Electronic TUBES

G-E HAM NEWS

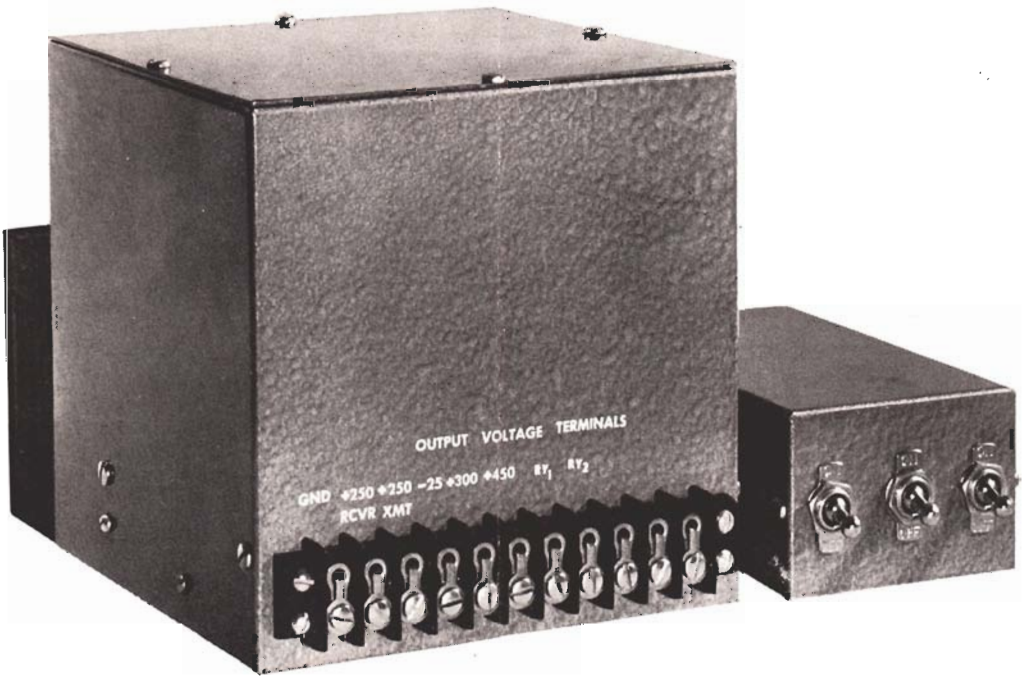
GENERAL ELECTRIC

JULY–AUGUST, 1957 VOL. 12—NO. 4

100-WATT MOBILE POWER SUPPLY

features

- 6- or 12-volt DC input
- Built-in receiver power
- Battery saver circuit
- Over 70% efficient
- 450, 300 and 240 volts DC output



Meet the trend to higher power in mobile amateur communications with this high-efficiency vibrator power supply that will completely power your home-built or commercial mobile station.

—*Lighthouse Larry*

CONTENTS

100-WATT MOBILE POWER SUPPLY

The popularity of the efficient Mobile/Portable power supply (See G-E HAM NEWS, March-April, 1953, Vol. 8, No. 2, for details) has flooded my mail basket with requests for a similar supply having higher power output. The result—W2GSJ has designed a flexible and compact mobile power supply that delivers about 450, 300 and 240 volts simultaneously for a transmitter, in addition to 240 volts at 90 ma for a mobile receiver. Multiple output voltages make possible a battery-saving "high-low" transmitter power reducing circuit. Any mobileer who has inadvertently run down his car battery while operating for extended periods with the engine off will verify the importance of this feature.

—*Lighthouse Larry*

DESIGN CONSIDERATIONS

High efficiency generally is the most important factor in the design of mobile radio equipment, obviously because of the limited amount of power available from the average automotive electrical system. Some means of reducing the transmitter power input also is desirable to help prevent running down the car battery when the engine is not running. These features, plus compact size and conservatively rated components have been combined into this mobile high-voltage power supply intended for engine compartment mounting. This location assures short input power leads having low voltage drop, but the 6- x 6- x 8-inch over-all power supply dimensions are equally adaptable to under-dash or trunk compartment mounting.

The input power required by this supply is almost directly proportional to the output power drain. No power is wasted in overcoming friction losses, as in a rotary-type mobile high-voltage supply. The only moving parts are tightly sealed inside the vibrator, immune to oil and dirt.

The big demand for efficient and powerful commercial mobile radio communication equipment has led to the development of new heavy-duty vibrator-type high-voltage power supply components. The new split-reed, dual-interrupter type vibrator overcomes the power capacity limitations of previous types. Power supplies capable of delivering up to 100 watts of high-voltage DC output are now possible with a single vibrator.

In addition, this vibrator permits the design of power supplies requiring no component changes for operation from either the 6- or 12-volt DC power systems with which most automobiles are equipped.

Many vibrator power supplies have been, until recently, designed around the synchronous type vibrator. A simplified schematic diagram of such a supply is shown in Fig. 1. One set of vibrator contacts switches the battery current alternately through two opposed primary windings of a transformer, thus inducing a square-wave AC voltage in the secondary. This AC secondary voltage is then rectified by a second set of contacts on the vibrator armature. The limitations of this circuit are low current handling capacity of the vibrator and the need to use a different number of turns on the transformer primary when the battery voltage is changed, e.g., when moving the supply from a car with a 6-volt system to one with a 12-volt system.

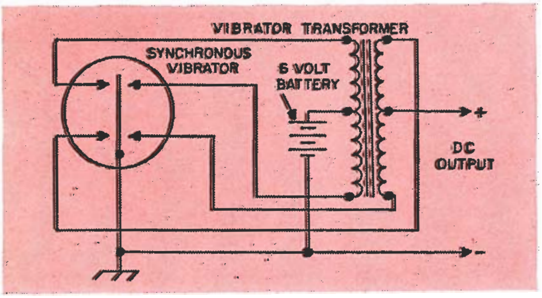


Fig. 1. Simplified diagram of a typical synchronous vibrator and rectifier circuit.

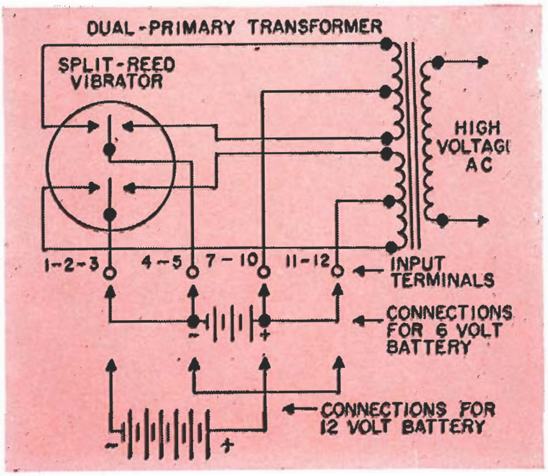


Fig. 2. Simplified diagram of a typical split-reed vibrator and 6/12-volt DC changeover system.

In the split-reed vibrator, two sets of double-throw contacts are electrically isolated from each other, as depicted in Fig. 2. These contacts in currently available split-reed vibrators have much greater current carrying capacity than the usual synchronous or single-interrupter types.

However, a power transformer having two center-tapped primary windings is required. One set of contacts switches the DC current alternately between halves of one primary winding, and the other set simultaneously switches the other winding.

Therefore, the primaries can be connected in parallel for 6-volt operation, or in series for operation from a 12-volt DC supply. No wiring changes are necessary in the supply if the battery is properly connected to the power input terminals. The voltage change-over connections can be made by means of multiple-contact input power connectors, if desired.

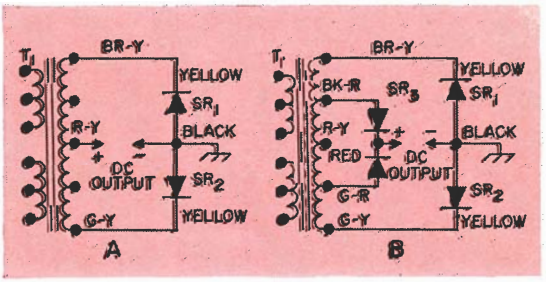


Fig. 3. Simplified diagrams of: A—the full-wave rectifier circuit from which the 250-volt DC output is obtained; and B—the 300-volt DC bridge circuit tapped across a portion of the high-voltage winding on T_1.

Since the vibrator contacts open and close abruptly, the periodically interrupted voltage impressed on the transformer primary has practically a square waveform. The secondary voltage also has nearly a square waveform, and thus the peak voltage on the rectifiers is only slightly higher than the average voltage of the waveform. This means that the rectifiers in a vibrator-type power supply can be operated on a square-wave voltage close to their maximum peak inverse voltage rating, instead of considerably below this rating, as when a sine wave AC voltage is applied to them.

CIRCUIT DETAILS—HIGH-VOLTAGE SECTION

Since the high voltage section of this power supply has three distinct rectifier circuits, simplified diagrams of the rectifier circuits which furnish the 250- and 300-volt outputs are shown in Fig. 3A and 3B. Note that each rectifier has two sections. The parts numbers and transformers color-coded leads are the same as those shown in the complete schematic diagram, Fig. 4. In the 250-volt DC circuit of Fig. 3A, the full transformer secondary voltage [leads BR-Y (Brown-Yellow) and G-Y (Green-Yellow)] is applied to a full-wave rectifier consisting of half of SR_1 and SR_2. These two rectifiers form a portion of all three rectifier circuits. Since the junction between the black rectifier terminals is grounded, the positive 250-volt output is taken from the R-Y (Red-Yellow) transformer lead. This is the opposite of the usual full-wave rectifier circuit. This voltage is filtered by C_{3B}, C_{4A}, C_{4B}, L_1 and a 47-ohm resistor in Fig. 4.

PARTS LIST

C_1, C_2—100-mfd, 450-volt electrolytic (Sprague TVL-1750).
C_3, C_4—dual 40-mfd, 450-volt per section electrolytic (Sprague TVL-2764).
C_5—0.003-mfd, 2500-volt working mica capacitor.
C_6—50-mfd, 50-volt electrolytic (Sprague TVA-1308).
E_1—Vibrator, dual interrupter, split reed; 6-volt coil, 115 CPS reed frequency, 7-pin base (Mallory type 1701, Oak No. V-6853, Radiart No. 5722, or G-E Cat. No. A-7141584-P3).
F_1—30-ampere cartridge fuse and holder.
F_2—15-ampere cartridge fuse and holder.
J_1—12-pin male chassis plug (Cinch-Jones No. P-312-AB).
J_2—8-pin male chassis plug (Cinch-Jones No. P-308-AB).
J_3—4-pin male chassis plug (Cinch-Jones No. P-304-AB).
J_4, J_5—4-pin female socket (Cinch-Jones No. S-304-AB).
L_1—1.5-hy, 100-ma filter choke, 150 ohms maximum DC resistance.
L_2—7-uh, 1-ampere RF choke (Ohmite Z-50).
L_3—120-uh, 10-ampere filament RF choke.
P_1—12-pin female cable socket (Cinch-Jones No. S-312-CCT).
P_2—8-pin female cable socket (Cinch-Jones No. S-308-CCT).
P_3—4-pin female cable socket (Cinch-Jones No. S-304-CCT).
P_4, P_5—4-pin male cable plug (Cinch-Jones No. P-304-CCT).
R_1—10-ohm, 10-watt adjustable resistor.
Ry_1, Ry_2— two-pole, double-throw relay, 6-volt DC coil (Advance No. MG/2C/6VD or PC/2C/6VD; Potter & Brumfield MR-11-D 6V or KL-11-D 6V; Guardian No. 200-6D coil and 200-2 contact assembly; Ohmite DOSX-158T, DOX-145T or CRUX-199T).
Ry_3—single-pole, single-throw relay, 6-volt DC coil, 30-ampere contacts (auto headlamp or equivalent).
S_1, S_2, S_3—single-pole, single-throw switch.
SR_1, SR_2—2-section selenium rectifier, 150 ma, 380 volts peak inverse per section, connected for doubler (G-E pt. No. A-7144141-P2); or, two 150-ma, 380-volt selenium rectifiers in series (Federal No. 1005-A).
SR_3—2-section selenium rectifier, 150 ma, 380 volts peak inverse per section, connected for center tap (G-E No. A-7144141-P1); or two Federal No. 1005A rectifiers with red terminals connected together.
SR_4—150-ma, 64-volt peak inverse selenium rectifier (G-E No. A-7140806-P1 or Federal No. 1015).
T_1—Vibrator power transformer, dual center-tapped 6-volt primaries; secondaries; 420 volts, tapped at center and 150 volts each side of center, 300 ma; 20-volt, 150-ma bias voltage winding (G-E No. B-7486449-P1).
TS_1—8-terminal barrier terminal strip (Cinch-Jones No. 8-141-Y).

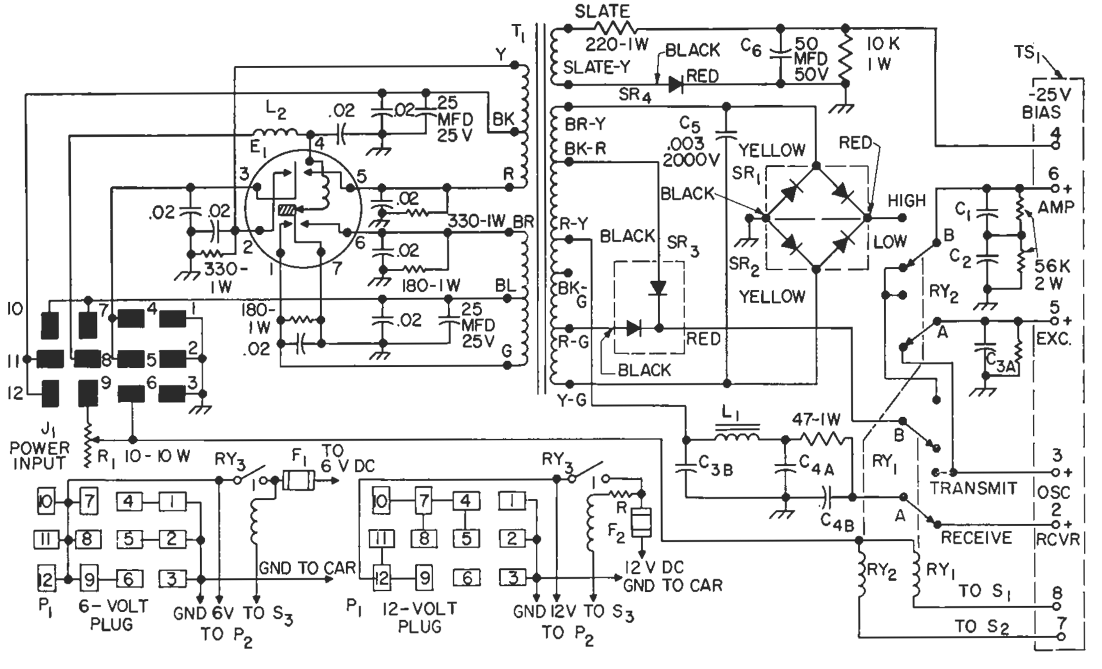


Fig. 4. Complete schematic diagram of the mobile power supply. Separate 6- and 12-volt power input plugs and cables are shown at the bottom of the diagram.

The 300-volt DC output is obtained from a bridge rectifier circuit at Fig. 3B consisting again of one-half of SR_1 and SR_2 in the legs connected to ground, plus SR_3 in the two bridge legs from which the positive voltage is obtained. During one-half of each AC cycle, the voltage across the BK-R (Black-Red)—Y-G section of the high-voltage winding is rectified by the upper section of SR_3 and SR_2 in the bridge. On the other half of each AC cycle, the voltage between transformer taps G-R (Green-Red) and BR-Y is rectified by the lower section of SR_3, and SR_1. The transformer output voltage from these taps is about 300 volts AC.

Another bridge rectifier circuit is employed for the 450-volt DC output, again with the two grounded legs of the rectifier circuit passing through SR_1 and SR_2. The other two sections on these rectifiers form the legs of the bridge from which the positive DC voltage is taken at the junction of the red terminals.

Since there is very little ripple voltage in the DC output from the rectifiers, a single 40-mfd, 450-volt capacitor, C_{3A}, on the 300-volt output was adequate. Two 100-mfd, 450-volt capacitors, C_1 and C_2, were placed in series across the 450-volt output.

A "transmit-receive" power switching circuit is included in the power supply so that the 250-volt output may be applied to a mobile receiver or converter. This is accomplished with one pair of contacts on a double-pole, double-throw relay, RY_1, which also turns on the 300-volt output to a transmitter exciter when its relay coil is energized. A second double-pole, double-throw relay, RY_2, turns on the 450-volt DC output to a transmitter final amplifier when its coil is energized. It also provides the power-reducing feature when the coil is not energized, by applying 300 volts to the 450-volt output terminal, and 250 volts to the 300-volt output terminal. A single-pole, double-throw relay may be substituted for RY_2 if the power-reducing feature is desired only on the 450-volt circuit.

Since all rectifiers have high voltage on them continuously when the supply is operating, the idling current flow through the unused rectifiers when receiving was reduced to almost zero by disconnecting them from the

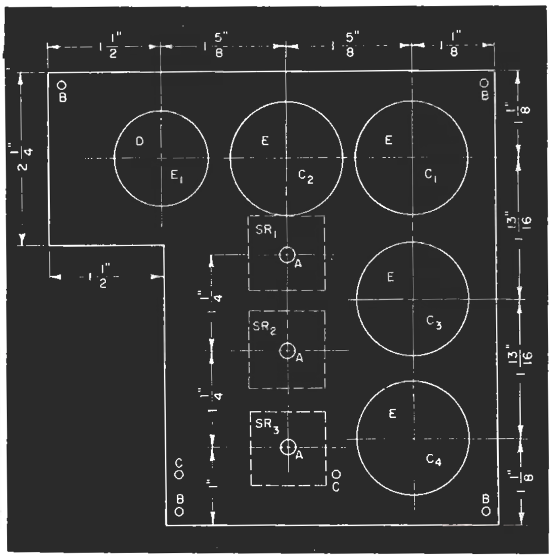


Fig. 5. Drilling diagram of the chassis plate on which most components are mounted. Small holes should be drilled to suit the mounting holes of parts actually used.

DRILLING LEGEND—"A" drill-No. 26 for rectifiers; "B" drill—No. 18 for angle brackets; "C" drill—No. 18 for choke L_1; "D" socket punch—1 ¼ inches in diameter for vibrator socket; "E" socket punch—1 ½ inches in diameter for filter capacitors.

filter capacitors and bleeder resistors with RY_1 and RY_2. Leaving C_1, C_2 and C_{3A} connected to these rectifiers would result in an unwanted continuous current drain through the rectifiers. This does not apply to the 250-volt output, from which power is drawn both when receiving and transmitting.

A special 20-volt secondary winding on the transformer provides transmitter negative bias through rectifier SR_4, filtered by a 50-mfd, 50-volt capacitor, C_6.

CIRCUIT DETAILS—LOW-VOLTAGE SECTION

The basic circuit of the split-reed vibrator and the series-parallel input voltage change-over on the transformer primaries already has been described under "DESIGN CONSIDERATIONS." In this power supply, changing from 6- to 12-volt input was accomplished with a 12-pin Cinch-Jones "300" series power plug and socket, P_1 and J_1, respectively.

A separate low-voltage input cable is used for each voltage, as shown in Fig. 4. Leads from P_1 to the main power relay, RY_3, should be made as short as possible to reduce the voltage drop. This is particularly true with a 6-volt power source, where a cable resistance of only 0.04 ohms will cause a 1-volt drop when the power supply is running at full load.

The 6-volt input plug connects the alternate pairs of vibrator contacts, and halves of the transformer primaries, in parallel. For 12 volts input, the low-voltage current path is as follows, assuming that the vibrator contacts between pins 7 and 1, and pins 3 and 2, are closed: The G (Green) lower primary lead is grounded through vibrator pins 1 and 7; the BL (Blue) center tap lead runs through vibrator pins 3 and 2 to lead Y (Yellow) on the upper primary; and the BK (Black) center tap lead is connected through pins 11 and 12 on J_1 to the ungrounded 12-volt lead.

The proper voltage for the 6-volt vibrator coil, connected to pin 8 on J_1, also is obtained by changing connections on P_1. With a 6-volt input, this voltage is applied directly to pin 8. Attaching the 12-volt plug connects pin 8 on J_1 to pins 7 and 10. Thus, 6 volts for the vibrator is obtained from the mid-point of the series-connected transformer primaries.

Similarly, 6 volts for the coils of relays RY_1 and RY_2 is supplied from the 6-volt power cable through pin 6 on J_1. With the 12-volt plug, a voltage dropping resistor, R_1, is connected in series with the relay coils, and the other end of the resistor receives 12 volts through pin 9. If the power supply is to be operated exclusively from a 12-volt supply, relays having 12-volt coils may be substituted, thus eliminating R_1.

There usually is some sparking at the vibrator contacts while they are operating, so several components were included in the circuit to filter and suppress any noise or "hash" that results from this sparking. These parts, also shown in Fig. 4, include eight 0.02-mfd 500-volt disc ceramic and two 25-mfd electrolytic capacitors; plus two 180-ohm and two 330-ohm, 1-watt resistors; and RF choke L_2.

COMPONENT PARTS

The heart of this power supply is the vibrator transformer designed especially for General Electric two-way mobile radio equipment. It is readily available as a replacement part from many of the 3000 G-E mobile radio service stations, or directly from the address listed below.[1] Similar transformers are made for other makes of mobile radio gear. Or, a transformer with a similar high-voltage winding can be rewound with the two center-tapped primary windings.

Communications type vibrators, such as those listed in the "PARTS LIST," are usually stocked by radio parts distributors. The G-E industrial type 2-section

[1] The General Electric parts should be ordered from: Mr. Donald Clark, General Electric Co., Product Service Renewal Parts Section, Communication Products, 509 Kent Street, Utica, N. Y. Current prices, plus shipping charges are as follows: Transformer T_1, \$14.70; vibrator E_1, \$5.75; rectifiers SR_1, SR_2, and SR_3, \$7.75 each; rectifier SR_4, \$1.40.

selenium rectifiers used in the model power supply may be obtained from the same source as the transformer. Two standard replacement type selenium rectifiers may be substituted for each of the 2-section units, if desired, by observing the polarities.

The relays recommended for RY_1 and RY_2 have well-spaced contacts that will break the high voltage without excessive arcing. Any available type with the proper coil voltage may be used if they will withstand the voltage. All filter capacitors in the supply are operated well below maximum rating so that any probable combination of high temperatures and high input voltage will not exceed the rated working voltage.

MECHANICAL DETAILS

All components except the power transformer were enclosed inside a 6- x 6- x 6-inch aluminum utility box (Bud AU-1039) for protection from the dirt and oil that collects in an automobile's engine compartment. A sub-chassis made from $\frac{1}{16}$-inch thick sheet aluminum was cut and drilled according to the drilling diagram, Fig. 5. Additional holes should be drilled in the plate to match those on RY_1 and RY_2. If both relays will not fit into the space shown in the top view, Fig. 6, the filter choke, L_1, or one of the relays may be fastened to the side wall of the box. All chassis drilling and the cutouts for the transformer, power input socket, and output terminal strip, TS_1, should be completed before the chassis is permanently fastened in place with small angle brackets 2 inches from the bottom of the box.

One electrolytic capacitor, C_1, is assembled on the insulated mounting plate furnished with these capacitors. When twisting the locking lugs, be sure they do not come near the metal chassis. The can of this capacitor is more than 200 volts above ground and was insulated with a fiber sleeve.

The large seven-pin tube socket into which the vibrator plugs should have ground lugs on the metal mounting plate for the by-pass capacitors which are later wired onto the socket. Or, two soldering lugs may be placed under each mounting screw for this purpose. If the power supply is to be operated with the chassis in a vertical plane, pins 1 and 4 should be in a vertical plane. The smaller components below the chassis should not be installed until parts above the chassis have been assembled and wired.

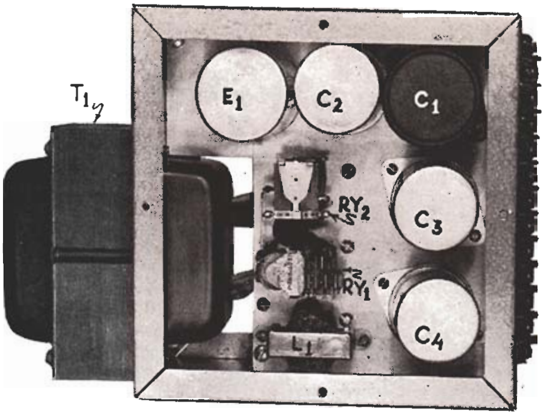


Fig. 6. Top view of the power supply interior. If larger relays are used, RY_1 can be mounted on the chassis plate, and RY_2 on the box side wall above choke L_1.

The transformer primary leads are wired to the input plug and vibrator socket with shortest possible leads before the by-pass capacitors and other parts are mounted on the vibrator socket. The other small parts, including R_1, are installed in the locations shown in the bottom view photograph, Fig. 7. The bias voltage rectifier and filter components are mounted on the box side wall right below the three selenium rectifiers visible in this view. The buffer capacitor,

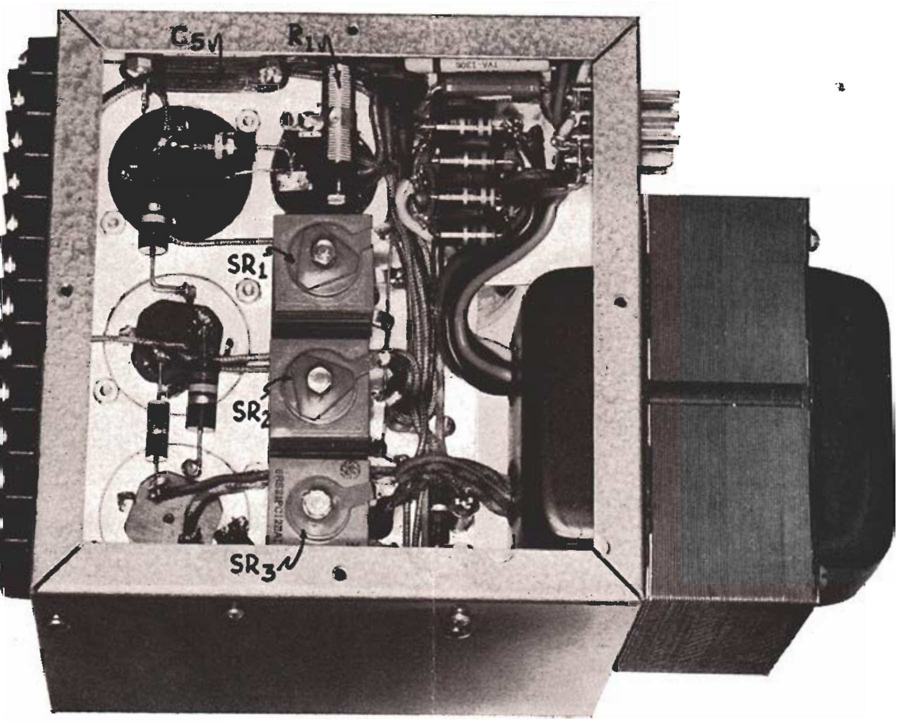


Fig. 7. Bottom view of the power supply. The vibrator socket is hidden by the resistors and disc ceramic capacitors in the hash filter. RF choke L_2 and the 25-mfd capacitors can be seen just above these parts. The bias rectifier and filter is fastened to the box side wall at the bottom of the picture.

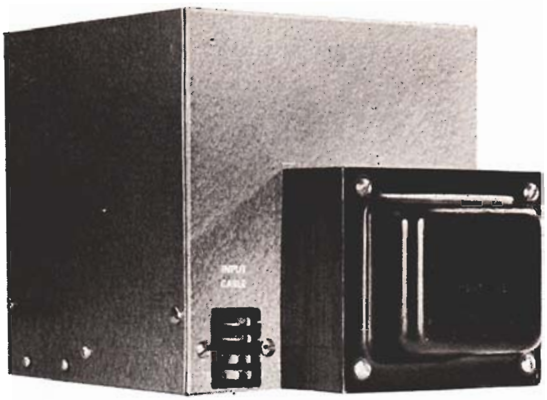


Fig. 8. End view of the power supply showing locations of the power input plug, J_1, and the power transformer.

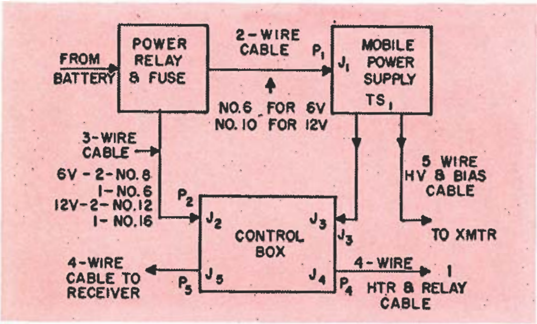


Fig. 9. Block diagram of suggested power and control cables and a switching system for the mobile power supply, when similar circuits are not already available.

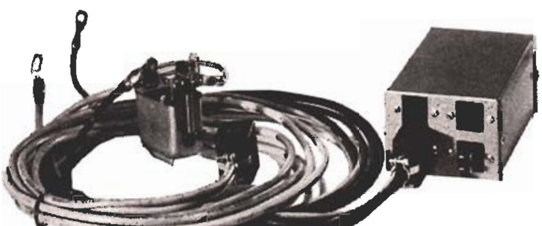


Fig. 10. View of the suggested low-voltage cable harness, main power relay, RY_3, and the control box wired according to Fig. 11 below.

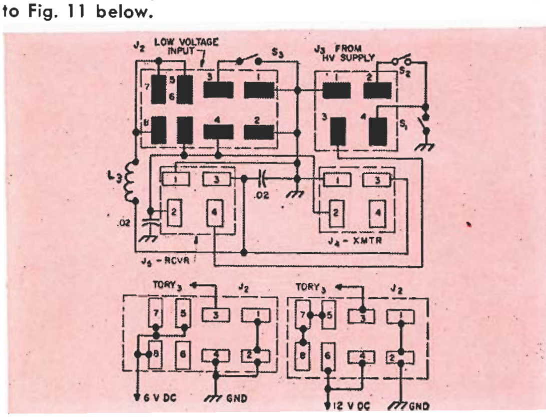


Fig. 11. Schematic diagram of a suggested control box for the mobile power supply, including power plugs for changing tube heaters for 6- or 12-volt operation. A push-to-talk button can be connected across S_1.

C , connected across the transformer secondary, can be seen in the upper left corner. All parts should be securely fastened to withstand vibration.

The power supply can be constructed on a standard chassis, if desired, or even in a small steel amplifier foundation unit made by several radio chassis manufacturers. The parts layout is not critical, except that the vibrator, input power socket, and transformer primary leads should be closely grouped to minimize hash radiation from the vibrator circuit.

INSTALLATION

This power supply may be operated in conjunction with the suggested mobile power system shown in the block diagram, Fig. 9. Note that a separate cable is recommended for the heater power circuit for two reasons. First, this minimizes heater voltage variations when the high voltage supply is switched from receiving to transmitting; second, the possibility of vibrator hash pickup by the heater wiring is minimized. A picture of the low-voltage cable harness used with this power supply is shown in Fig. 10.

Provision has been made for changing the mobile receiver and transmitter heater power circuits for either 6- or 12-volt operation in the schematic diagram of a suggested power control box, Fig. 11. An 8-contact Cinch-Jones plug and socket, P_2 and J_2, automatically makes the proper connections when the 6- or 12-volt plug is attached. (See "Mobile Tube Heater Hints" on page 8 for the suggested series-parallel heater circuit.) High voltage for the receiver, plus the control switch circuits for RY_1 and RY_2, are brought into the control box from the high voltage supply through J_3. The power cable for the receiver is then plugged into J .

The high voltage leads for the transmitter should be run directly from the power supply, but the transmitter heater power and "transmit-receive" control circuit may be run to the transmitter through a cable plugged into J_4. Three switches were included on the control box, with S_1 as the "transmit-receive" switch; S_2 as the "high-low" transmitter power control; and S_3 as the main power switch for RY_3.

If similar control circuits and power wiring already are available in your mobile radio installation, they may be used instead. Relay RY_3 should be mounted very close to the point from which power is taken from the automotive electrical system.

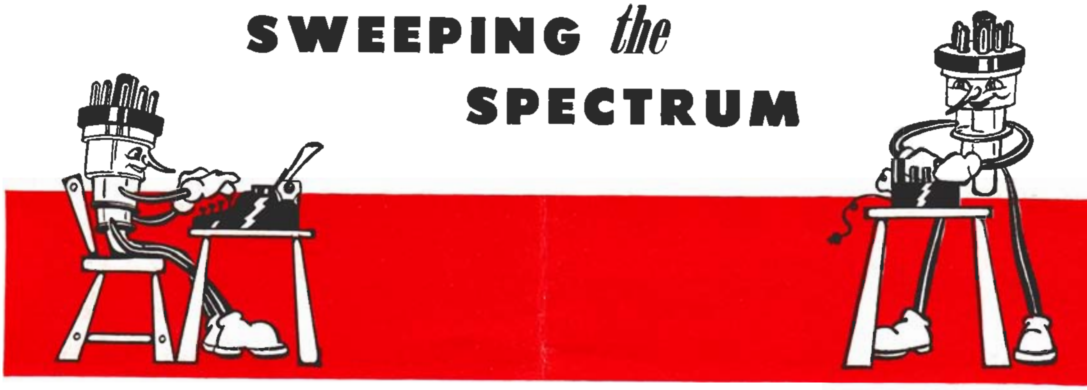
OPERATION

First test the power supply at half input voltage, but with full voltage applied to the vibrator coil. This is accomplished by temporarily removing the jumper between pins 7 and 8 on the 12-volt power plug, P_1. Pin 8 is then jumpered to pin 9. The cable is then attached to J_1 on the power supply and to a 6-volt DC power source. Approximately half the rated voltages should be measured at the output terminal strip if the power supply has been properly wired.

Replace the original connections on the 12-volt power plug and test the supply with full input voltage. A 2500-ohm, 100-watt resistor, or four 25-watt, 115-volt lamp bulbs in series, makes a good load resistance. The output voltages should measure close to 450, 300 and 240 volts under load.

The power supply may be checked for vibrator hash simply by connecting it to any all-band receiver having a power plug for battery-powered operation. Additional 0.02-mfd by-pass capacitors at RY_3, the output terminal strip, and control box should eliminate any hash still present. If not, try disconnecting the heater power lead at RY_3 with the high voltage supply running. If the hash disappears before the tube heaters cool off, the optional heater circuit RF choke, L_3, should reduce any hash reaching the receiver via the heater power leads. Every experienced mobileer will agree that noises in each mobile radio installation usually must be eliminated on a "search-and-filter" basis.

SWEEPING *the* SPECTRUM



MEET THE DESIGNER—W2GSJ, Kenneth K. Bay, impressed by the efficient plate power supplies in General Electric's line of two-way mobile radio equipment, suggested a simplified version of that power supply for radio amateurs in this issue. He points out that this is another example of how radio amateurs benefit from new developments in the commercial electronics field.

For example, the power transformer, T_1, is a specialized part that otherwise would not be available to radio amateurs at modest cost. This is in addition to the many new electronic tubes originally developed for television and communications that are now found in amateur radio equipment.

Ken is a design engineer on the transmitter portion of G.E.'s two-way mobile radio at the Electronics Park plant in Syracuse, N. Y. Though primarily a traffic handler on the 80-meter CW band, he also works DX on 40 and 20 meters. First licensed in 1940, Ken is one of those fortunate amateurs who has clung to the letters in his original call through three changes in call area, first as W4GSJ, then W8GSJ, and finally his current W2GSJ.

⁂ ⁂ ⁂

While we're on the subject of amateur radio mobile operation, one of the local boys related a story about being caught with a run-down car battery in a remote hill-top location after operating his 75-watt mobile rig for a couple of hours with the engine not running. And the hill top didn't help him either, because the car was parked in a slight hollow and resisted all attempts to push it by hand!

He then had to walk five miles to the nearest farm house, engage a team of horses ($$$) and tow the car to a downgrade where it would roll fast enough to start the engine. A real climax to this ill-fated mobile venture would be to say that the car rolled down the hill without the driver and was wrecked. Fortunately, this amateur's luck changed and he arrived home safely. Moral: Don't make long-winded mobile transmissions—or better yet—include our power-reducing circuit in your own mobile power supply and reduce unnecessary battery drain.

⁂ ⁂ ⁂

I've just finished reading through a stack of amateur radio club bulletins and newspapers that many clubs have mailed to me—and the following item caught my eye in several publications.

. . . An increasing number of amateur radio clubs are holding their annual election of officers in the late spring, with the new term of office starting in July or August. Since many clubs have little formal activity outside of picnics during the summer months, one group of officers is thus able to plan and carry out a program of activities for the entire fall-winter-spring season, during which most meetings and other functions take place. Several clubs have reported that this term of office results in much less disruption of program planning than when they elected new officers at the end of the calendar year.

⁂ ⁂ ⁂

Some communications receivers on which the amateur bands are directly calibrated are capable of surprisingly accurate frequency measurements when a certain tuning procedure is followed. Of course, an accurately adjusted 100-kilocycle frequency standard should be used to provide calibration points. Here's how a local radio amateur was able to attain an over-all measurement accuracy of 16.3 parts per million on all three frequencies while participating in a recent ARRL Frequency Measurement Test. An error of less than 75 parts per million qualifies an ARRL member for a class 1 Official Observer rating.

He first let the receiver warm up for several hours before the test to minimize drift. The next step was to carefully tune for maximum "S" meter reading on the 100-kilocycle calibrator signal nearest the previously announced approximate measurement frequency on the 3.5-megacycle band. The dial pointer was then adjusted for correct calibration at this point and the receiver's beat frequency oscillator was tuned to zero beat.

When the test signal was located, he tuned the receiver to zero beat, carefully estimated the frequency reading and quickly wrote it down. Next, the signal was zero-beated while tuning from a lower frequency on the receiver and a second dial reading was taken. This was repeated from the higher frequency side to zero beat, then repeated a fourth time by tuning across the signal and reversing the dial direction to minimize backlash. As many readings as possible were taken, tuning each time from alternate directions, before the test signal shifted to the 7-megacycle amateur band.

After switching the receiver to that band, the dial pointer was again set correctly at the nearest 100-kilocycle calibrator point. Again, many alternate dial readings were taken on the 7-megacycle test signal. The whole procedure was repeated a third time to obtain a series of readings on the 14-megacycle test signal. This signal operates only for about five minutes on each frequency, so some advance practice in rapidly calibrating the receiver is desirable.

All readings for each test frequency were then added up and divided by the number of readings taken at each frequency to determine the average frequency of each test signal. When the results were announced, our friend's error on 3.5 megacycles was only 27 cycles, or less than 8 parts per million!

The next ARRL frequency measuring test is on September 18. Full details, including the approximate frequencies, will be given in QST magazine a month or two in advance. Take this opportunity to find out just how close you can measure frequencies using just your receiver and a crystal calibrator.

—*Lighthouse Larry*

MOBILE TUBE HEATER HINTS

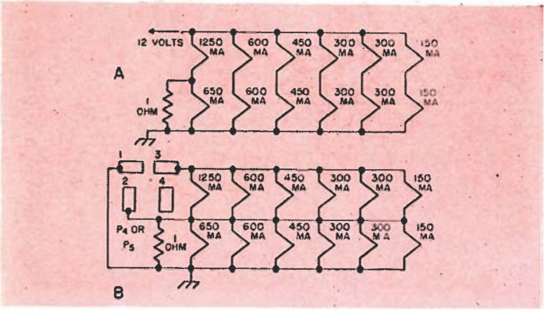


Fig. 12. Mobile tube heater circuits

Maximum versatility in amateur radio mobile radio equipment is possible only when the tube heater circuit is designed for operation from either a 6- or 12-volt supply. There was no such problem in the good old days when only 6-volt automotive electrical systems were popular, since the usual practice was to connect a string of 6-volt tube heaters in parallel.

One approach to operating 6-volt tube heaters on 12 volts is to select pairs of tubes in the equipment having identical heater current ratings and connect them in series. This results in the circuit of Fig. 12A, representing tube heaters with several current ratings. The main disadvantage of this circuit is that an unequal voltage may appear across each tube in a series string when the heater resistances at operating temperature are not the same. Thus, the higher resistance tube heater will operate at higher than the rated voltage.

A pair of tubes having dissimilar heater current ratings is shown at the left to illustrate how a current-balancing resistor is connected across the tube having the lower current drain. Since 600 ma flows through this resistor, a tube heater requiring this current could be substituted for the resistor. These circuit values apply to a mobile transmitter using a 6AG7 and a GL-6146 with the heaters in series.

The disadvantages of this circuit are overcome by connecting mobile radio equipment tube heaters in the circuit shown at Fig. 12B. The 6-volt tube heaters are divided into two groups having the same total current drain, each of which is then connected in parallel. One heater lead is made common to both strings, and the chassis can be used for the grounded lead in the lower string, if desired.

For 6-volt operation, pins 1 and 3 on $P_{4/5}$ are connected together, and pin 2 runs to the ungrounded side of the 6-volt power source. For 12-volt operation, the ungrounded 12-volt source is connected to pin 3 on the plug, and no external connection is made to pin 2. Pin 1 connects to the grounded side of the power source for both voltages. This circuit tends to cancel out the effects of differences in the heater resistance of individual tubes. In addition, the current drain of both strings can be precisely balanced with an adjustable resistance across one heater string.

Keep this circuit in mind when you build your next mobile transmitter, converter, receiver, or when reworking your present mobile gear to operate from the 12-volt electrical system in that new car. It's practically the standard heater circuit for modern commercial two-way radio equipment.

Electronic TUBES

G-E HAM NEWS

Available FREE from

G-E Electronic Tube Distributors

published bi-monthly by
ELECTRONIC COMPONENTS DIVISION
GENERAL ELECTRIC
Schenectady 5, N. Y.

In Canada
CANADIAN GENERAL ELECTRIC CO., LTD.
189 Dufferin St., Toronto 3, Ontario

E. A. NEAL, W2JZK—EDITOR

Printed in U.S.A.

VOL. 12—NO. 4

JULY–AUGUST, 1957

Form 3547 Requested