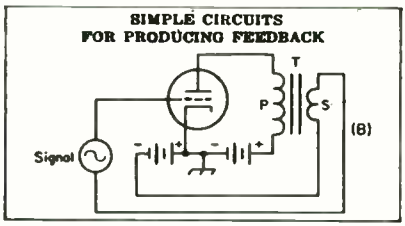
TYPICAL TRANSISTOR BASES





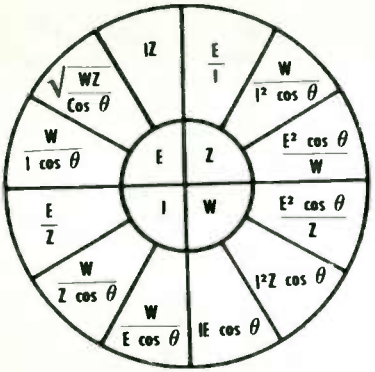
BASIC TRANSISTOR AMPLIFIER CIRCUITS. R_L, the load resistance, may be an actual resistor or the primary of a transformer. The input signal may be supplied from a transformer secondary or by resistance-capacitance coupling. In any case it is to be understood that a d.c. path must exist between the base and the emitter. PNP transistors are shown in these circuits. If NPN types are used, the battery polarities must be reversed.





OHM'S LAW FORMULAS

OHM'S LAW FORMULAS FOR A-C CIRCUITS



I = Current in Amperes
Z = Impedance in Ohms
E = Potential Across Z in Volts
W = Power in Watts
O = Phase Angle in Degrees

To solve any Ohm's Law equation locate the symbol for the unknown value in the center wheel and then use the formula, in the outer circle, that contains the known values.

DECIBELS

The number of decibels corresponding to a given power ratio is expressed by the following formula:

$$Db = 10 \log \frac{P_2}{P_1}$$

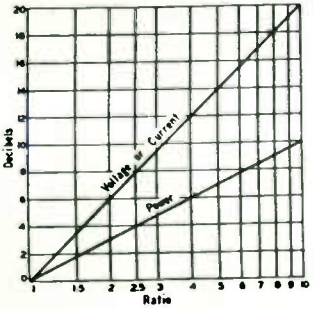
Common logarithms (base 10) are used.

Note that the decibel is based on power ratios. Voltage or current ratios can be used only when the impedance is the same for both values of voltage or current.

$$\text{(Volts) } Db = 20 \log \frac{E_2}{E_1}$$

$$\text{(Current) } Dd = 20 \log \frac{I_2}{I_1}$$

These formulas are shown graphically in the chart for ratios from 1 to 10. Gains (increases) expressed in decibels may be added arithmetically; losses (decreases) may be subtracted. A power decrease is indicated by prefixing the decibel figure with a minus sign. Thus 6 db. means that the power has been multiplied by 4, while −6 db. means that the power has been divided by 4.

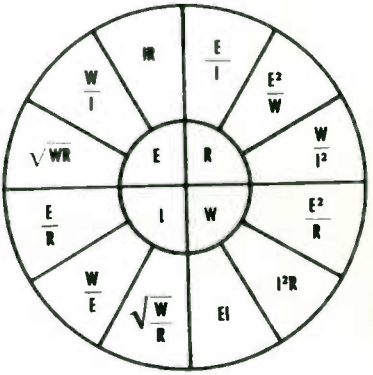


The formula given for power ratios is independent of source and load impedance values. However, the formulas for voltage and current ratios hold true only when the source and load impedances (Z_1 and Z_2) are equal. When these impedances differ the following formulas should be used for voltage and current ratios:

$$\text{(Volts) } Db = 20 \log \frac{E_2}{E_1} \frac{Z_1}{Z_2}$$

$$\text{(Current) } Db = 20 \log \frac{I_2}{I_1} \frac{Z_1}{Z_2}$$

OHM'S LAW FORMULAS FOR D-C CIRCUITS



I = Current in Amperes
E = Potential Across R in Volts
R = Resistance in Ohms
W = Power in Watts

In the following table is a summary of the U. S. amateur bands on which operation is permitted as of our press date. Figures are megacycles. Aø means an unmodulated carrier, A1 means c.w. telegraphy, A2 is tone-modulated c.w. telegraphy, A3 is amplitude-modulated phone, A4 is facsimile, A5 is television, n.f.m. designates narrow-band frequency — or phase-modulated radiotelephony, f.m. means frequency modulation, phone (including n.f.m.) or telegraphy, and F1 is frequency-shift keying.

80 meters	3.500-4.000	— A1
	3.500-3.800	— F1
	3.800-4.000	— A3 and n.f.m
	7.000-7.300	— A1
40 m.	7.000-7.200	— F1
	7.200-7.300	— A3 and n.f.m
	14.000-14.350	— A1
20 m.	14.000-14.200	— F1
	14.200-14.300	— A3 and n.f.m.
	14.300-14.350	— F1
	21.000-21.450	— A1
15 m.	21.000-21.250	— F1
	21.250-21.450	— A3 and n.f.m.
	28.000-29.700	— A1
10 m.	28.500-29.700	— A3 and n.f.m.
	29.000-29.700	— f.m.
	50-54	— A1
	50.0-50.9	— A2, A3, A4, n.f.m
6 m.	51-54	— Aø, A2, A3, A4, n.f.m.
	52.5-54	— f.m.
	144-148	— A1
2 m.	144-147.9	Aø, A1, A2, A3, A4, f.m.
	220-225	
	420-450	
	1,215-1,300	

AMATEUR BANDS AND TABLES

In the following table is a summary of the U. S. amateur bands on which operation is permitted as of our press date. Figures are megacycles. A0 means an unmodulated carrier, A1 means c.w. telegraphy, A2 is tone-modulated c.w. telegraphy, A3 is amplitude-modulated phone. A4 is facsimile, A5 is television, n.f.m. designates narrow-band frequency — or phase-modulated radiotelephony, f.m. means frequency modulation, phone (including n.f.m.) or telegraphy, and F1 is frequency-shift keying.

80 meters	3.500-4.000	— A1
	3.500-3.800	— F1
	3.800-4.000	— A3 and n.f.m
40 m.	7.000-7.300	— A1
	7.000-7.200	— F1
	7.200-7.300	— A3 and n.f.m
20 m.	14.000-14.350	— A1
	14.000-14.200	— F1
	14.200-14.300	— A3 and n.f.m.
	14.300-14.350	— F1
15 m.	21.000-21.450	— A1
	21.000-21.250	— F1
	21.250-21.450	— A3 and n.f.m.
10 m.	28.000-29.700	— A1
	28.500-29.700	— A3 and n.f.m.
	29.000-29.700	— f.m.
6 m.	50-54	— A1
	50.0-50.9	— A2, A3, A4, n.f.m
	51-54	— A0, A2, A3, A4, n.f.m.
	52.5-54	— f.m.
2 m.	144-148	— A1
	144-147.9	A0, A1, A2, A3, A4, f.m.
	220-225	A0, A1, A2, A3, A4, f.m.
	420-450†	A0, A1, A2, A3, A4, A5, f.m.
	1,215-1,300	A0, A1, A2, A3, A4, A5, f.m.
	2,300- 2,456	A0, A1, A2, A3, A4, A5, f.m., pulse
	3,500 3,700	A0, A1, A2, A3, A4, A5, f.m., pulse
	5,650 5,925	A0, A1, A2, A3, A4, A5, f.m., pulse
	10,000-10,500‡	A0, A1, A2, A3, A4, A5, f.m., pulse
	21,000-22,000	A0, A1, A2, A3, A4, A5, f.m., pulse
	All above 30,000	A0, A1, A2, A3, A4, A5, f.m., pulse

RELATIVE RESISTIVITY OF METALS

Aluminum	1.70
Brass	3.57
Cadmium	5.26
Chromium	1.82
Copper (hard-drawn)	1.12
Copper (annealed)	1.00
Iron (pure)	5.65
Lead	14.30
Nickel	6.25 to 8.33
Phosphor Bronze	2.78
Silver	0.94
Tin	7.70
Zinc	3.54

PREFIXES

Prefix	Meaning	Value
Millimicro	One-billionth	0.000,000,001 or 10^{-9}
Micro	One-millionth	0.000,001 or 10^{-6}
Milli	One-thousandth	0.001 or 10^{-3}
Centi	One-hundredth	0.01 or 10^{-2}
Deci	One-tenth	0.1 or 10^{-1}

Conversion Factors For Fractional And Multiple Units

To Change From	To	Divide By	Multiply By
Units	Micro-units		1,000,000
	Milli-units		1,000
	Kilo-units	1,000	
	Mega-units	1,000,000	
Micro-units	Milli-units	1,000	
	Units	1,000,000	
Milli-units	Micro-units		1,000
	Units	1,000	
Kilo-units	Units		1,000
	Mega-units	1,000	
Mega-units	Units		1,000,000
	Kilo-units		1,000

Deka	Ten	10	or 10
Hecto	One hundred	100	or 10^2
Kilo	One thousand	1,000	or 10^3
Myria	Ten thousand	10,000	or 10^4
Mega	One million	1,000,000	or 10^6

PILOT-LAMP DATA

Lamp No.	Bead Color	Base (Miniature)	Bulb Type	Rating Volts	Rating Amp.
40	Brown	Screw	T-3¼	6-8	0.15
40A[1]	Brown	Bayonet	T-3¼	6-8	0.15
41	White	Screw	T-3¼	2.5	0.5
42	Green	Screw	T-3¼	3.2	**
43	White	Bayonet	T-3¼	2.5	0.5
44	Blue	Bayonet	T-3¼	6-8	0.25
45	*	Bayonet	T-3¼	3.2	**
46[2]	Blue	Screw	T-3¼	6-8	0.25
47[1]	Brown	Bayonet	T-3¼	6-9	0.15
48	Pink	Screw	T-3¼	2.0	0.06
49[3]	Pink	Bayonet	T-3¼	2.0	0.06
[4]	White	Screw	T-3¼	2.1	0.12
49A[3]	White	Bayonet	T-3¼	2.1	0.12
50	White	Screw	G-3½	6-8	0.2
51[2]	White	Bayonet	G-3½	6-8	0.2
	White	Screw	G-4½	6-8	0.4
55	White	Bayonet	G-4½	6-8	0.4
292[5]	White	Screw	T-3¼	2.9	0.17
292A[5]	White	Bayonet	T-3¼	2.9	0.17
1455	Brown	Screw	G-5	18.0	0.25
1455A	Brown	Bayonet	G-5	18.0	0.25

[1]40A and 47 are interchangeable.
[2]Have frosted bulb.
[3]49 and 49A are interchangeable.
[4]Replace with No. 48.
[5]Use in 2.5 volt sets where regular bulb burns out too frequently.
*White in G.E. and Sylvania; green in National, Union, Raytheon and Tung-Sol.
**0.35 in G.E. and Sylvania; 0.5 in National, Union, Raytheon and Tung-Sol.

MASTER ELECTRONIC PARTS LIST

TRANSISTORS	RADIO SHACK NO.	PRICE
2N140	276-401	.99
2N107	276-403	.99
2N46	276-404	.99
2N197	276-405	.99
2N242	276-406	1.19
2N1515	276-407	2.29
2N358	276-408	1.09
2N149	276-409	1.15
2N313	276-410	.99
2N649	276-411	.99
2N310	276-412	1.29
CK722(2)	276-1034	.59

RECTIFIERS	RADIO SHACK NO.	PRICE
1 AMP 100 PIV	276-1708	.39
SCR 6 AMP @ 200 PIV	276-1132	2.49
12 AMPS @ 400 PIV	276-1063	1.98
IN34	276-1709	.27
1N625	276-418	.39

RESISTORS	RADIO SHACK NO.	PRICE
(all 1/2W unless otherwise specified)		
10	70-0195	.12
100	70-0195	.12
150	70-0195	.12
180	70-0195	.12
220	70-0195	.12
330	70-0195	.12
470	70-0195	.12
1000	70-0195	.12
1600	70-0195	.12
2200	70-0195	.12
3300	70-0195	.12
3900	70-0195	.12
4700	70-0195	.12
5600	70-0195	.12
6800	70-0195	.12
8200	70-0195	.12
10000	70-0195	.12
15000	70-0195	.12
18000	70-0195	.12
22000	70-0195	.12
33000	70-0195	.12
39000	70-0195	.12
47000	70-0195	.12
56000	70-0195	.12

RESISTORS	RADIO SHACK NO.	PRICE
82000	70-0195	.12
100000	70-0195	.12
220000	70-0195	.12
270000	70-0195	.12
330000	70-0195	.12
560000	70-0195	.12
680000	70-0195	.12
820000	70-0195	.12
1 MEG.	70-0195	.12
1.2 MEG	70-0195	.12
2.2 MEG	70-0195	.12
500Ω Adjustable 10W	80-0101	1.19

POTENTIOMETERS	RADIO SHACK NO.	PRICE
500 W/SPST	271-066	.79
5K W/SPST	271-1620	.79
5K-	271-1714	.59
10K	271-1715	.59
50K	271-1716	.59
25K W/SPST	271-094	.79
100K	271-092	.59
500K	271-210	.59
1 MEG	271-211	.59
2 MEG	271-093	.59

CAPACITORS (uf)	RADIO SHACK NO.	PRICE
1.0	71-416	.59
.1	71-409	.22
.25	71-412	.30
.5	71-468	.88
.01	71-5194	.18
.02	71-452	.19
.05	71-407	.17

CAPACITORS (uuf)	RADIO SHACK NO.	PRICE
5	71-5087	.16
47	71-5101	.16
82	71-5105	.16
220	71-5111	.16
1000	71-5123	.16
2000	71-5182	.16
4700	71-5189	.16
5000	71-5190	.16

(Continued on next page)

MASTER ELECTRONIC PARTS LIST

ELECTROLYTIC CAPACITORS	RADIO SHACK NO.	PRICE
3 MFD	272-958	.29
5 MFD	272-952	.29
10 MFD	272-960	.31
30 MFD	272-961	.31
50 MFD	272-962	.35
100 MFD	272-963	.45
500 MFD	272-986	.72
1000 MFD	272-1718	.98

CAPACITORS VARIABLE	RADIO SHACK NO.	PRICE
365 uuf	272-1343	1.19
365	272-1341	.59
2-25	71-4029	.27
4-40	71-4030	.29
7-100	71-4031	.32
55-300	71-4035	.45

TRANSFORMERS	RADIO SHACK NO.	PRICE
500ΩCT-3.2Ω	273-1379	.79
1000ΩCT-8Ω	273-1380	.79
24V @ 1.2A	273-1480	1.98
12V @ 1.2A	273-1505	1.69
IF Transformer	273-049	.49
6.3V @ 1.2A	273-050	.98

BATTERIES	RADIO SHACK NO.	PRICE
1½VD Cell	23-466	.15
22½V	23-097	1.29
9V Rect.	23-464	.29
15V	23-509	1.05
1.35V	23-592	.45

SPEAKERS	RADIO SHACK NO.	PRICE
6" SPKR	40-1207	2.39
2¾" SPKR	40-262	.98
5x7 SPKR	40-1215	4.49

ANTENNAS	RADIO SHACK NO.	PRICE
Loopstick	270-1430	.59
Walkie Talkie Whip	21-1156	1.99

MISC.	RADIO SHACK NO.	PRICE
Phono Jack	75-0966	.12
SPST Switch	275-602	.30
Hand Key	20-1085	.69
Miniature Phone Jack	75-3392	.29
Headphone	33-180	1.98
Min. Phone Plug	75-3394	.59
Lapel Microphone	33-100	1.89
Carbon Microphone	279-1425	.79
DPDT Slide Switch	275-067	.20
VU Meter	22-019	3.95
COAX Chassis Connector	278-201	.50
Crystal Socket	75-9131	.12
SPST Push Switch	275-1385	.25
Induction Coil	44-533	.99
Low Z Headphone	33-175	.98
R.F Choke 2.5 MH	270-1713	.75
B2M	276-1025	1.50
Socket for TO-3 Case	75-4969	.19
Binding Post (pkg of 10)	274-333	.99
#47 Bulb	77-3396	.15
Tape	64-2348	.29
Line Cord	278-1255	.39
5A 3AG Fuse (5)	77-2768	.19
AC Outlet (2)	270-640	.29
SPST Slide Sw (2)	275-315	.25
SPDT Slide SW (2)	275-125	.29
Fuse Holder	270-364	.39
Clip-in Fuse Holder (2)	270-739	.32
T Adapter	42-2439	1.25
4x2¼x2¼	77-0680	.80
2¾x2⅛x1⅝	77-0677	.65
5x9½x2	77-0347	1.45