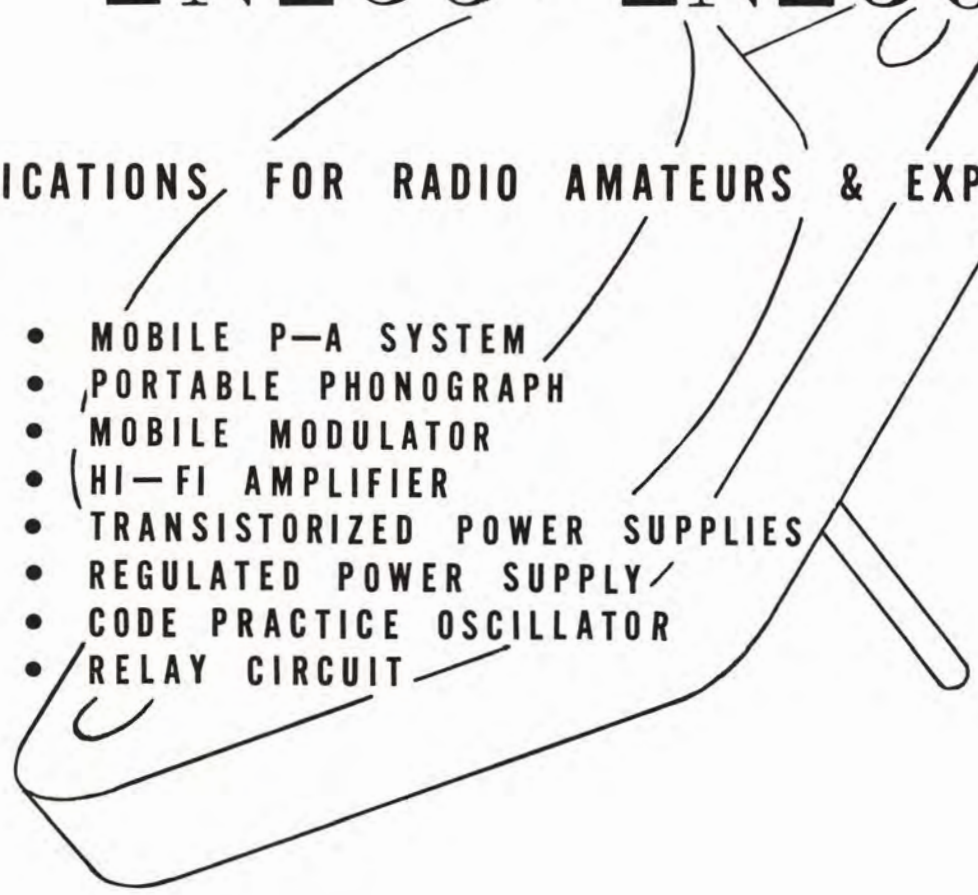
POWER TRANSISTORS

2N255 - 2N256

APPLICATIONS FOR RADIO AMATEURS & EXPERIMENTERS

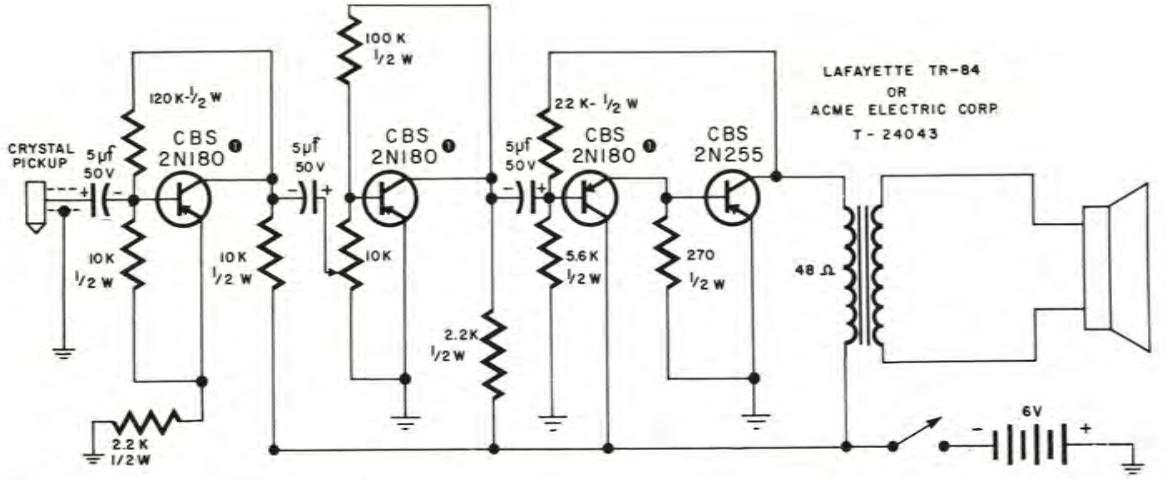
- MOBILE P—A SYSTEM
- PORTABLE PHONOGRAPH
- MOBILE MODULATOR
- HI—FI AMPLIFIER
- TRANSISTORIZED POWER SUPPLIES
- REGULATED POWER SUPPLY
- CODE PRACTICE OSCILLATOR
- RELAY CIRCUIT



CBS-HYTRON

A DIVISION OF COLUMBIA BROADCASTING SYSTEM, INC.

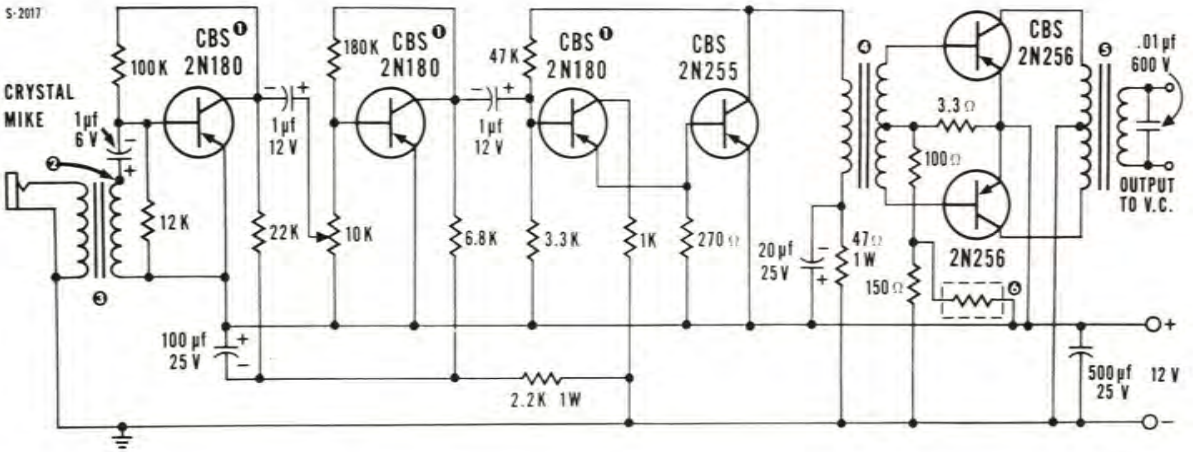
Semiconductor Operations, Lowell, Massachusetts



PORTABLE PHONOGRAPH AMPLIFIER - A light weight portable record player having one half watt output may be constructed using this transistor amplifier. The turntable used may be either the new battery-powered electric type or the manual type. A simple electronic power supply may be substituted for the battery. Total current drain is about 514 milliamperes.

NOTE 1:

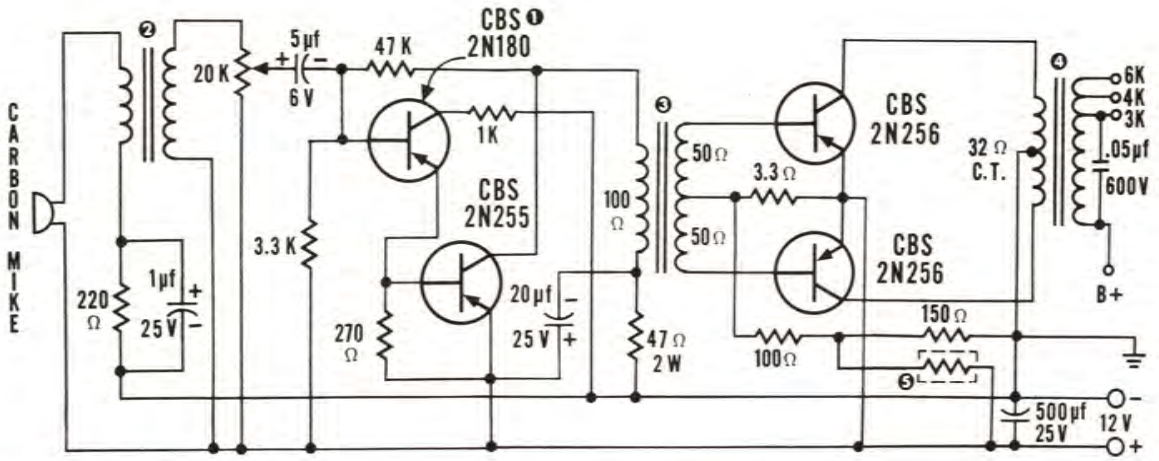
The circuit has been designed so that transistors having lower Betas, such as types 2N107, GT222, and CK722, may be substituted for the 2N180 units.



MOBILE PUBLIC ADDRESS SYSTEM - This high power amplifier will operate directly from a 12-volt storage battery without a transformer and vibrator supply. The push-pull, Class B-operated 2N256's will furnish 10 watts of audio power. Installation of power transistors is discussed elsewhere in this booklet under Precautions On Using Transistors. This design shows negative ground for automobile service. Because circuit ground is the positive side, wire to one point and bypass with a large capacitor.

NOTES:

1. Lower gain transistors, such as the 2N107, GT222, and CK722, may be substituted for 2N180 units.
2. For dynamic microphone, eliminate transformer and connect at point indicated.
3. Argonne AR-100.
4. TRIAD TY-61X, ACME T-24042, LAFAYETTE TR-85, ARGONNE AR504, N. E. 2252.
5. TRIAD TY-64X, CHICAGO TAMS-12 (24 to 32 ohms input to speaker impedance, 10 watts).
6. Thermistor required to protect transistors when subjected to high temperature: VECO 21W1 (100 ohms, -3.77%/°C)
7. All resistors are 1/2 watt units except as noted.



MOBILE MODULATOR - This unit will supply 10 to 12 watts of audio power which is sufficient to 100% modulate a 6V6 or 2E26 final r-f amplifier. Installation of power transistors is discussed elsewhere in this booklet under Precautions On Using Transistors. The microphone transformer is not critical. Several are suggested in Note 2. The output transformer can be the universal tube-to-speaker type with several impedance taps, one of which is centered; i.e., with 4, 8, 16 ohm taps, the 4 ohm tap is centered between the common tap and the 16 ohm tap. The common tap connects to one collector; the 16 ohm tap to the other collector; and the 4 ohm tap to the power supply. The transistors' output impedance is twice as large as these values so that the secondary impedance is double the marked values. Otherwise, the modulation transformer (TRIAD TY65Z) is designed for transistor modulators and connected as marked.

NOTES:

1. Lower gain transistors, such as the 2N107, GT222, and CK722, may be substituted for the 2N180 units.
2. TRIAD TY-54X, TZ-25, or THORDARSON TR-25.
3. TRIAD TY-61X, LAFAYETTE TR-85, ACME T-24042, N. E. 2552, ARGONNE AR504.
4. TRIAD TY-65Z modulation transformer, or tube-to-speaker output transformer matching 24 to 32 ohms input to 4,000 ohms as described above.
5. Thermistor required to protect transistors when subjected to high temperature: VECO 21W1 (100 ohms, -3.7%/°C).
6. All resistors are 1/2 watt units except as noted.

PRECAUTIONS ON USING TRANSISTORS

MECHANICAL AND INSTALLATION - Since transistors are mechanically rugged devices, undue concern about reasonably rough treatment is not necessary. The primary consideration to be observed is the avoidance of extreme shock and excessive bending or twisting of the leads.

The power transistors should be mounted on a suitable radiator. In circuits where the collector is above ground, the radiator should be insulated from the chassis, but bolting to the chassis with insulated bolts and inserting a mica washer between transistor and chassis will suffice.

TEMPERATURE - Temperature extremes can have a severe effect upon transistor life. Storage temperatures permissible are well beyond the range of temperatures normally encountered but overheating of the transistor in a circuit can be disastrous, especially in power amplifiers. For high power levels, the transistor case is attached to a heat radiator which may be the chassis.

Heat increases collector cutoff current (Ico) which, in turn, reduces power output and further increases the heat developed. This may result in a runaway condition. The circuit can be stabilized by using a thermistor in the base circuit; thus, rising temperature decreases the base-to-emitter voltage and stabilizes Ico.

Precautions should be observed while soldering. Solder with the transistor out of the socket; or, if the transistor has flexible leads, hold pliers on the lead between the point being soldered and the transistor.

Operating temperature may be checked by attaching a thermometer to the power transistor case. For types 2N255 and 2N256 temperature should not exceed 151°F or 66°C.

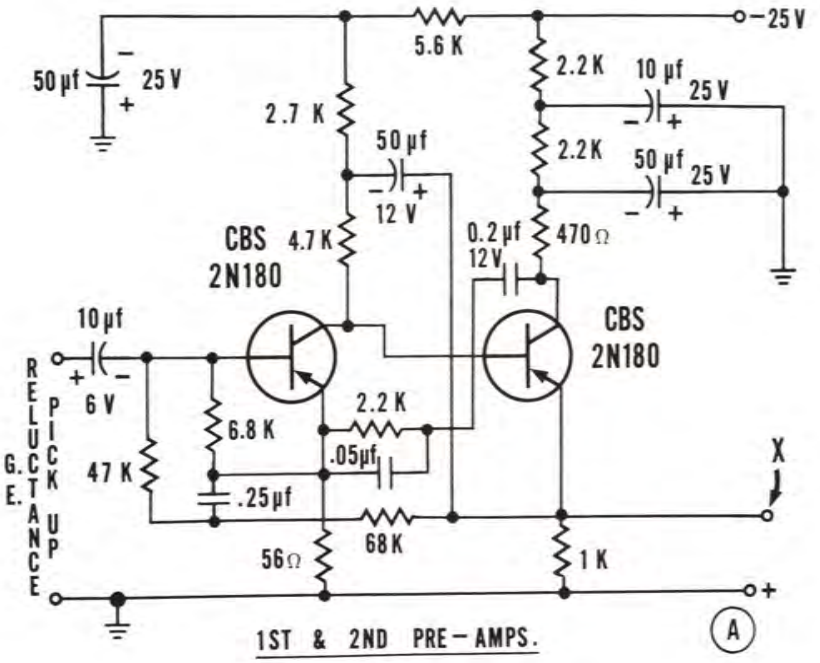
ELECTRICAL CONDITIONS - Transistors are capable of extremely long life if operated within their ratings. However, small excesses in the voltage or power ratings may destroy the transistor instantaneously. Therefore, precautionary increases must be taken if experimenting or testing new circuits. Some important considerations follow.

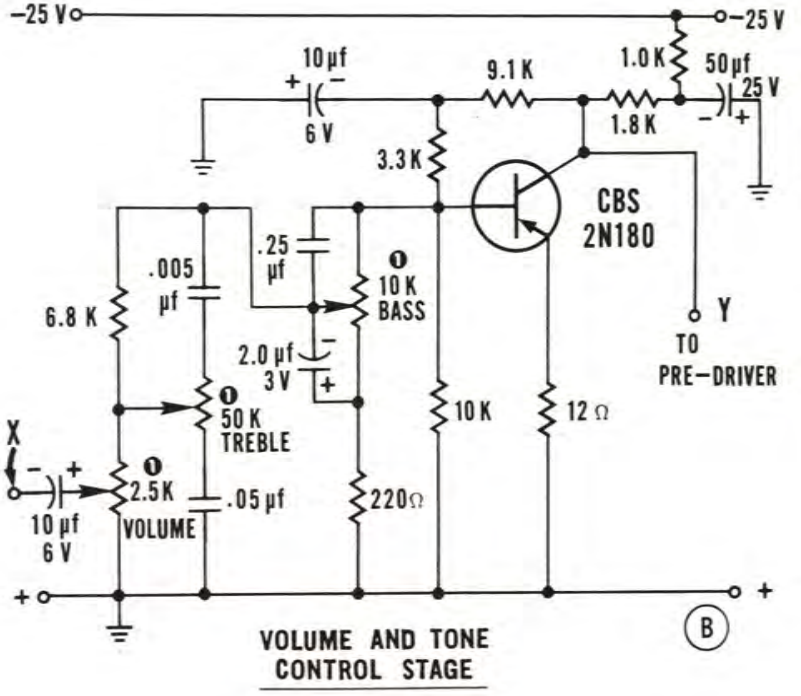
First: Double check the polarity of the supply voltage. Incorrect polarity endangers both transistors and electrolytic capacitors.

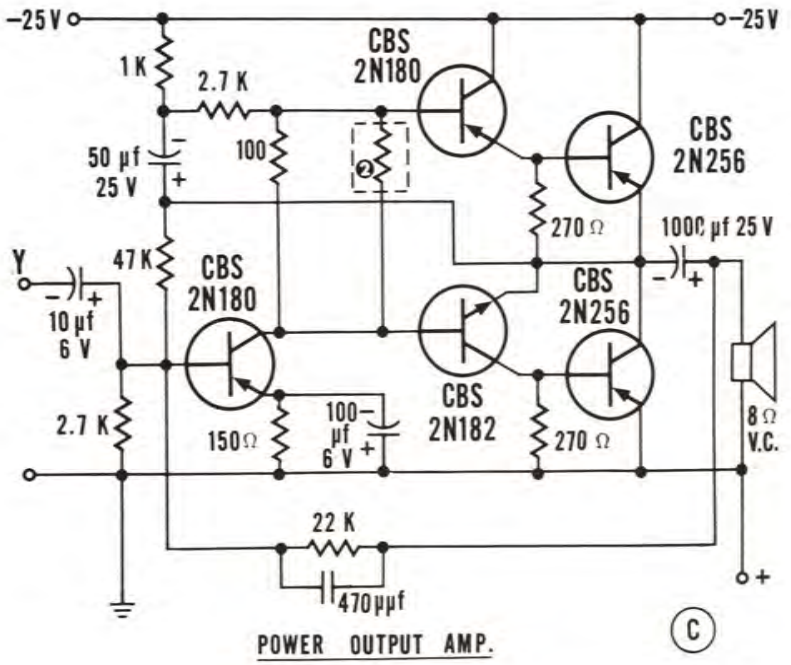
Second: When first testing a new circuit, apply voltage in easy stages, starting at a lower than normal value to see if operation appears to be normal. Beware of high voltage surges. It is a good idea to load a 6 or 12-volt unregulated electronic power supply with a storage battery to stabilize the voltage.

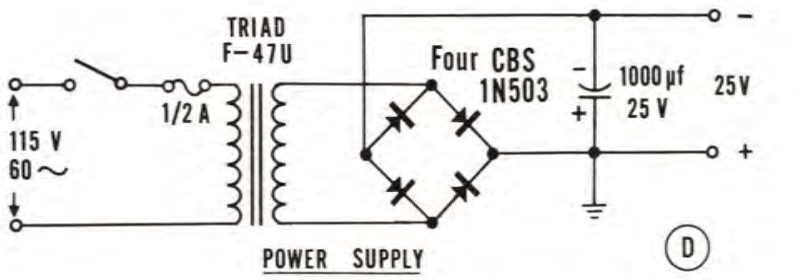
Third: Before the circuit is allowed to operate for an extended period, measure the collector current in the power stages and adjust bias if necessary.

Fourth: Never operate a power stage without connecting a load to the output.









HI-FI AMPLIFIER - In addition to eliminating all audio transformers from the circuit, this 6-watt amplifier has a frequency response of ±1.5 db from 30 to 15,000 cps, 2.5% intermodulation distortion, a -74 db noise level, and less than 1% harmonic distortion.

The circuit features negative feedback, a complementary-symmetry driver, and direct-coupling between the pre-driver, driver, and output stages. Installation of power transistors is discussed elsewhere in this booklet under Precautions On Using Transistors.

NOTES:

1. All potentiometers are logarithmic taper types.
2. Thermistor required to protect transistors when subjected to high temperature: VECO 21W1 (100 ohms, -3.7%/°C)
3. Bring all grounds to common point.

TRANSISTORIZED POWER SUPPLIES

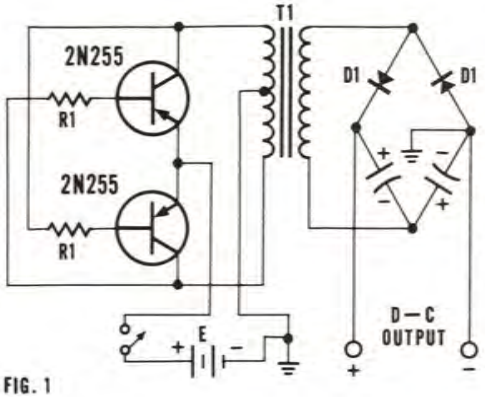


FIG. 1

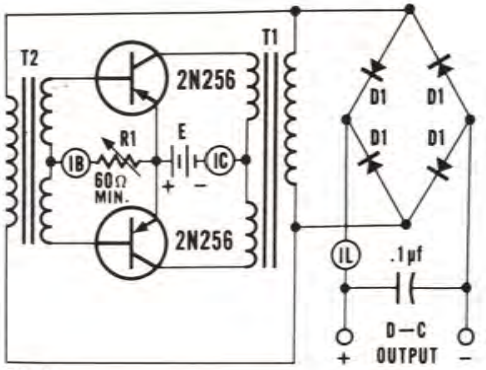


FIG. 2

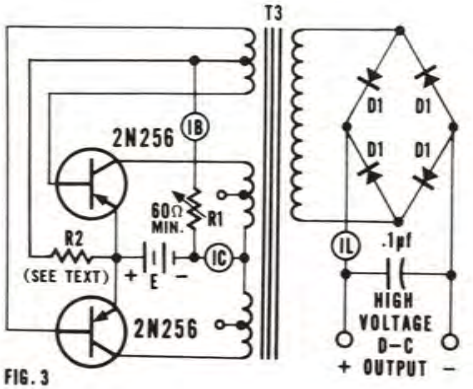


FIG. 3

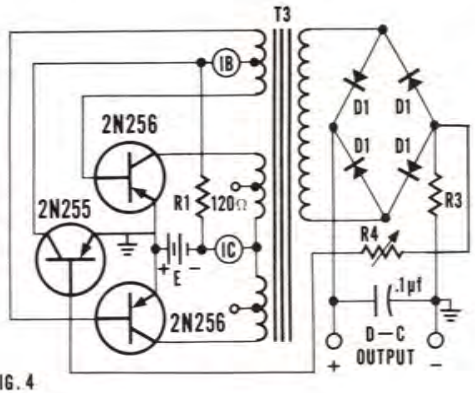


FIG. 4

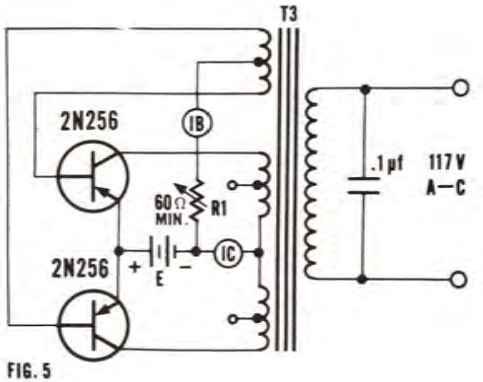


FIG. 5

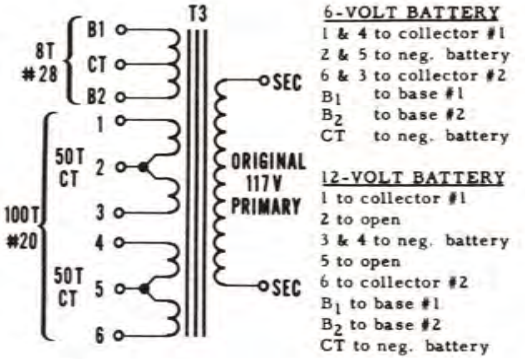


FIG. 6

TRANSISTORIZED POWER SUPPLIES--Figures 1 through 4 show several different d-c voltage multipliers. In Figure 1, cross-coupling resistors provide feedback. In Figure 2, feedback is accomplished by an additional transformer T2. In Figure 3, forward bias insures that oscillations are self-starting, and a single transformer conserves space and weight. In Figure 4, a CBS 2N255 transistor replaces R2 to self-regulate the output.

Figure 5 gives the circuit of a d-c to a-c converter. The output waveform is essentially square with a frequency of approximately 60 cps. Figure 6 describes the construction of transformer T3, a Thermadore* No. 6L2412 which has been rewound.

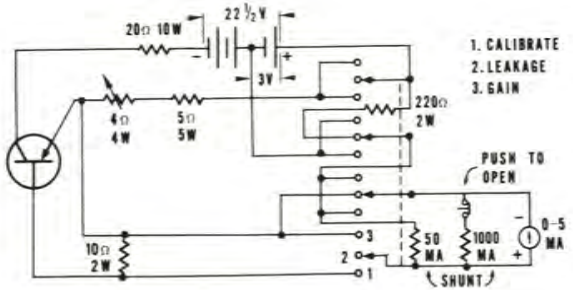
Maximum switching ratings for CBS 2N255 and 2N256 power transistors are 2 amperes for each collector and 100 milliamperes for each base. The minimum value of R1 is E/0.1 in Figure 1, or E/0.2 for the other circuits, where E equals the battery voltage.

The turns ratio of T1 is approximately one-half the output voltage divided by the input voltage. For example, to develop 250 volts from a 6-volt source, the turns ratio should be about 20/1, which can be provided by a 115V/6.3V CT filament transformer. The power handling capacity of T1 should at least equal the d-c output power requirements.

In Figure 2, T2 has a turns ratio of 5 to 10 times that of T1. For example, a tube-to-voice coil transformer (20,000/8/4 ohms impedance) works nicely with the above filament transformer.

In Figure 3, R2 should be about 10 times the resistance of R1. In Figure 4, R3 should be small compared to the load resistance ($R3 = R_L/20$). R4 is adjusted for the desired output.

*Norris Thermadore Corp., 5217 Boyle Street, Los Angeles, California



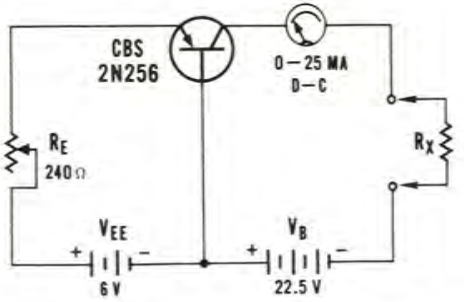
POWER TRANSISTOR TESTER--This circuit will accurately test power transistors for: (a) all combinations of opens, shorts, leakage, and voltage breakdown, and (b) power gain, simulated by a d-c test.

There are three switch positions, namely: "Leakage," "Power Gain," and "Calibrate." A spring-return normally keeps the switch in the "Leakage" position.

In the "Calibrate" position, adjust the "Calibrate" knob until the meter reads "2" (400 ma). If this is impossible, replace the battery. Do not push the button.

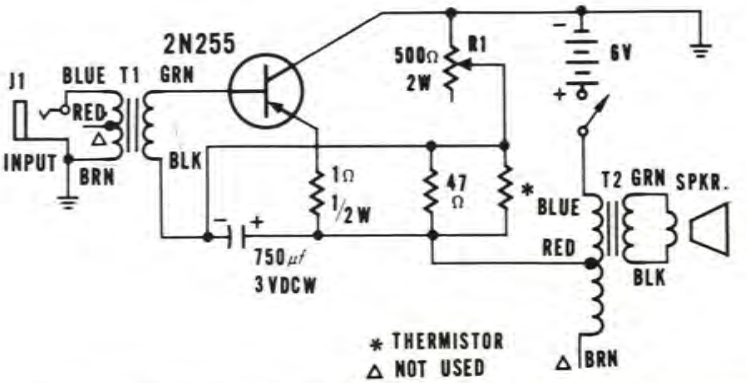
In the "Leakage" position, a meter reading greater than 0.1 (20 ma) indicates a C-B, C-E, or C-B-E short. If the reading is less than 0.1, push the button. Then a new reading greater than 2 (2 ma) is excessive leakage. Creeping upscale is leakage.

In the "Gain" position, a reading greater than 0.5 (100 ma) is a B-E short or any open. If the reading is below 0.5, push the button. If the new reading is less than 0.5 (10 ma), there is a C-B, C-E, or C-B-E short. A reading of 2.2 (44 ma) indicates an available power gain of 30 db. Higher readings indicate lower power gains and vice versa.



METER PROTECTION CIRCUIT--When a d-c milliameter, or ammeter, is connected in a circuit to measure an unknown current, it is important that some form of protection be employed to prevent damage to the meter. A CBS 2N256 power transistor is ideal for this purpose as shown in the accompanying circuit.

R_X is the unknown impedance through which the current is to be measured, and across which the voltage is to be held to V_B. The current is indicated by the meter M. The emitter current, I_E, is fed from the source, V_{EE}, and is adjusted by a resistor, R_E, to the highest value of current which the meter can withstand; in this case, 25 milliamperes. Of course, meters for higher currents may be used up to the 3-ampere maximum rating of the transistor, provided that the power dissipation rating of the transistor is not exceeded.



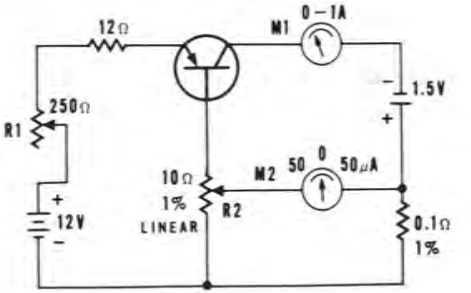
PORTABLE POWER BOOSTER--This single-stage, transformer-coupled, Class A power amplifier can boost the power output of personal portable radios to as much as 1 watt to drive the loudspeaker. The unit is plugged into the portable's phone jack.

Input transformer T1 matches the receiver's medium output impedance to the power transistor's low input impedance. T2 matches the transistor output impedance to the low impedance of the loudspeaker voice coil.

Adjust R1 to give an emitter current of 0.5 ampere.

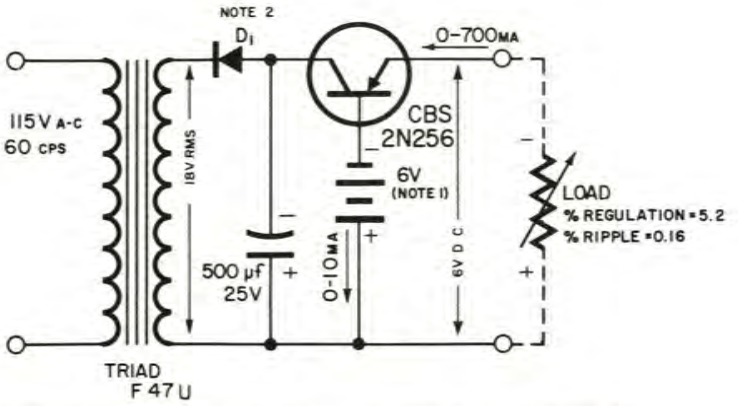
This circuit permits the transistor to be bolted directly to the chassis for a heat sink.

T1: 500-ohm to 8-ohm transistor transformer
(Argonne AR-164)
T2: 48-ohm to 3.2-ohm output transformer
(Argonne AR-503)
PM loudspeaker: 6" x 8" dia., 3.2-ohm voice coil
Heat sink chassis: 4" x 3-1/8" x 1" (ICA 29082)
*40-ohm thermistor, VECO 14X2

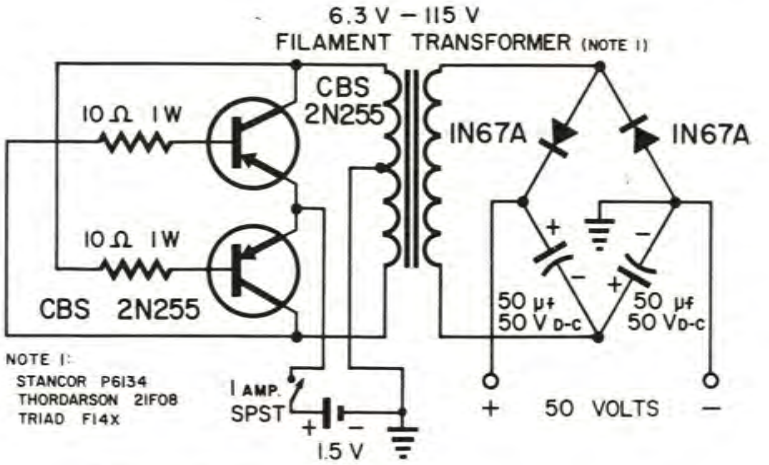


POWER TRANSISTOR BETA TESTER--This beta tester is direct reading. A PNP power transistor, such as the CBS 2N255 or 2N256, is plugged into the test socket. R1 is adjusted for the desired collector current, such as 0.5 ampere, on meter M1. Then R2 is adjusted for 0 current on meter M2. R2 has a dial scale of 0-100 divisions on which beta is read directly.

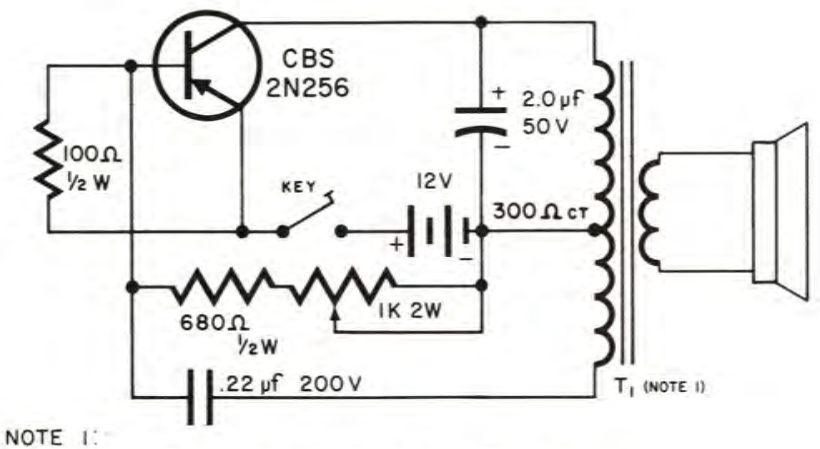
NPN power transistors may be tested if the battery polarities and the connections to meter M1 are reversed.



REGULATED POWER SUPPLY - A regulated supply of the series type in which the output voltage remains constant for wide variations of input (value of secondary voltage should never exceed 25 V rms). The output voltage is less than one half volt higher than that of the reference battery. Different reference voltages may be used for other output voltages.

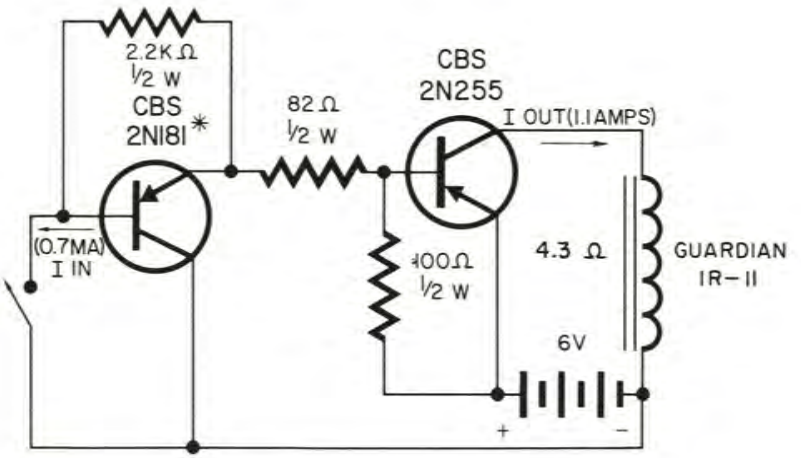


D-C VOLTAGE MULTIPLIER - This d-c voltage multiplier will provide high voltage from a low-voltage source, thus eliminating the troublesome vibrator or bulky B+ battery. When the CBS transistors oscillate, they provide an a-c voltage across the transformer. The output voltage and current are determined by the battery voltage and transformer turns ratio; therefore, they may be varied to suit the application as long as the transistor and diode ratings are not exceeded.



NOTE 1:
T1 – ARGONNE AR-121, NEW ENGLAND TYPE 399, OR TRIAD TY-57X

CODE PRACTICE OSCILLATOR - A single transistor audio oscillator for code practice that has sufficient output, 300 mw, to drive a small loud speaker. The circuit incorporates a tone control. A volume control may be added in the form of an L-pad in the speaker voice-coil lead. Its smooth variable tone output makes code practice a pleasure.



RELAY CIRCUIT - A sensitive relay circuit having high-temperature stability in which an input current of less than 1.0 ma will control a 1.0 ampere solenoid. It is useful in model boats, airplanes, and other remote control devices.

* If amplifier is not subjected to extremes of temperature a 2N107 transistor may be substituted.

CBS 2N255 • 2N256 PNP POWER TRANSISTORS

The advanced-engineered CBS types 2N255 and 2N256 are PNP alloy-junction germanium transistors which have high power-handling capability coupled with high current amplification. These units are especially designed for experimental use.

Electrically the 2N255 and 2N256 are similar, being intended for use in 6-volt and 12-volt systems, respectively. △

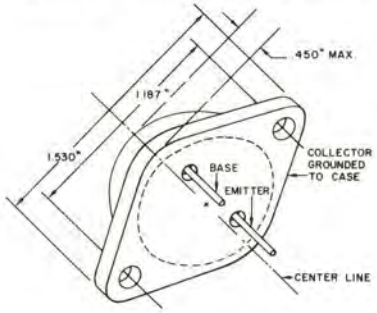
Each unit is hermetically sealed for increased protection; therefore, these transistors will give years of reliable service when operated within their maximum ratings.

△Care must be exercised to prevent reverse biasing or application of voltages above the maximums.

The construction of the transistors is designed for high heat dissipation through the metal flange to which the collector is connected. Several methods of mounting are practical for amplifier circuitry. For collector - grounded circuits, fasten the transistor flange directly to the chassis. A heat-radiator plate that is insulated from the chassis can be used for other circuits; or if high heat dissipation is not required, the base pins can support the unit with the collector-circuit lead fastened directly to the flange. ○ The two heavy plug-in leads fit standard 9-pin miniature sockets, eliminating the necessity for special sockets or soldering directly to the leads.

○Not recommended if subjected to high mechanical stress.

MECHANICAL DATA



ELECTRICAL DATA

RATINGS, ABSOLUTE MAXIMUM, AT 25 °C

	2N255	2N256	
Collector to base voltage, d-c ●	-15	-30	volts
Emitter to base voltage, d-c	-15	-30	volts
Collector current, steady state d-c	-3	-3	amp
Dissipation, total in free air	1.5	1.5	watts
Derating per °C ambient temp. increase	.024	.024	watt
Dissipation, total with heat radiator ▲	8.5	8.5	watts
Derating per °C ambient temp. increase	0.1	0.1	watt
Operating temperature, junction	-40 to 85		°C
Storage temperature	-40 to 85		°C

TYPICAL CHARACTERISTICS AT 25 °C

Collector current	-500	-500	ma
Collector voltage	-6	-12	volts
Base resistance	9 to 24		ohms
Alpha cutoff frequency, $F_{\alpha_{co}}$	200	200	kc
Collector to base current amplification, d-c	30 to 50		
Saturation voltage, V_s, I_c = 1.0 amp	0.5	0.5	volt
Operating temp. gradient, junction and surface of copper base	3	3	°C/watt

TYPICAL OPERATION AT 25 °C ■

Class A Amplifier (One Unit, Common Emitter Connected)

Collector supply voltage	-7	-14	volts
Collector to emitter voltage, d-c	-6	-12	volts
Collector current, d-c	-500	-500	ma
Base to emitter voltage, d-c	0.4 to 0.6		volt
Base current, d-c	-10 to -16		ma
Input resistance	10 to 25		ohms
Load resistance	14	28	ohms
Power output	1	2	watts
Total harmonic distortion	5 to 7		%
Power input	2 to 10		mw
Power gain	19 to 26	22 to 29	db

Push-Pull Class B Amplifier (Common Emitter Connected)

Values for each unit	2N255	2N256	
Collector supply voltage ▽	-7	-14	volts
Collector current, zero signal	-50	-50	ma
Collector current, max. signal	-500	-500	ma
Peak collector current	-1500	-1500	ma
Base current, zero signal	-0.5 to -1.5		ma
Base current, max. signal	-10 to -16		ma
Dissipation, max. signal	0.8	1.6	watts
Input resistance	18 to 48		ohms
Load resistance	4	8	ohms
Power output □	5	10	watts
Power input □	25 to 150		mw
Power gain □	12 to 20	15 to 23	db

NOTES:

- ● These are peak values; the 2N255 and 2N256 should be operated from 6 and 12-volt batteries, respectively.
- ▲ When operated within maximum rated power dissipation using a 6" x 6" x 1/8" aluminum heat radiator, the temperature should not exceed 151° F (66° C) on the surface of the case.
- ■ Use of an efficient heat radiator for operation at these conditions is imperative.
- ▽ The supply voltages given for the 2N255 and 2N256 are those used in mobile operation, nominally -6 and -12 volts, respectively.
- □ Values for both units.

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