Quality Disc Recorder

By RICHARD H. DORF

Recording components are amplifier and mechanism in case and power supply at the right.

FOR the large number of audio enthusiasts who are not satisfied with ordinary-quality recorders, here is a portable system which is capable of making records comparable in quality to the best commercial jobs. Besides giving the recordist the benefits of high fidelity, the system is compact, versatile enough for PA work, and suitable for record listening at home. The three functions—recording, PA or monitoring, and record playing—are selected by a novel "gearshift" switch on the side of the amplifier.

The amplifier is designed for use with the audio control console described on page 34 of the February issue of RADIO-ELECTRONICS. However, any other preamplifier could be used, or additional voltage amplifiers could be added to the recording amplifier itself. When used with the console, the entire recording system is portable in two parts: the console is fastened to the power supply with thumbscrews and carried by means of the handle on the console top; and the recorder case, containing amplifier and turntable assembly, is carried by its handle. While the combination is neither as light nor as small as many commercial portable recorders, the results it gives and the versatility it offers are well worth the added size.

Fig. 1 is a schematic diagram of the recording amplifier. The output of the console which feeds it is zero db in 500 ohms, which results in 1.73 volts. Rather than use an expensive (and hum-sensitive) transformer at the input of the recording amplifier, the 6C5 input grid resistor is a 500-ohm potentiometer. This terminates the 500-ohm line from the console correctly, and the 6C5 gives enough amplification to overcome the loss caused by the lack of the usual step-up (line-to-grid) transformer.

The second 6C5 gives additional voltage amplification. (There is a little more than necessary, as a matter of fact.) The 6N7 is a self-balancing phase inverter, and the output stage is a pair of push-pull 2A3's. (6B4's—with the necessary filament- and bias-voltage changes—might be more available today. The 2A3's were on hand when the unit was built.)

Equalization

Of the two unusual features in the amplifier, the more important for recording purposes is the carefully calculated equalization. As the writer has previously pointed out (*Practical Disc Recording*, Gernsback Library, No. 39), there must be a certain amount of pre-emphasis in the high-frequency range during recording so that signal-to-noise ratio will be high in playback. As a practical matter, too, the record-playing systems owned by most people have a drop in the high range, making pre-emphasis necessary to restore fidelity.

The only standard for pre-emphasis in the recording field is the so-called NAB curve, which results in a boost of 16 db at 10,000 cycles. Most phonograph records have frequency curves somewhere between the NAB standard and a characteristic with slightly less boost. Fig. 2 shows the response of this amplifier with the switch in the recording position. The boost is 2.5 db less than the NAB prescribes at 10,000 cycles, giving a very close approximation to what is found on most records. As a result, any good playback system adjusted for ordinary records will give top results with records made with this amplifier.

The equalizer circuit used to obtain the curve consists of R1 and C1 in combination with R2. The network, though extremely simple, cannot be arrived at by ear. In building the amplifier, the constructor should not vary the values of the equalizer circuit, no matter what changes he may want to make in other sections of the amplifier.

A crystal cutter, the Brush RC-20, is used because it gives the best results for the least amount of money as far as fidelity is concerned. Because a crystal cutter is a constant-amplitude device, a resistor must be placed in series with it to obtain the modified-constant-velocity characteristic usual in phonograph records.

Fig. 3 is a diagram of the components on the motor board. The amplifier output is fed from the 2A3 plates through 0.5-μf blocking capacitors (Fig. 1) to the cutter jack. The cutter plug (Fig. 3) is plugged into this jack to carry audio to the cutter. R3 is the necessary series resistor.

The "gear shift"

The second interesting feature of the system is the switching arrangement. The amplifier can be used, not only for recording, but also for listening. A 3-position, 6-circuit rotary switch S1 (Fig. 1) selects any of three functions: In position 1, output is fed to the cutter; in position 2, output is fed through a high-fidelity transformer to the speak-

er; and, in position 3, output is also fed to the speaker, but the input circuit is transferred from the regular line to a crystal pickup mounted on the motor board.

As the under-chassis photograph shows, S1 is mounted lengthwise on the chassis. Long switch supports allow the two wafers to be placed reasonably close to the circuits they control so that accidental feedback is not likely and long leads are unnecessary.

The photograph of the main case shows how the amplifier is mounted so that only the dust cover shows. If the knob controlling S1 were at the end of the chassis, it would be inconvenient to turn. Therefore a metal shaft coupler was attached to the shaft in place of a knob. One of its screws was removed and a long rod, the end of which was threaded, was screwed in its place. This rod (it can be seen at the right of the amplifier) controls the switch very much like an automobile gear-shift lever. Pull it toward you and record; leave it at center and listen to the output of the console; push it to the rear and use the built-in crystal pickup.

Two volume controls R4 and R5 are switched at the amplifier input. R4 is mounted at the left end of the chassis and has no knob. Once set for the proper recording level, it is thereafter left alone. R5 is mounted on the chassis, an extension shaft projecting through the dust cover. The control knob seen atop the amplifier is used to control volume when listening. The crystal pickup has its own volume control, as Fig. 3 shows.

S1-c switches the equalizer. When it is not in the circuit, in position 2, the amplifier output to the speaker is flat within 2 db from 50 to 15,000 cycles. It is switched in when the crystal pickup is used because it has almost exactly the correct high boost to give a good crystal pickup the right correction for standard records.

The power supply (Fig. 4), a standard job with plenty of filtering, is built on a separate chassis 14 x 6 x 2½ inches with a standard amplifier dust cover. Separation of the power supply from both recording amplifier and console (which it also supplies) keeps hum down to the irreducible minimum. Octal tube sockets mounted on the rear apron accommodate plugs and cables to carry power to amplifier and console.

Fig. 3 shows how the components mounted on the recorder motor board are connected. The rectifier and milliammeter provide an additional check on volume being fed to the cutter, although the decibel meter mounted on the console should be used mainly; the milliammeter will give false readings, since it is preceded by high-boost equalization. It is, however, a positive indicator which will show at once any mistakes or faults in switching or connections. If the meter kicks, the cutter is almost certainly receiving audio. R6, an adjustable meter multiplier, is mounted on the motor board underneath the turntable and has no knob. When it is once set, tampering is not likely.

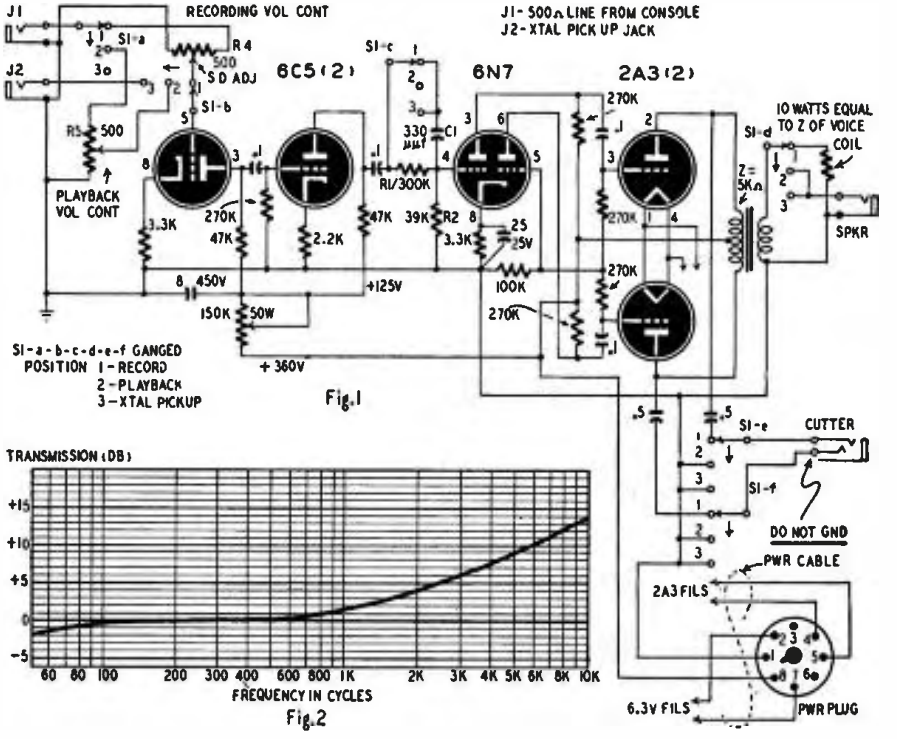


Fig. 1—Complete circuit of the recording amplifier. Fig. 2—Equalized frequency response.

Making the case

The construction of the case is shown in detail in Fig. 5. These dimensions will do for almost any 12-inch recording mechanism. The one shown in the photo is a prewar Rek-O-Cut. An overhead-lathe mechanism almost always gives superior results to a swinging-arm unit, and the case cover is high enough to accommodate most lathes.

The amplifier is set in the rear of the case. Holes are drilled into the amplifier chassis through the 1 x 1 cross-member on the floor of the case. The chassis holes are tapped so that a machine screw can be passed through each hole in the wood to hold the amplifier in place. Similar holes for additional supporting screws are made through the rear of the case into the amplifier. The amplifier chassis is 5 inches deep, and the space allowed is 5¼ inches. Its width is 10 inches, allowing space for plugs on either side.

The 1 x 1 motor-board supports are flush with the top of the sides. The motor board is placed (and fastened with edge screws) on top of these; it is, thus, above the sides of the case. When the cover is lowered, the edges of the motor board keep the sides of the cover exactly in line.

The photograph shows how the components are mounted on the motor board. Mountings are not given in the

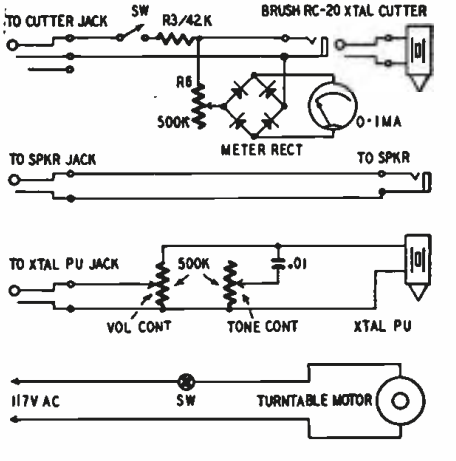


Fig. 3—Components mounted on the motor board.

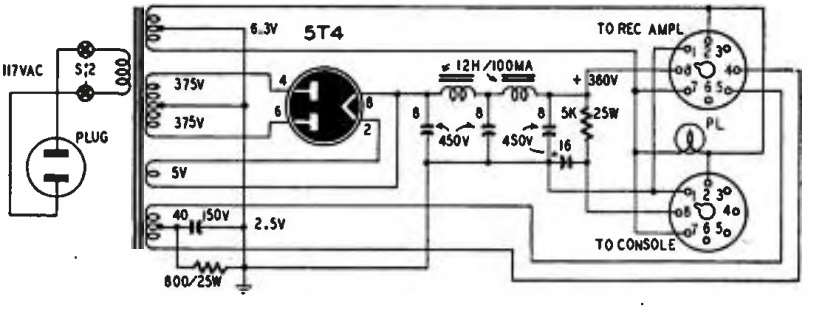


Fig. 4—The power supply. A 25,000-ohm, 25-watt bleeder can be added for better regulation.

drawing because they will depend on the particular recording mechanism used. Two 5-inch speakers were on hand when the recorder was built, so they were placed in the cover. For better results, an external high-quality speaker may be plugged into the speaker jack mounted on the right rear of the motor board.

The cover is fastened to the case with loose-pin hinges, similar to those used on portable typewriters, so that the cover can be removed entirely. Trunk catches (large ones) fasten the front for carrying. A heavy leather handle attached to the front of the cover must be positioned so that the weight will be evenly distributed. After assembly, the closed case was up-ended and balanced on a sharp-edged support to find the center of balance. The balance point was marked, and the handle placed there.

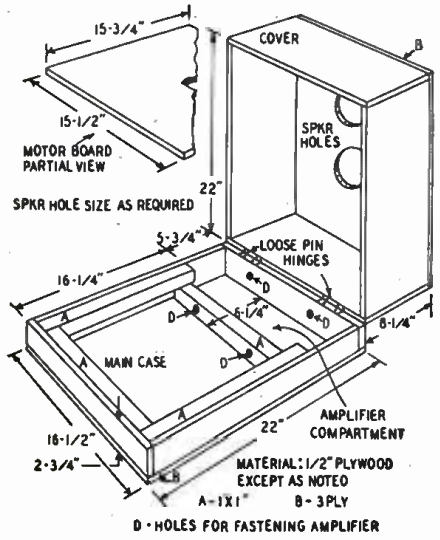


Fig. 5—How to make amplifier-recorder case.

Keeping in mind the fact that the amplifier and mechanism are heavy and that either can easily be damaged if dropped, be sure to make all wood joints in the case firm and strong. The original job was done by a cabinetmaker, who rabbeted the joints and used the strongest possible glue. Heavier stock would also provide insurance against accidents but might add too much to the weight.

The mechanism and pickup must be fastened down tightly for carrying. The photo reveals the angle brackets and thumbscrews used for the cutter. The method will vary, of course, with different mechanisms, but the only requirement is that nothing must be allowed to move. An ordinary alligator clip screwed to the motor board keeps the pickup in place. Clip brackets in the top of the cover carry stylus containers. and cleats carry cables. A photographer's telescopic tripod is carried, too, as a microphone stand.

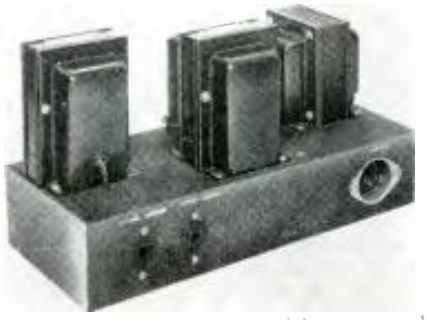
There is always a thread-removal problem with disc recorders. It is solved in this unit with an Audiodisc Chip Chaser, which is a felt "brush" fastened to hinged supports. The device is sold with a heavy metal base and is usually just placed next to the turntable. To make the chaser part of the assembly, the base was removed and the vertical support screwed to a small angle bracket fastened to the motor board.

Adjusting the system

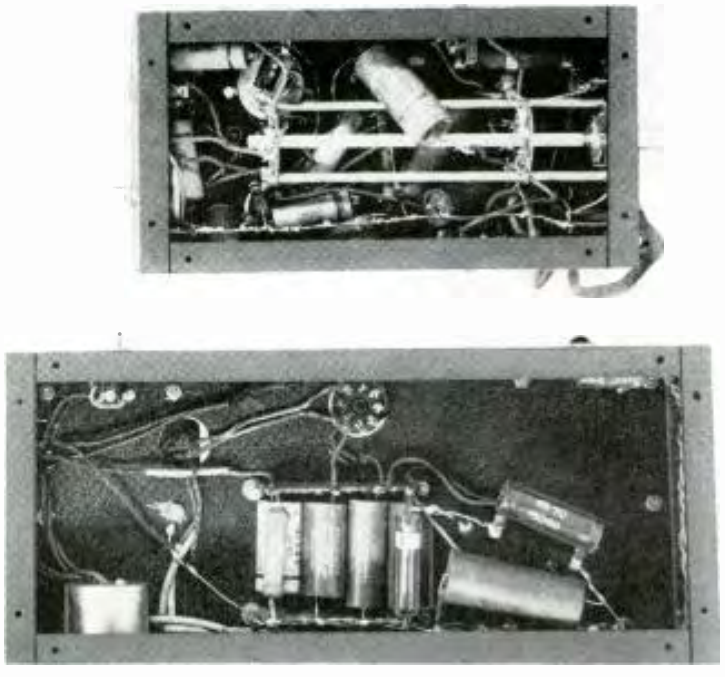
There are only two adjustments to be made in the electrical system before using the recorder. These are setting R4 and R6 for the correct recording level.

Feed a 200-cycle tone through the console and adjust the volume control on the console so the decibel meter reads zero. Adjust R4 so that a vacuum-tube voltmeter (a good nonelectronic voltmeter could be used) connected directly across the cutter reads between 90 and 100 volts. Never disturb R4 again. Make a mark on the milliammeter on the motor board at about the 0.6-ma point. Then adjust R6 until the meter needle is at the mark. When recording, do not depend on the milliammeter to read correct level, since high frequencies will not register correctly (due to the equalization).

The amplifier chassis without its dust cover.



The power supply uses two big, heavy chokes.



Amplifier (above) and power supply (below). Notice the long switch assembly.

MATERIALS FOR RECORDER

Resistors: 1—2,200, 2—3,300, 1—39,000, 1—42,000, 2—47,000, 1—100,000, 5—270,000, 1—300,000 ohms, ½ watt; 1—800, 1—5,000 ohms, 25 watts; 1—150,000 ohms, 50 watts, adjustable; 2—500-, 3—500,000-ohm potentiometers; 1—10-watt resistor equal to impedance of voice coil.

Capacitors: 1—330 μμf, mica; 1—.01, 4—0.1, 2—0.5 μf, 600 volts, paper; 1—25 μf, 25 volts, 1—40 μf, 150 volts, 4—8, 1—16 μf, 450 volts, electrolytic.

Transformers and chokes: 1—power, 750 volts center-tapped, 100 ma, 6.3 volts, 4 amperes, 5 volts, 3 amperes, 2.5 volts, 8 amperes; 1—output, 5,000-ohm push-pull plates to voice coil, 15 watts, 100-ma primary; 2—12-h, 100-ma filter chokes.

Tubes: 2—6C5, 1—6N7, 2—2A3, 1—5T4.

Switches: 1—3-pasition, 6-circuit, rotary, with largest available indexing assembly; 2—s.p.s.t. toggle, 1—d.p.s.t. toggle.

Connectors: 5—single-circuit, non-shorting phone jacks; 1—2-circuit phone jack (for PL-68-type plug); 3—single-circuit phone plugs; 1—2-circuit phone plug (PL-68); 2—octal tube sockets; 1—cable-end octal male plug; 1—chassis-mounting, unpolarized, male 117-volt plug.

Recording components: 1—turntable; 1—Brush RC-20 crystal cutter; 1—crystal pickup.

Miscellaneous: 1—meter rectifier; 1—0-1-ma d.c. meter; 1—6-volt pilot-light assembly; 4—octal, 2—4-prang tube sockets; 1—threaded rod and shaft caupler for "gear shift"; wood for case (see Fig. 5); loud-speaker(s); loose-pin hinges; trunk catches; knobs, hardware, etc.