HIGH-POWER MOBILE RADIO SYSTEMS

W6DLO and W6WPH, above, have designed and constructed high-power mobile amateur radio stations for their station wagons which give them home-station performance on the highway. G-E HAM NEWS is proud to present a series of three articles which describe their systems, starting in this issue. Techniques for power supplies, receivers, and linear amplifiers for CW and SSB communication will be covered.

PART I — In this issue: POWER SUPPLY IDEAS — A 3-phase AC power system, and high voltage power supply circuits.


PART III — November-December, 1960: MOBILE LINEAR AMPLIFIER — A compact linear amplifier designed especially for mobile operation.

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- MOBILE POWER SUPPLY IDEAS ............. page 3
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  "Compactor" Multi-function Devices ......................... page 8
MEET THE AUTHORS . . .

WADLD — A. P. (Al) Present, is an engineer with the electronics laboratory at General Electric’s Cakhoma Lamp Plant.

WDFWE — W. C. (Bill) Louden, is technical consultant in Discharge Advance Engineering at G-E’s Large Lamp Department. Both of these operations are located at General Electric’s Nela Park, in Cleveland, Ohio, home of our world-famous Lighting Institute.

Al and Bill have amassed years of experience in developing radio equipment — and their 3-phase power system — for mobile use. Their present SSB installations reflect the results, and are nearly all home builds, including the antennas, except for the Command set receivers. Their stations operate on all frequencies from 3.5 to 29.7 megacycles, but their favorite channels for daily mobile operation are from 14,200 to 14,300 kilocycles. Their phrasing type SSB excitors have some unusual circuits and ideas, so the readers of G-E HAM NEWS will be seeing novel features of this equipment in coming issues. The receiving systems and a linear amplifier will be described in the next two issues. Dramatic evidence of the reliability of their equipment was illustrated by their being able to keep three-times-daily schedules while separated at times by more than 2,000 miles during vacation motoring trips in 1959 and 1960.

KING-SIZE KIT . . .

While browsing through a recent issue of Broadcast Engineering magazine, I saw an article describing what appears to be the largest electronic equipment in kit form on the market — a one-kilowatt broadcast transmitter!

The kit was designed for simplified assembly — which should take about 100 hours, says the manufacturer — but obvious is a project for a person with some experience in the broadcast equipment field. When the transmitter is completed, the manufacturer sends a representative to run proof-of-performance tests in accordance with FCC regulations.

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ADDED ALTERNATOR INFO . . .

The alternators which form the key component of the mobile power system described in this article, were manufactured by the Leece-Neville Co., 5109 Hamilton, Cleveland 14, Ohio. They are available from automotive parts suppliers, or often may be obtained secondhand when operators of two-way radio equipped vehicle fleets trade in their old equipment for new models.

These alternators also may be ordered as optional accessories on many makes of U.S. automobiles. WADLD and WDFWE ordered their station wagon factory-equipped with the alternator systems. And, of course, similar alternators will be supplied to fleet mobile equipment on several makes of 1961 automobiles. While these alternators may not have the reserve power capacity of the Leece-Neville system, mobiles with equipment requiring up to 300 watts of DC power can take advantage of the S-phase power available by stepping it up directly to high voltage.

This eliminates the usual three steps of converting the 3-phase AC power into DC, then back to AC in a vibrator or transistor oscillator, and finally back to DC in the high voltage transformer and rectifiers.

NEW MOBILE MANUAL . . .

A new and revised edition of the Mobile Manual for Radio Amateurs has just been published. This second edition, edited by the headquarters staff of ARRL, is a comprehensive digest of more than 80 articles from QST on the subject of amateur mobile, emergency and portable equipment. It’s a valuable how-to-do-it manual for the mobile enthusiast; contains the detailed, technical, and diagnostic data and diagrams in ARRL’s newest handbook on your nearby electronics supply distributor.

LOG FORM QSL’S GONE . . .

By the time this item appears in print, our supply of the G-E Log Form QSL card will be completely exhausted. We called your attention to the dwindling supply in the March-April issue. So please don’t send in any more orders because we will only have to return them to you.

However, work is progressing on the Third Edition of QSL Card — "Ham News" and the new QSL Card with QSL Package, as described in this column in the May-June issue. We’re planning to have them available by December of this year, both from G-E Tube distributors, and by mail order from the G-E HAM NEWS office.

—Lighthouse Larry
TODAY'S MORE POWERFUL mobile amateur radio equipment can overload even the larger electrical systems in late model automobiles. Solve this problem by installing a constant voltage, variable-frequency, 3-phase, AC power system—large enough for even a kilowatt mobile rig—using the principles and ideas described in this article.

With many mobile radio installations now requiring 300 watts and more power from automotive electrical systems, it is usually necessary to run the car's engine when this equipment is operated for more than a few minutes at a time to avoid discharging the battery. The standard automotive electrical system, as shown in Fig. 1, just wasn't designed for this purpose.

Many commercial, police and taxi vehicles have 3-phase AC alternators installed to provide extra power for two-way radio equipment. One manufacturer, Lenco-Nevilles, supplies either 6-volt, 100-ampere, or 12-volt, 10-ampere alternator systems, rated at 600 watts output (see page 2 for details). However, the 600-watt limitation is due mainly to the rectifier connected to the alternator output to change the 3-phase AC current into direct current, as shown in the block diagram of Fig. 2. Over 250,000 miles of field "testing" on the alternators installed to power W6DDL/M and W3WFR/M have proven this system capable of supplying more than 1 KVA of power, even under severe driving conditions.

Note that the rectifier is used mainly for battery charging and other normal needs of the automotive electrical system. The high voltage DC power supply can be fed directly from the alternator, avoiding the less efficient method of first rectifying the 3-phase AC power into direct current, and then obtaining high voltage with a dynamotor, transistorized DC-to-DC converter, or vibratory power supply.

Voltage regulation of the alternator system is very good. The "variable frequency" mentioned above occurs because changes in engine speed, from 100 cycles with the engine idling, to nearly 1,000 cycles at top speed. However, modern power transformers, even though rated for 60-cycle operation, are capable of operating efficiently over this wide frequency range. And, usually the 60-cycle ratings may be considerably exceeded at the high power frequency supply frequencies.

(continued on page 5)
FIG. 3. DIAGRAM of the 3-phase automotive power system devised by the author. The 3-phase 12.5-volt output from the alternator is stepped up to 117 volts with a home-made distribution transformer. Sufficient power for a full-kilowatt transmitter is available from the components specified in this article.

FIG. 4. CONTROL PANEL schematic diagram for the 3-phase AC electric cell system. Points 7" and 5, should be rated higher than the maximum current drains from the AC circuit by the radio equipment. Switches 5 to 6 are SPST type toggle and operate DC relays which perform the functions indicated in the diagram.

WORLD is the operator's seat of his high-power 55a mobile installation. Control panel is V center of dash, with voltmeters, m466, to monitor the 12-volt DC and 117-volt AC circuits. Receiver is crystal detector type modi- fied BC-433 Command Set tuner. Note hand key for CW operation just in left of steering wheel.
Up to about 500 watts of DC power can be obtained from a 3-phase high voltage supply having transformers that step up the 12-volt AC alternator output to a few hundred volts. For higher power requirements, it is desirable to first step up the 12 volts to about 150 volts AC, and then use standard transformers in the high voltage DC power supply. This concept is illustrated in the complete mobile power supply systems used by WEEDO and WWHF, shown in the diagram of Fig. 6.

The 3-phase distribution step-up transformers used in these installations, pictured on this page, were made by the authors. Constructional details are given in a folder which is available from the G-E RAM NEWS office. It is also possible to use three 12-volt to 120-volt step-up transformers with primaries and secondaries in a delta connection, but the efficiency and regulation may not be as good.

An essential part of the system is the control and indicator circuit shown in Fig. 4. All three neon lamps should light with the system in operation; one lamp not glowing indicates that one of the three AC phases may be grounded to the car. The polarized 3-prong plug is handy for operating soldering irons and other accessories. Control switches S1, S2, and S3 operate 12-volt DC relays to perform the required functions.

Once the alternator installation is complete and the regulator is working properly, test the regulation of the 120-volt distribution transformer with the lamp load shown in Fig. 5. Measure the voltage in each phase with the three 60-watt lamps connected; it should be about 120 volts. Then close the DPST switch; about 110 volts should be indicated. Try this test at different engine speeds. The engine idling speed should be set to maintain the voltage reading at 120 volts, with the full 780-watt load.

When planning the filament and plate power supplies for the radio equipment, make sure that the load balanced to within 5 percent is presented in the 3-phase system, both at 12 and 120 volts AC. Use three filament transformers for the equipment, one across each phase, with approximately the same power drain on each.

Plate power supplies designed for a 3-phase supply usually are closely balanced. Suggested circuits for high-power supplies are shown in Figs. 6 through 10. Characteristics of the various circuits are shown in TABLE I. Note that 3-phase rectifier circuits—particularly the full-wave—feature low ripple voltage, low peak inverse voltages on the rectifiers, and high output voltage.

Use whatever components are available—rectifier tubes if you have filament transformers for the circuits of Fig. 5 and 7—or silicon rectifiers in the circuits of Figs. 8, 9, and 10. Only 4 to 6 tubes of high resistance is required on power supplies for r.f. equipment; a small 4-ampere choke and two...
INSTALLATIONS OF POWER SUPPLIES and linear amplifiers in WEDU's (left) and WENY's (right) station wagons. Storage compartments under cargo decks are handy locations for high voltage power supplies, while r.f. equipment is fastened to shelves atop rear wheel housing.

BIBLIOGRAPHY OF ARTICLES ON THREE-PHASE MOBILE POWER SYSTEMS


FIG. 6. 3-PHASE STAR HALF WAVE rectifier circuit for tube rectifiers. See Fig. 7 for component details.

FIG. 7. 3-PHASE STAR BRIDGE full wave rectifier circuit for high vacuum (5U8G, 5A4G, etc.) and mercury vapor (5L8G, 5L6G) rectifier tubes (V1 to V4). Transformers T1, T2, and T3, designated by "P1" and "S1" to indicate primary and secondary, are discussed in the text. Filament transformer T1 should be rated for the current draft of the rectifier tubes. T1, T2, and T3 are rated for one tube each. See TABLE 1 for voltage, current and peak inverse ratings.
### TABLE I — 3-PHASE RECTIFIER CHARACTERISTICS

<table>
<thead>
<tr>
<th>FIGURE NO.</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC secondary volts per 1,000 DC volts</td>
<td>855</td>
<td>428</td>
<td>855</td>
<td>428</td>
<td>740</td>
</tr>
<tr>
<td>DC volts output per 1,000 AC volts</td>
<td>1,170</td>
<td>3,340</td>
<td>1,170</td>
<td>3,240</td>
<td>1,350</td>
</tr>
<tr>
<td>Permissible DC output current above rating of single rectifier</td>
<td>300%</td>
<td>300%</td>
<td>300%</td>
<td>300%</td>
<td>300%</td>
</tr>
<tr>
<td>Peak inverse voltage per leg per 1,000 DC volts</td>
<td>2,090</td>
<td>1,050</td>
<td>2,090</td>
<td>1,050</td>
<td>1,050</td>
</tr>
<tr>
<td>Ripple frequency</td>
<td>3 f</td>
<td>6 f</td>
<td>3 f</td>
<td>6 f</td>
<td>6 f</td>
</tr>
<tr>
<td>Ripple voltage as percentage of DC output voltage</td>
<td>18%</td>
<td>4.2%</td>
<td>18%</td>
<td>4.2%</td>
<td>4.2%</td>
</tr>
</tbody>
</table>

(continued from page 5)

4-watt capacitors in a "brute force" filter are sufficient for exciter and audio equipment.

WBLDL uses the circuit of Fig. 7 with six GL-816 rectifiers and three 830-volt secondary transformers (Stancor PC-8301) in his 2,000-volt DC supply. A 200,000-volt dual output supply, using the circuit of Fig. 9, was made with three 129A to 240-volt, 50-watt step-down isolation transformers (Chicago-SD-50). This powers his exciter and supplies screen voltage for a pair of GL-814 pentodes in his linear amplifier.

WSWPH uses a similar 300/600-volt power supply, plus a high-voltage supply with the circuit of Fig. 9 and three 1,050-volt transformers (Stancor PC-8501) to obtain 2,500 volts DC to operate a pair of GL-4DEV/4-125-AL's in his linear amplifier.

Many amateurs will find the 3-phase alternator system to be the answer to their mobile power supply problems, just as WBDLD and WSWPH have found that it makes home-station results in signal reports possible from their mobile installation.

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**FIG. 8: 3-PHASE STAR HALF WAVE** rectifier circuit with silicon rectifiers of D1, D2, and D3. More than a single rectifier in each leg of the circuit will be necessary for output voltages above 200 volts. G-E type 1N1695 silicon rectifiers are suitable.

**FIG. 9: 3-PHASE STAR BRIDGE** rectifier circuit with silicon rectifiers. Approximately half to full DC output voltage can be obtained from the junction of the three high voltage windings, marked "250-300." This half-voltage feature also can be obtained from the circuit in Fig. 7.

**FIG. 10: 3-PHASE DELTA BRIDGE** full-wave rectifier circuit with silicon rectifiers. The "delta" connection of the high voltage windings reduce the DC output voltage to about 38 percent that of the star bridge circuit in Fig. 9, using the same transformers.
GENERAL ELECTRIC Announces...

COMPACTRON

Multi-function Devices

A new electronic device that combines into one unit the functions now performed by several components has been announced by G.E.'s Receiving Tube Department.

Combining the functions of two and more conventional miniature receiving tubes into a single envelope, "Compactron" devices make possible amateur and commercial receivers with four or five such envelopes containing all the functions now performed by a ten or eleven-tube receiver.

Table radio with two "Compactron" devices replacing the present five-tube lineup, and television receivers with ten such devices utilizing the same circuitry now requiring fifteen tubes, also are envisioned. Significant reductions in cabinet size also are possible with this new component.

"Compactron" devices use a new 15-pin base with a pin circle 0.750 inches in diameter, shown above at the right. Seated heights (see photo above) range from 1 to 3% inches, with a bulb diameter of 1 5/16 inches. They will be in production soon. G.E. HAM NEWS is planning construction articles containing "Compactron" devices for 1961.

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