4 CHANNEL MIXER for Your Amplifier

By DAVID A. KING

THERE are many amplifiers in use today, both of professional and home constructed types, that have been designed with a single input terminal. These amplifiers are entirely adequate for any purpose where it is desired to amplify sound from only one source at a time. For those who desire to make more elaborate sound pick-ups for such purposes as moving picture sound-tracks and other home recording ventures, the electronic mixing panel described herein will prove of real value.

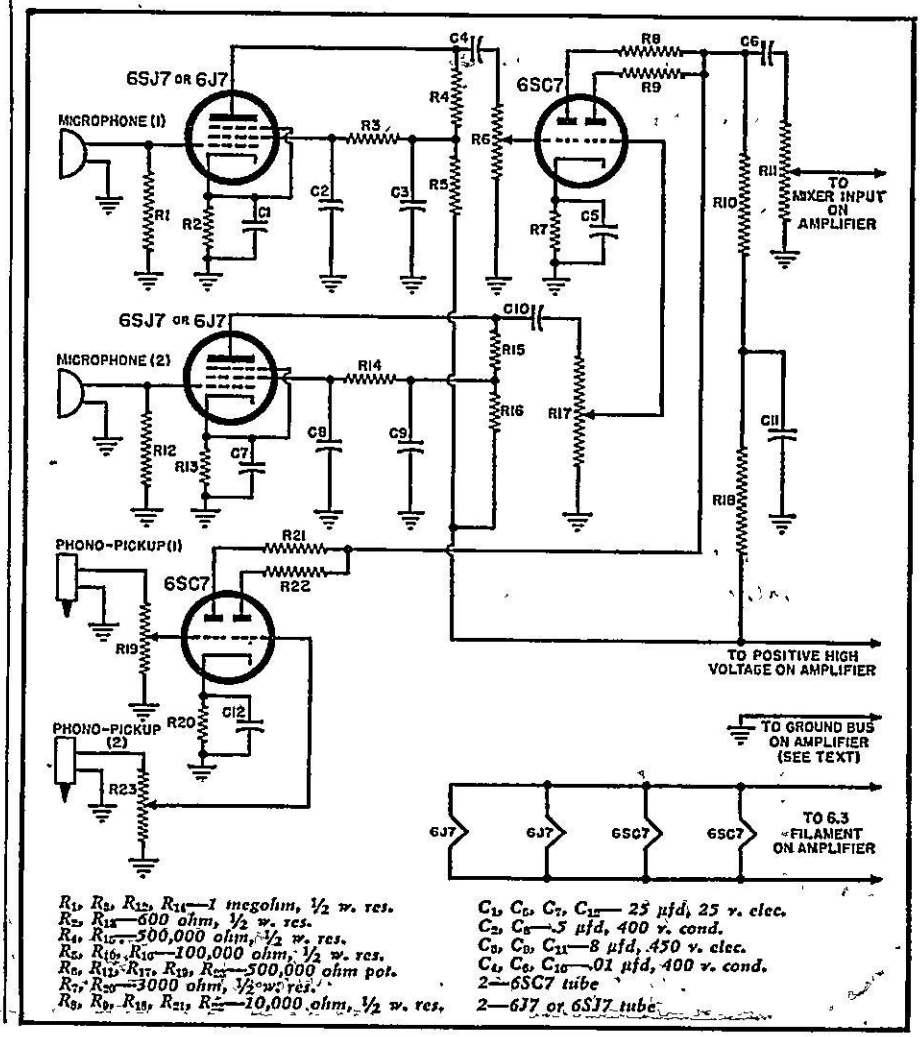
In designing this mixer it was proposed to develop a unit which, while retaining all or most of the advantages enjoyed by expensive professional equipment, still used standard receiver parts. Many of these parts, as in the case of the amplifier, can well be salvaged from discarded radio receivers.

Many volume controls designed for use in home radio sets are somewhat noisy when used ahead of a high-gain instrument where even minute variations in voltage are amplified to the point where they will produce annoying volumes of sound in the loudspeaker.

This fault has been eliminated in the present design by removing the volume controls from the low-level input to the grid circuit of the mixer tube. This means the addition of one extra tube for each low-level channel but, in the opinion of the writer, this extra tube is more than justified by the quieter operation gained through its use.

Through the use of standard electronic mixer tubes, the use of ex-

Schematic diagram of four-tube mixer. Each input has its individual volume control.



R_1, R_3, R_{12}, R_{14}—1 megohm, ½ w. res.
R_2, R_{13}—600 ohm, ½ w. res.
R_4, R_{15}—500,000 ohm, ½ w. res.
R_5, R_{16}, R_{10}—100,000 ohm, ½ w. res.
R_6, R_{13}, R_{17}, R_{19}, R_{22}—500,000 ohm pot.
R_7, R_{20}—3000 ohm, ½ w. res.
R_8, R_9, R_{18}, R_{21}, R_{23}—10,000 ohm, ½ w. res.

C_1, C_4, C_7, C_{12}— 25 µfd, 25 v. elec.
C_2, C_6—.5 µfd, 400 v. cond.
C_3, C_8, C_{11}—8 µfd, 450 v. elec.
C_4, C_5, C_{10}—.01 µfd, 400 v. cond.
2—6SC7 tube
2—6J7 or 6SJ7 tube

pensive pads has been eliminated and a mixer has been provided where each channel can be set to its own level without inter-acting with any of the other channels.

The tube line-up shown is perfectly satisfactory with the circuit constants shown. The reader is referred to any standard hand-book of resistance-coupled amplifier design for constants for tubes other than those shown. The only exception to this is the variation shown in the schematic where it is noted that 6J7 tubes may be substituted for the 6SJ7 tubes used by the writer. Since these tubes differ only in a few minor respects insofar as audio frequency applications are concerned, the same circuit constants may be used with either tube. One added precaution to be used with the 6J7 tube, though, is to be sure to use a shielded lead to the grid-cap and to use one of the little cap-shields over the grid-cap. In the case of a "G" tube, of either type, it will be found that a close-fitting metal shield will give a huge reduction in noise pick-up.

In planning your mixer panel layout remember that the usual construction rules prevail; keep all leads as short as possible and parts well spaced to prevent intercoupling. All circuits are so routed as to prevent coupling from output to input through any path whatsoever. To this end, the output of the mixer panel should be well separated physically and the associated wiring so routed as to prevent capacitance or inductive coupling between these circuits. It will be noted that de-coupling nets have been introduced into the plate-circuit of each tube. These nets were found to be absolutely indispensable in the prevention of motor-boating and other forms of instability.

As indicated in the schematic, a ground bus interconnected with that on the amplifier will be found to reduce hum and other forms of disturbances to a minimum. Carry this ground bus on mounting lugs which are carefully insulated from the chassis and do not connect this bus to the mixer chassis at any point. Bond the mixer chassis to the amplifier chassis to prevent the formation of static charges between these units. It may be found that a good connection to earth ground will reduce noise level and it will certainly prevent any chance of shock due to any stray voltage between chassis and ground.

In wiring this unit, bear in mind that the low-level input circuits (those marked "mic. 1 and mic. 2" on the schematic) are carrying voltages which are amplified some 7000 to 10,000 times before they are reproduced in the loud-speaker. For that reason, noise voltages which would ordinarily be negligible assume proportions comparable to program level. This latter is true since the output of high-quality microphones is so minute as to be comparable in value to the noise voltage in a carelessly laid-out circuit.

This is mentioned, not as an attempt

to scare the reader, but to save him from the rather disappointing experience of finding that his mixer is a source of noise rather than a means of amplifying the speech and music it is designed to handle.

These voltages can be reduced to the point where they can be neglected by a few simple precautions. First, keep all low-level signal leads as short as possible and run them entirely in shielded wire. This applies to the grid leads of the low-level or microphone input tubes. Bond these shields carefully to the ground bus, but insulate them carefully where they pass through the chassis. Second, use some type of shielded input jack. An ordinary single circuit radio jack will do if it isn't too large physically. If a large jack is unavoidable, enclose it in its own shield to avoid pick-up. A still better input jack for the "mikes" is the regular amphenol button-contact jack. This latter may be hard to obtain, however. Third, never try to use ordinary wire to connect a high-quality microphone to any amplifier. Use regular microphone cable which is carefully shielded. Even when using cable of this type, carefully avoid cable runs longer than those recommended by the manufacturer of your microphone. This is usually about 50 feet for most makes of high-impedance instruments.

If longer cable runs are necessary, obtain a microphone with a line transformer in its case and provide a line-to-grid transformer for each microphone channel. This latter, if carefully shielded, will provide somewhat better over-all response for the microphone placed at some distance from the mixer.

One more excellent precaution, which will pay off in reduced hum level, is to make sure that all wires carrying raw a.c. (such as filament leads) are carried through the circuit as twisted pairs and pushed as far into a corner of the chassis as possible.

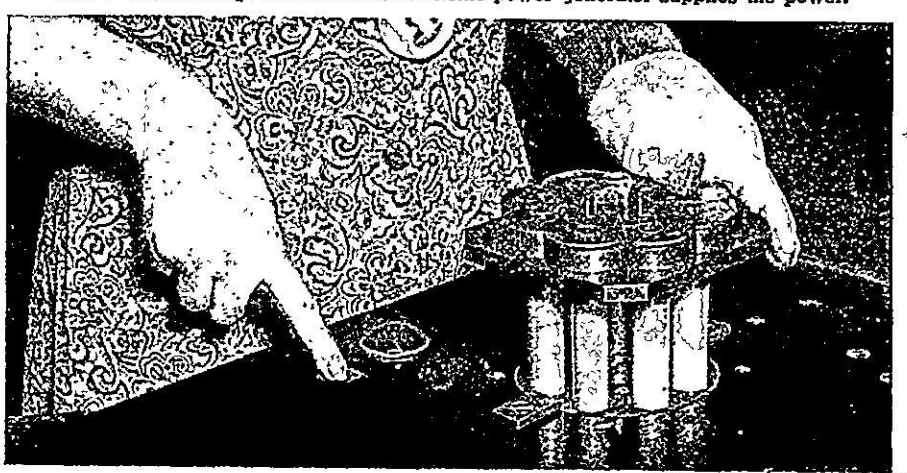
It will be remembered that the filament circuit of the amplifier was grounded on one side to avoid hum pick-up. It would be an excellent idea to ground the mixer filament lead, as well. However, an obvious precaution would be to make sure that the *same* lead is grounded in both amplifier and mixer to avoid any chance of a short circuit.

The panel lay-out is left up to the reader's taste with these few notes. First, if obtainable, select a panel of some metallic material such as iron or aluminum. This may, of course, be finished to suit. Second, lay out the channel controls in logical sequence across the top of the panel and place the master control below them or, if preferred, place the master control near the top of the panel and line the other controls up along the bottom. This is for the sake of avoiding confusion in operation. If practicable, make all microphone and phono connections to the back of the mixer cabinet and keep the low-level tubes as far away from the panel as the size of the chassis permits. This latter is not of too much importance, however, provided shielding has been carried out as suggested.

The wiring complete, connect the mixer to the power amplifier as indicated in the schematic. Before placing tubes in the sockets, check voltages on the tube sockets with a good voltmeter if one is available. Failing this, at least check the filament terminals with a neon bulb to be sure that plate and heater leads haven't been crossed. This could cause considerable damage to the amplifier's power pack even though a tube were not burned out.

Now place the tubes in position. Place a finger on the input circuit of one of the low-level inputs and *slowly* advance the corresponding mixer control. The result should be a loud humming sound in the loudspeaker. Now turn this mixer control to zero and try the other low-level channel

Eight elements for test equipment are soldered at one time, in a few seconds, by this new, ingenious electronic power heating set-up in the Camden plant, RCA Victor Division, Radio Corporation of America. Elements are assembled with a pre-formed ring of solder in position at juncture to be sealed, then secured in a fixture. Operator lowers them through holes in work surface, into alternating magnetic field of an induction coil, then applies high-frequency power to coil by pressing a button. Induced currents generate heat in the elements and flow solder uniformly and almost instantly. A 15-kilowatt electronic power generator supplies the power.



the same way. Now feed in sound from either a microphone or some other source of equal level and check the amplifier and mixer for quality. If instruments are at hand, an audio oscillator may be used to drive the amplifier and mixer and the over-all frequency response determined for each channel in turn.

In operation, connect each input channel of the mixer to an appropriate sound source, *i.e.*, one or two microphones for spoken commentary and sound-effects and two phono pickups for "canned" sound-effects or musical backgrounds (or both!). If possible arrange to have the microphones placed in rooms away from that used for the mixer panel. This latter is to provide an opportunity to use a loudspeaker to "monitor" the mixing results and adjust each separate channel to its proper level. Failing this, a pair of headphones may be connected into the circuit.

Nothing, in the writer's opinion, can give any person any greater satisfaction than to achieve fine results with apparatus built by his own hands. If those results are a well-planned soundtrack for a home movie film or a well-recorded sound-drama, a person has an artistic achievement as well as a scientific one to "point to with pride". —30—

Transmitter Checking

(*Continued from page* 34)

velope pattern, as stated above, are much simpler than those of the trapezoidal pattern. The method consists of feeding some of the output of the modulated amplifier to the vertical axis. This is done with a coil of one or more turns of wire fed to the input terminals by means of a twisted pair. On high frequencies (100 kc. and above) direct connection should be made to the vertical deflector plates of the scope. This measure is necessary because the amplifier contained in the instrument is not capable of handling high frequencies.

The sweep circuit is synchronized with the audio oscillator that is fed to the input of the speech amplifier equipment. To do this, feed the audio output from the oscillator to the synchronization terminals through a .01 μfd. condenser. The height of the pattern is varied by changing the number of turns of the coil or its distance from the output tank. The load, antenna, or antenna tuner is left connected to observe performance under actual working conditions. With the sweep circuit properly synchronized and at a multiple of the audio oscillator frequency, an image appears with several sine waves. By increasing the audio oscillator output, the percentage of modulation is correspondingly increased. By this method, all types of modulation may be observed including plate, grid, screen, and suppressor modulation. Fig. 1 shows the necessary hookup.