Simple Design for Station-Built Console

Designing and constructing a console for the specific requirements of an FM station proves to be effective from the standpoint of operating flexibility as well as money-saving—also in operating convenience.

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WE HAD BEEN on the air at KCMS-FM about one year when it became almost painfully obvious we needed more control facilities and more flexibility. The new equipment would have to meet the high standards of the critical Audiophile listener and be within the cost limitations imposed by an FM station's budget. The preceding sentence contains an inconsistency that was solved only by building the equipment ourselves.

We established the standards and the abilities. They were:

- 6 microphone inputs
- 6 remote telephone lines or 0-db inputs, balanced, and with automatic cue
- 3 turntables, with record cueing and control of turnover and rolloff
- 2-channel operation (for possibility of binaural)
- 2 monitor amplifiers, one for control room and one for studios
- 3 provisions for interlocking phone bells and warning lights

Standards:

- Maximum of 0.2 percent distortion
- Noise down 80 db from operating level into transmitter. (+10 VU max)
- Sine-wave frequency response, 10 to 50,000 cps ± 1½ db
- Minimum number of tube types

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Fig. 1. The completed console in its operating position with the announcer's microphone directly above it.

The Basic Design

Referring to the detail schematic, *Fig. 2*, it will be seen that all of the preamps, both microphone and phonograph are essentialy identical. A single 12AX7 is used in a regular phonograph preamp circuit using negative feedback equalization. The microphone stages had an A-10 (UTC) input transformer loaded with 50,000 ohms (UTC's recommendation for best response) and the feedback capacitor and resistor were selected for flat response and 8 db of feedback. This value brings the microphone control to "straight up" position to match the average LP record at "straight up" (Fairchild or GE pickup). The phono stages are equipped to provide turnover frequencies of 200, 400, and 800 cps, in addition to flat, and a fifth position connects the preamp to a remote line transformer. Note there is no grid input resistor; this is in accord with GE's specifications for the A1-900 high-frequency compensator.

The program amplifier and control room monitor are similar and will be recognized basically as Williamson types. The program amplifier is located on the main chassis, and the spare—which is used as the control-room monitor—is located on the power-supply chassis. The "house" or studio amplifier is beside the spare and is single ended. This latter amplifier has only 3 watts output, which has proved enough for the purpose it serves—two 8-in. speakers in two studios. The power

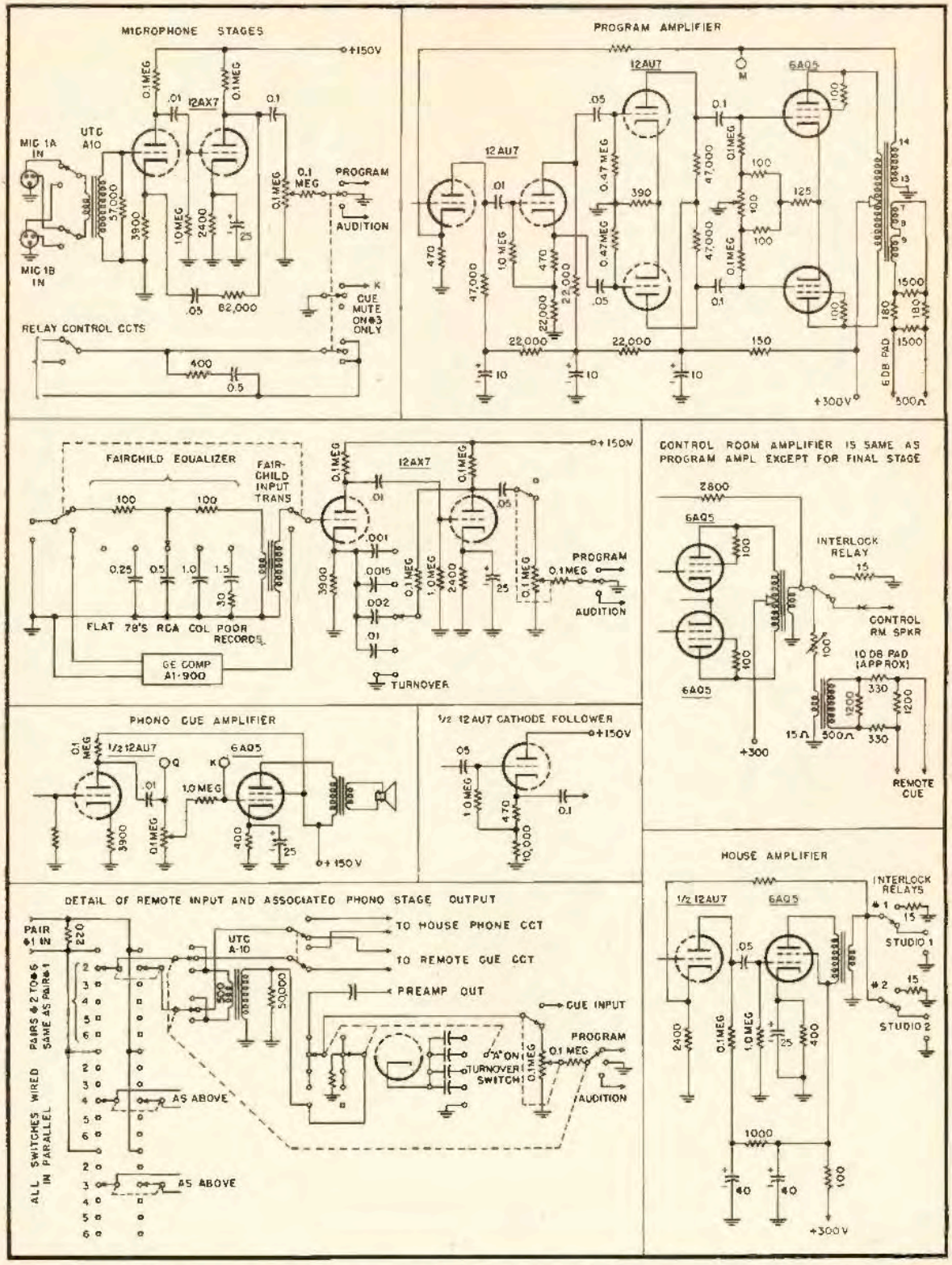

Fig. 2. Detail schematics of the various individual sections of the entire console. These units are interconnected as shown in the block schematic, Fig. 3.

supply has two sections—a regulated low voltage of 150 volts for the preamps and a regulated 300 volts for the program, spare, and house amplifiers. The filaments in the main chassis are d.c. and the remainder, balanced a.c. to ground. *Figure* 1 shows the unit in operating position, and *Fig.* 3 is a block schematic which uses the detailed sections of *Fig.* 2.

Actual Construction

Six microphone inputs were required. Actual practice indicated that seldom more than two were used at one time, so three stages were installed, which should give a reasonable safety factor. One is located behind each key, and each key can select between two microphones, which also selects the proper interlock relay. The three phono stages were similarly installed, one behind each key.

Fig. 4. The console and its associated power supply during the testing process.

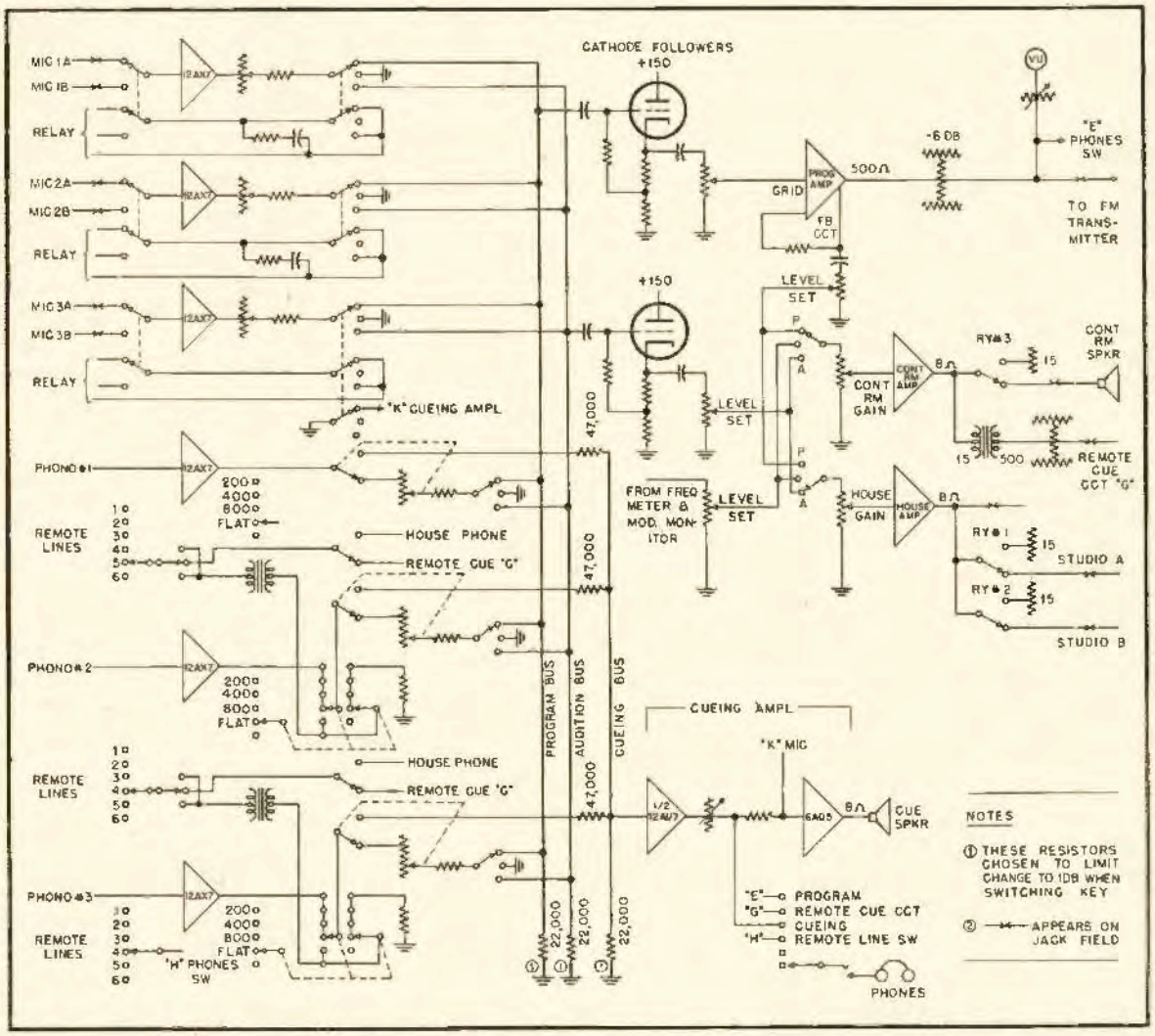

Fig. 3. Block schematic of the console. The actual schematics of the various sections are shown in Fig. 2.

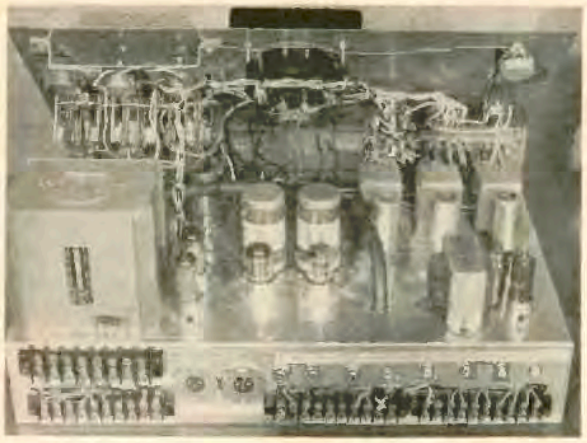

Fig. 5. Topside view of the console chassis.

On the front of the panel, above PHONOS 2 and 3, are installed two six-position double-pole switches. Six remote inputs are tied to these two switches wired in parallel. The output of each switch goes to the key. The center position of the key feeds cue out on the remote position selected. The small toggle switch above PHONO KEY 1, removes this cue and substitutes the house phone. This makes it very simple to talk to an engineer on a remote. Moving the key to PROGRAM or AUDITION automatically disconnects the cue and connects the line to the input transformer, which is strapped for 500 ohms. Each of the six inputs has a 220-ohm resistor across it. This presents the proper load of 125 ohms for Western Electric 23-A equalizer. This equalizer is on the patch field and can be dropped across any pair. A 200-ohm wire wound pot is in series with it and is adjusted for equalization necessary. The 23-A was designed for 8500 cps, but we have found that we can equalize local lines so they are down only a few db at 15 kc. Under each key is its gain control. Turning any one of the three phono gain controls to zero switches the input to the cue bus. Just below and to the left of each gain control is a small knob which selects the turnover position; the fifth position removes the phono output and picks up the remote line transformer output. Remote lines may be auditioned on the local cue bus. This same switch loads the secondary of the remote lines transformer to prevent cross talk if a remote line selected has high level accidentally switched in (guess how we found we needed this?). It was also necessary to roll off the high-frequency response of the remote cue level. Since the amplifier supplying this cue had negative feedback over the output stage, it was necessary to pad the level down 12 db, then roll off the high-frequency response. The response is down 6 db at 5000 cps. The six-position switch above phono No. 1 switches the headphones as a balanced pair to any of the six remote lines. There are three switches below and to the left of the three microphone gain controls. These switches select between microphone 1A and 1B, and operate the interlock relay. They also complete the symmetry of the front panel.

Circuitry

The stage following the preamps is a cathode follower. This was done so the control room and house amplifiers could be located on the power-supply chassis. There are three of these cathode followers, one for the program amplifier, (to maintain circuit symmetry) one for the control room and house amplifiers, and the third is used for a recording output or AM transmitter. This required two 12AU7's. The fourth triode section is used as the first amplifier for the phono cue system. The final portion of the phono cue system is identical to the house amplifier except it has no feedback. Please note the series resistor from the cue volume control to the 6AQ5. The grid of the 6AQ5 is shorted when the control room microphone is in program position. The series resistor prevents grounding of the audio to the earphones.

The cue volume is above MIC 1 key. The control above MIC 2 key is a six-position double-pole switch. Position 1 is balanced and is across the program output line; position 2 is balanced and is across the remote cue. Position 3 is unbalanced and across the phono cue position; 4 is balanced and is fed from the six-position selector for remote lines. Positions 5 and 6 are not used. Note that the head phone jack is insulated from ground. Note also the series resistor of 1,000 ohms—this prevents inexperienced personnel from dropping a 50-ohm headset across the program loop. The control above MIC 3 is a VU multiplier, providing for 4, 8, 12, 20, 24, and 30 VU levels at the indicated "0". The control in the extreme upper left edge is house amplifier gain. The three keys to the right of the VU meter are (1) house amplifier input, (2) control room amplifier input, and (3) recording output. All are wired the same—left for program, center "off air," and right for audition. The three small holes above each key are screwdriver-adjusted gain controls for program, off air, and audition. Circuits may thus be switched from one position to another with no change in volume.

Two controls are yet to be noted. Immediately under the VU meter, the master gain control and under this on the vertical portion of the panel is the control room gain.

Construction

The amplifier was constructed on a pan, the front panel was assembled and then the two were joined and the interconnections made. Volume controls may be replaced and switch keys may be cleaned without disassembling. *Figures* 5 and 6 show the above- and below-chassis appearance.

Two other controls are located on the power supply chassis—a series resistor to set the d.c. filament voltage, and a level control for remote cue. The power-supply is shown schematically in *Fig.* 7, and its underside is seen in *Fig.* 8.

Other construction details of importance are now noted. Both chassis have a one-point ground; a piece of No. 10 copper wire then passes over the various components. The grounded point in both cases is the low-level input. One ground wire is carried from power supply to amplifier chassis. Filaments are balanced in the main chassis, so in the event of a

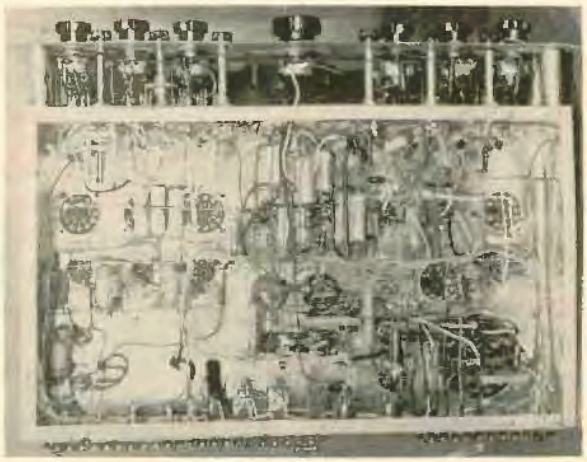

Fig. 6. Underside view of the console chassis. Note that there are no shielded wires, and the one heavy ground bus serves for all ground connections.

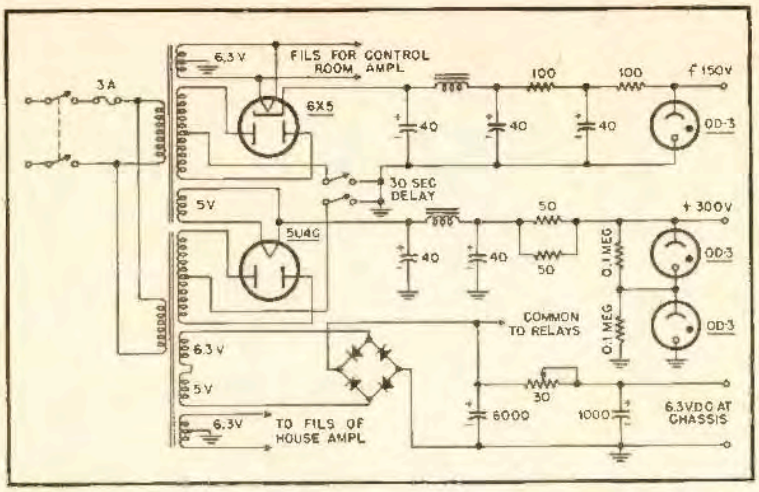

Fig. 7. Schematic of the power supply circuits.

d.c. failure, they may run on a.c. until the trouble is cleared. To prevent ground loops, the two shielded lines carrying audio for control room and house amplifiers are grounded at the main amplifier chassis only. The ground connection on the input transformers is not connected to the ground bus.

The telephone type relays, shown on the power-supply chassis at the left in *Fig.* 4, are operated on d.c. ahead of the series dropping resistor; the terminal strip next to them is for phone interlock and red lights. The output transformer for the control room did not have a balanced 500-ohm circuit, so a small line-to-speaker transformer was connected in reverse to provide balanced remote cue. The voltage to feed the bridge rectifier was obtained by connecting the 6- and 5-volt filament windings in series. The output of the bridge rectifier was connected to a 6,000-μf capacitor (never underestimate the peak-to-peak value that 6,000 μf can provide). The rectifier supplies thirteen volts under load at its output terminals. The 5-volt filament of the small transformer operates the 5U4GA and the low-voltage supply uses a 6X5GT. Only 6 tube types are used including the rectifiers and VR's; 6–12AX7's, 7–12AU7's, 6 6AQ5's, 1–6X5, 1–5U4GA, and 3–OD-3's (VR-150)—a total of 24 tubes.

A time delay of thirty seconds is incorporated in the B– leads to prevent overload of the VR's during the tube warm up. No shielded wire is used in the construction of either chassis, yet crosstalk is down 50 db. The big rectifier was obtained from an old pin ball machine. High-frequency equalization was accomplished by the cut-and-try method in the case of the Fairchild pickups, using the Dubbings test record, and follows within 1 db. We sent our equalization system and the values chosen to Fairchild. We quote from their letter, ". . . with regard to the circuit which you propose for equalization, we feel that this may very well prove satisfactory as far as matching is concerned. However, it should be pointed out that high-frequency attenuation at this point in the circuit will result in a poorer signal to noise ratio since the total noise of the first stage is passed on to later circuits."

The instruction sheets issued with the Fairchild pickups advise rolling off the highs in a plate circuit. This was impossible since the stage involved has negative feedback and following stages are mixed with other signals. Further, we wanted to be able to use other manufacturers' pickups, and most of these use some type of front end equalization. The output of the new Fairchild 220 with the new coupling transformer is more than a GE. All of the resistors in the program amplifier are wire-wound to keep down noise.

Post Mortem

The console has been in operation for three months now. During this time we have had no break-downs, but we can suggest some improvements. The telephone type keys could be replaced with lever action rotary. This would greatly simplify their wiring. The 6-position switches for remotes should be pushbutton types so wired as to give one input priority. We have found on some remotes that we needed an electrostatic shield, so we patch in a W.E. 111-C line-to-line transformer (repeating coil) for this condition.

UTC has informed us that the LS-55 can be wired for an approximate Ultra-Linear operation, and we have since tried this with the result that the amplifier is apparently more stable, and it provides a "richer" sound in the low-frequency range. The connections to the LS-55 for this type of operation are, to quote from a letter from UTC: "tie the present plate points together to B+ (terminals 1 and 6; connect terminal 4 to plate 1, terminal 2 to screen 1, terminal 3 to plate 2, and terminal 5 to screen 2. This will result in a somewhat higher stage gain than is possible with the triode connection, and will require a change of the feedback resistor to maintain 10 db of feedback." We did not find it necessary to change the resistor.

It is also desirable to remove the 51,000-ohm resistors from the secondaries of the three microphone input transformers when used with the W.E. 639A, and the RCA velocity microphones. The resistor should remain in the circuit with the Altec 21C and with most dynamic models, however.

We have had no trouble with microphonics. You can pound on the front of the console and not hear a thing.

The most gratifying part of the construction of this console was the response of our listeners. Some of them are most critical and they tell us how much they like it. When listeners call in and tell us the same record sounds better "off the air" than it does on their own equipment, we feel that we have "clean" operation.

The approximate cost of this console was $200, but we used many parts from the junk box. It took approximately four weeks to build it, including testing, but the work was spread over about a year. With steady work it could be done in a 40-hour week. We will be pleased to answer any correspondence concerning this "station-built" console.

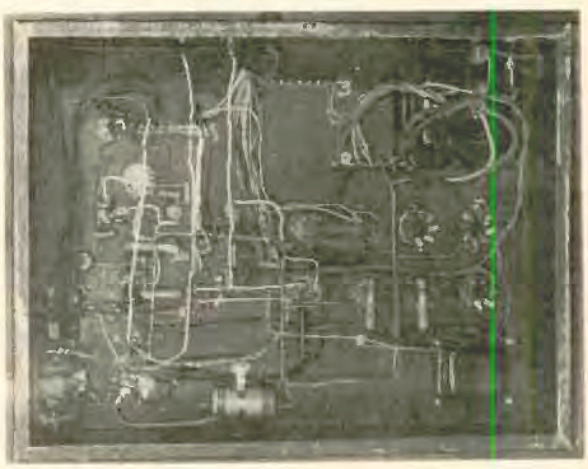

Fig. 8. Underside of the power supply chassis.