

# 4711 MIXER

## PARTS LIST

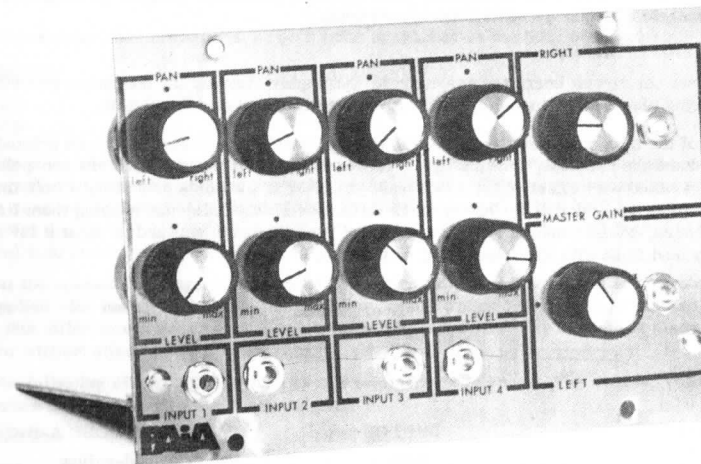
- 2 - 150K resistors (brown-green-yellow)
- 2 - 150 ohm resistors (brown-green-brown)
- 2 - 470 ohm resistors (yellow-violet-brown)
- 4 - 10K resistors (brown-black-orange)
- 8 - 220K resistors (red-red-yellow)
- 16 - 470K resistors (yellow-violet-yellow)
- 2 - 15 pf. capacitors
- 2 - 100 mfd., 16 v. electrolytic capacitors
- 2 - 2.2 mfd., 6 v. electrolytic capacitors
- 2 - 748 op amp ICs
- 2 - 5K potentiometers
- 8 - 500K potentiometers
- 6 - miniature phone jacks
- 10 - knobs
- 20 - potentiometer nuts
- 1 - 12 inch length of braid
- 1 - 10 inch length of RG-174-U coax
- 1 - 6 inch length of tubing
- 2 - 4-40 X 1/4 inch screws
- 2 - 4-40 nuts
- 2 - 4-40 X 1 inch screws
- 2 - 4 X 3/4 inch spacers
- 2 - "L" brackets
- 3 - 28 inch lengths of wire
- 3 - flea clips
- 4 - #4 X 3/8 inch self tap screws
- 4 - #4 lockwashers
- 1 - 4711 front panel & circuit board package
- 1 - 4711 instruction manual

Check the parts in this bag carefully against this list. Report and differences immediately.

**PAIA**  
ELECTRONICS, INC.

4711

## MIXER



If there is one module that the developing synthesist never seems to have enough of it is mixers. Increasing expertise at the instrument produces increasing sophistication and subtlety in the sounds produced. In most cases the more subtle and "natural" the sound the more individual component sounds are required to produce it.

The PAIA 4711 Mixer allows for the mixing of up to 4 channels of program material with individual level controls for each channel. Pan pots allow the 4 input channels to be split between the two output channels in any proportion from 0 to 100%. Master gain controls on the output channels allow for raising and lowering the total output levels while maintaining constant percentage of program material from the 4 inputs.

## SPECIFICATIONS

POWER REQUIREMENTS:	+9v. @ 4 ma.
	-9v. @ 4 ma.
INPUT IMPEDANCE:	10K ohms
OUTPUT IMPEDANCE:	less than 100 ohms
FREQ. RESPONSE	5 Hz to 20 kHz.
( 3 db, 10K load )	
MAX. GAIN:	6 db.
MAX. INPUT LEVEL:	10v. p-p
( single channel @ unity gain)	
CROSS TALK:	-60 db.

## SOLDERING

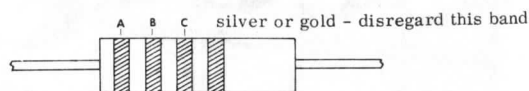
Use care when mounting all components. Use only rosin core solder (acid core solder is never used in electronics work). A proper solder joint has just enough solder to cover the round soldering pad and about 1/16 inch of the lead passing through it. There are two improper connections to beware of: Using too little solder will sometimes result in a connection which appears to be soldered but actually there is a layer of flux insulating the component lead from the solder bead. This situation can be cured by re-heating the joint and applying more solder. If too much solder is used on a joint there is the danger that a conducting bridge of excess solder will flow between adjacent circuit board conductors forming a short circuit. Unintentional solder bridges can be cleaned off by holding the board up-side down and flowing the excess solder off onto a clean hot soldering iron.

Select a soldering iron with a small tip and a power rating not more than 35 watts. Soldering guns are completely unacceptable for assembling transistorized equipment because the large magnetic field they generate can damage solid state components.

## CIRCUIT BOARD ASSEMBLY

- ( ) Prepare the circuit board for assembly by thoroughly cleaning the conductor side with a scouring cleanser. Rinse the board with clear water and dry completely.

Solder each of the fixed resistors in place following the parts placement designators printed on the circuit board and the assembly drawing figure 1. Note that the fixed resistors are non-polarized and may be mounted with either of their two leads in either of the holes provided. Cinch the resistors in place prior to soldering by putting their leads through the holes and pushing them firmly against the board, on the conductor side of the board bend the leads outward to about a 45° angle. Clip off each lead flush with the solder joint as the joint is made.



DESIGNATION	VALUE	COLOR CODE A-B-C
( ) R2	220K	red-red-yellow
( ) R3	470K	yellow-violet-yellow
( ) R4	470K	yellow-violet-yellow
( ) R5	470K	yellow-violet-yellow
( ) R6	470K	yellow-violet-yellow
( ) R7	220K	red-red-yellow
( ) R9	220K	red-red-yellow
( ) R10	470K	yellow-violet-yellow
( ) R11	470K	yellow-violet-yellow
( ) R12	470K	yellow-violet-yellow
( ) R13	470K	yellow-violet-yellow
( ) R14	220K	red-red-yellow
( ) R16	220K	red-red-yellow
( ) R17	470K	yellow-violet-yellow
( ) R18	470K	yellow-violet-yellow
( ) R19	470K	yellow-violet-yellow
( ) R20	470K	yellow-violet-yellow
( ) R21	220K	red-red-yellow
( ) R23	220K	red-red-yellow
( ) R24	470K	yellow-violet-yellow
( ) R25	470K	yellow-violet-yellow
( ) R26	470K	yellow-violet-yellow
( ) R27	470K	yellow-violet-yellow
( ) R28	220K	red-red-yellow
( ) R30	150K	brown-green-yellow
( ) R31	150K	brown-green-yellow
( ) R33	470 ohm	yellow-violet-brown
( ) R34	470 ohm	yellow-violet-brown

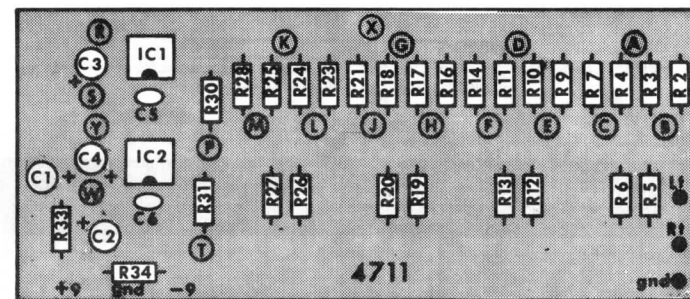


Figure 1

Install the ceramic disk capacitors. Their value is marked on the body of the part.

DESIGNATION	VALUE
( ) C5	15 pf.
( ) C6	15 pf.

Up to this point all components have been non polarized and either lead could be placed in either of the holes provided without affecting the operation of the circuit. Electrolytic capacitors are polarized and must be mounted so that the "+" lead of the capacitor goes through the "+" hole in the circuit board. In the event that the "-" lead of the capacitor is marked rather than the "+" lead it is to go through the unmarked hole in the circuit board.

Note that the operating voltage (v.) specified for a capacitor is the minimum acceptable rating. Capacitors supplied with specific kits may have a higher voltage rating than that specified and may be used despite this difference. For instance, a 100 mfd. 25v. capacitor may be used in place of a 100 mfd. 16v. capacitor without affecting the operation of the circuit.

Mount the following electrolytic capacitors and solder them in place. The values, voltage rating and polarization are marked on the body of the part.

DESIGNATION	DESCRIPTION
( ) C1	100 mfd. 16v.
( ) C2	100 mfd. 16v.
( ) C3	2.2 mfd. 6v.
( ) C4	2.2 mfd. 6v.

Mount the integrated circuits. Note that the orientation of these parts is keyed by a notch at one end of the case which aligns with the semi-circular key on the designator printed on the circuit board. Use particular care when installing these parts, like any other semi-conductor they are heat sensitive and should not be exposed to extraordinarily high soldering temperatures. Make sure that the orientation is correct before soldering, once the unit is in place it cannot be removed without destroying it.

DESIGNATION	TYPE NO.
( ) IC-1	748 type op-amp
( ) IC-2	748 type op-amp

In the following steps 4 shielded cable harnesses will be built up for use in later assembly steps. These harnesses are assembled at this time so that full lengths of wire in three different colors are available. Be sure to use three different colors in each harness to ease identification of the wires during installation. See figure 2.

- ( ) Cut four 4 inch lengths of one color insulated wire. Strip 1/4 inch of insulation from each end of each wire and twist the exposed strands tightly together. "Tin" the exposed strands by melting a small amount of solder into the wire.
- ( ) Cut four 4 inch length of a second color insulated wire. Strip 1/4 inch of insulation from each end of each wire and twist and tin the exposed strands.
- ( ) Cut four 2-1/2 inch lengths of a third color insulated wire. Strip 1/4 inch of insulation from each end of each wire and twist and tin the exposed strands.
- ( ) Prepare four 3 inch lengths of the flat ribbon braid supplied by inserting a pencil to spread the braid into a tube 2-1/2 inches long. With the pencil still in place twist one end of the tube to a point and solder the strands at the point together.

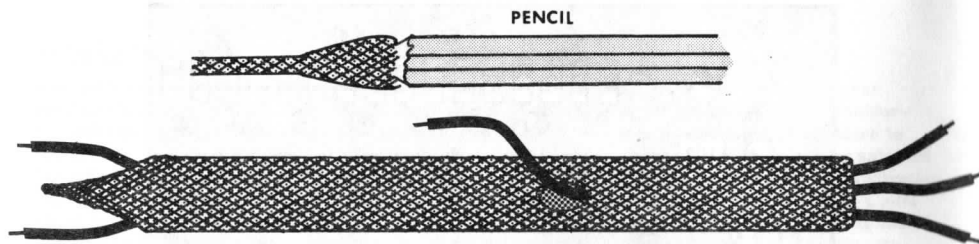


Figure 2

USING ONE OF THE TUBES JUST PREPARED PROCEED AS FOLLOWS:

- ( ) At a point 1/2 inch from the tinned tip of the tube, use the pencil to form a small hole. Insert two of the 4 inch wires prepared above (one of each color) through the length of the tube. Leave 1/2 inch of each wire exposed at the closed end of the tube.
- ( ) Use the pencil to form another hole 1-1/2 inches from the open end of the tube
- ( ) Insert one of the 2-1/2 inch wires previously prepared into this hole and out of the open end of the tube so that equal lengths of wire are exposed. Pull the ends of the tube to collapse it over the wires.

REPEAT THESE STEPS FOR THE REMAINING THREE TUBES AND PUT THESE HARNESSSES ASIDE FOR LATER USE.

In the following steps wires will be soldered to the circuit board which will later connect to the front panel controls and jacks. At each step prepare the wire by cutting it to the specified length and stripping 1/4 inch of insulation from each end of the wire. "Tin" each end of the wire by twisting the exposed strands tightly together and melting a small amount of solder into the wire.

Using the insulated wire provided make the following connections to the circuit board.

- ( ) a 2-1/4 inch length to point "R".
- ( ) a 2-1/2 inch length to point "S".
- ( ) a 4-3/4 inch length to point "W".
- ( ) a 4 inch length to point "X".
- ( ) a 4-3/4 inch length to point "Y".

THIS COMPLETES THE 4711 CIRCUIT BOARD ASSEMBLY. TEMPORARILY SET THE BOARD ASIDE AND PROCEED TO THE FRONT PANEL ASSEMBLY.

TO INSURE PROPER CLEARANCE AFTER FINAL ASSEMBLY prepare potentiometers R35 through R44 by carefully bending the lugs so that they are parallel to the axis of the shaft as shown in detail figure 3.

NOTE THAT 500K POTENTIOMETERS ARE USED IN THE NEXT 8 STEPS.

- ( ) Mount 500K potentiometer R35 in the position shown in figure 4. Use two 3/8 inch nuts, one behind the front panel as a spacer and the second on the front side of the panel to secure the potentiometer. Adjust the rear nut so that none of the threaded shaft of the control is exposed when the front nut is tightened down. This will allow the control knob which will be mounted in a later step to seat as closely as possible to the panel. Orient as illustrated in figure 4.

- ( ) In a similar manner mount 500K potentiometer R36.
- ( ) In a similar manner mount 500K potentiometer R37.
- ( ) In a similar manner mount 500K potentiometer R38.

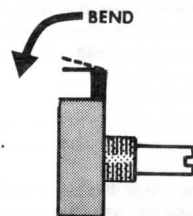


Figure 3

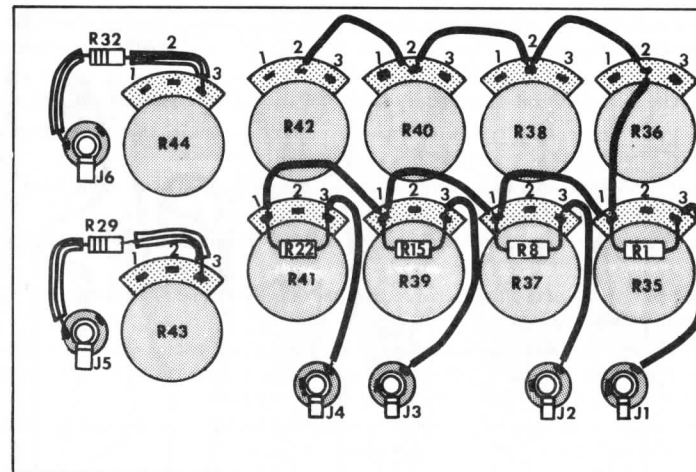


Figure 4

- ( ) In a similar manner mount 500K potentiometer R39.
- ( ) In a similar manner mount 500K potentiometer R40.
- ( ) In a similar manner mount 500K potentiometer R41.
- ( ) In a similar manner mount 500K potentiometer R42.

NOTE THAT 5K POTENTIOMETERS ARE USED IN THE NEXT TWO STEPS.

- ( ) In a similar manner mount 5K potentiometer R43.
- ( ) In a similar manner mount 5K potentiometer R44.
- ( ) Mount the miniature phone jack J1 in the position shown in figure 4. Fasten in place with the nut provided. Orient as illustrated.
- ( ) In a similar manner mount miniature phone jack J2.
- ( ) In a similar manner mount miniature phone jack J3.
- ( ) In a similar manner mount miniature phone jack J4.
- ( ) In a similar manner mount miniature phone jack J5.
- ( ) In a similar manner mount miniature phone jack J6.
- ( ) Using a 1-1/2 inch length of insulated wire make the connection between lug #2 of R42 and lug #2 of R40. Do not solder either connection at this time.
- ( ) Using a 1-1/2 inch length of insulated wire make the connection between lug #2 of R40 and lug #2 of R38 as shown in figure 4. Do not solder either connection at this time.
- ( ) Using a 1-1/2 inch length of insulated wire make the connection between lug #2 of R38 and lug #2 of R36. Solder two wires at R38 but do not solder the connection at R36.
- ( ) Prepare 10K resistors (brown-black-orange) R1, R8, R15 and R22 by cutting their leads to a length of 1/2 inch and bending the leads to a 90° angle from the body of the part.
- ( ) Install the previously prepared resistors between lugs #1 and #3 of potentiometers R35, R37, R39 and R41 as shown in figure 4. Do not solder any of these connections.
- ( ) Using a 1-3/4 inch length of insulated wire make the connection between lug #2 of R36 and lug #1 of R35. Solder the two wires at R36 but do not solder the connection at R35 at this time.
- ( ) Using a 2 inch length of insulated wire make the connection between lug #1 of R35 and lug #1 of R37. Solder two wires and the resistor lead at R35 but do not solder the connection at R37.

- ( ) Using a 2 inch length of insulated wire make the connection between lug #1 of R37 and lug #1 of R39. Solder the two wires and the resistor lead at R37 but do not solder the connection at R39.
- ( ) Using a 2 inch length of insulated wire make the connection between lug #1 of R39 and lug #1 of R41. Solder two wires and the resistor lead at R39 and the wire and resistor lead at R41.
- ( ) Using a 2 inch length of insulated wire make the connection between the "Hot" terminal of J1 and lug #3 of R35 as shown in figure 4. Solder both connections.
- ( ) Using a 2 inch length of insulated wire connect the "Hot" terminal of J2 to lug #3 of R37. Solder both connections.
- ( ) Using a 2 inch length of insulated wire connect the "Hot" terminal of J3 to lug #3 of R39. Solder both connections.
- ( ) Using a 2 inch length of insulated wire connect the "Hot" terminal of J4 to lug #3 of R41. Solder both connections.
- ( ) Prepare two 150 ohm resistors (brown-green-brown) R29 and R32 by cutting four 3/4 inch lengths of the plastic tubing provided and slipping these over the resistor leads. Clip the leads of the resistors off 1/4 inch beyond the end of the tubing.
- ( ) Connect one of the resistors prepared above (R29) between lug #3 of R43 and the left hand (ground) terminal of J5. Solder both connections.
- ( ) In a similar manner connect the other previously prepared resistor (R32) between lug #3 of R44 and the left hand (ground) terminal of J6. Solder both connections.

- ( ) Fasten the two "L" brackets to the front panel using one 1 inch 4-40 screw, one 3/4 inch spacer, one lockwasher and one 4-40 nut on each bracket as shown in figure 5. Note that the unthreaded hole in the "L" bracket is used in this operation.

- ( ) Fasten the circuit board to the front panel "L" brackets by passing 4-40 X 1/4 inch machine screws with lockwashers up through the holes in the circuit board and threading them into the threaded holes in the "L" brackets. Securely tighten all screws.

Make the final circuit board/front panel interconnections as follows:

- ( ) Connect the wire coming from circuit board point "X" to lug #2 of R40. Solder the three wires at this point.
- ( ) Connect the wire coming from circuit board point "R" to lug #1 of R43. Solder this connection.
- ( ) Connect the wire coming from circuit board point "Y" to lug #1 of R44. Solder this connection.
- ( ) Connect the wire coming from circuit board point "S" to the "hot" (right) terminal of J5. Solder this connection.
- ( ) Connect the wire coming from circuit board point "W" to the "hot" (right) terminal of J6. Solder this connection.

In the following steps the shielded cable harnesses previously prepared will be used to make connections from the panel controls to the circuit board. The braid of each of these harnesses will be soldered to a potentiometer lug. A CRIMPED MECHANICAL CONNECTION IS NOT NECESSARY HERE. Simply press the previously tinned portion of the braid against the

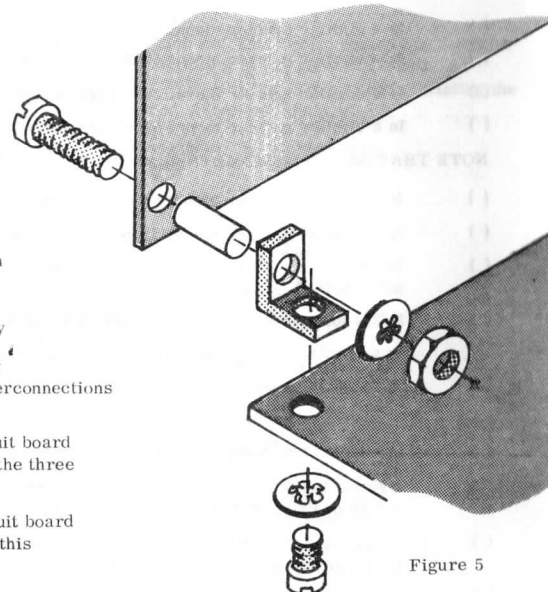


Figure 5

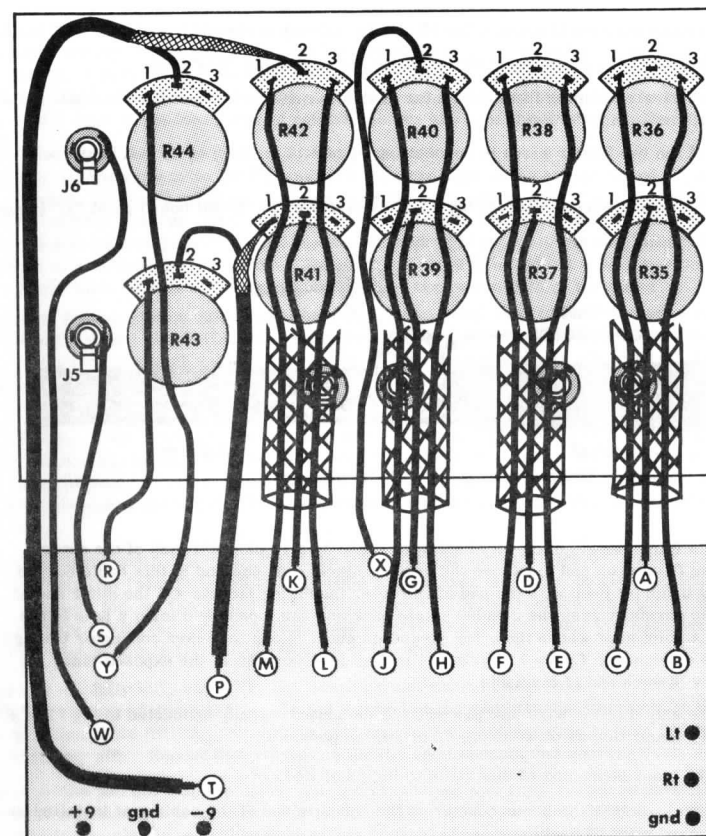
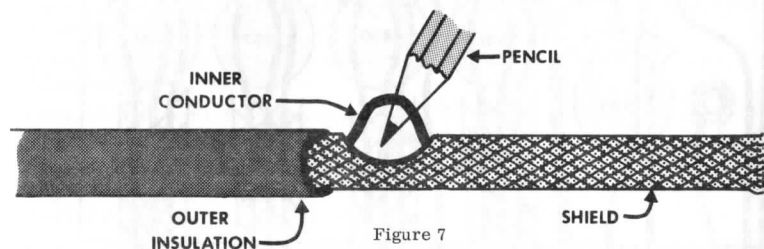


Figure 6 (note: previously installed wires omitted for clarity)

potentiometer lug and heat until the solder on the braid and the lug melts and flows together. Remove the soldering iron and hold the braid in place until the solder cools.

- ( ) Solder the tinned end of the braid of one of the previously prepared cable harnesses to lug #2 of R36.
- ( ) Use the short wire coming from the center of this harness to connect lug #2 of R35 (solder this connection) to circuit board point "A" (solder). Watch for shorts between R35 and the case of R36.
- ( ) Use one of the two longer wires to connect lug #1 of R36 (solder) to circuit board point "C" (solder).
- ( ) Use the remaining wire to connect lug #3 of R36 (solder) to circuit board point "B" (solder).
- ( ) Solder the tinned end of the braid of the second harness to lug #2 of R38.
- ( ) Use the short wire coming from the center of this harness to connect lug #2 of R37 (solder) to circuit board point "D" (solder).
- ( ) Use one of the two longer wires to connect lug #1 of R38 (solder) to circuit board point "F" (solder).
- ( ) Use the remaining wire to connect lug #3 of R38 (solder) to circuit board point "E" (solder).
- ( ) Solder the tinned end of the third harness to lug #2 of R40.
- ( ) Use the short wire coming from the center of the harness to connect lug #2 of R39 (solder) to circuit board point "G" (solder).
- ( ) Use one of the two longer wires to connect lug #1 of R40 (solder) to circuit board point "J" (solder).

- ( ) Use the remaining wire to connect lug #3 of R40 (solder) to circuit board point "H" (solder).
- ( ) Solder the tinned end of the braid of the fourth harness to lug #2 of R42.
- ( ) Use the short wire coming from the center of this harness to connect lug #2 of R41 (solder) to circuit board point "K" (solder).
- ( ) Use one of the two longer wires to connect lug #1 of R42 (solder) to circuit board point "M" (solder).
- ( ) Use the remaining wire to connect lug #3 of R42 (solder) to circuit board point "L" (solder).



- ( ) Prepare a 6 inch length of co-axial shielded cable by stripping 3/4 inch of the outer insulation from each end to expose the braided shield. At one end of this cable cut the shielding braid off even with the end of the outer insulating jacket. On the other end of this cable carefully push the braided shield back and use a pencil to form a hole in the braid at a point near where the outer insulation ends. Loop the inner conductor through this hole as shown in figure 7. Strip 1/4 inch of insulation from the exposed inner conductor at each end of the cable.
- ( ) Solder the shield of the wire just prepared to the shield already connected to lug #2 of R42. Make this connection as close to lug #2 of R42 as possible.
- ( ) Solder the inner conductor of this cable to lug #2 of R44.
- ( ) Connect and solder the inner conductor at the opposite end of the cable just installed to circuit board point "T".
- ( ) In a manner identical to the first, prepare a second piece of co-axial cable 3 inches long.
- ( ) Solder the shield of the cable just prepared to lug #1 of R41. This operation will be similar to soldering the cable harness shields, a crimped mechanical connection is not necessary.
- ( ) Solder the inner conductor of the cable just installed to lug #2 of R43.
- ( ) Connect and solder the inner conductor at the opposite end of this cable to circuit board point "P".
- ( ) Three "flea" clips have been included to facilitate power supply connections. Insert these clips in the holes at the end of the circuit board marked "+", " $\frac{+}{-}$ " and "-". These clips are a tight fit, it may be necessary to bend the narrow end of the clips slightly to fit the holes.
- ( ) With all front panel controls rotated fully counter-clockwise push on the knobs with the pointers aligned as follows:
  - Pan pots to the "t" in "left".
  - Level controls to the "n" in "min".
  - Master gains to the "m" in "min".

Once installed, these knobs will be difficult or impossible to remove - make sure that they are aligned as above and that the potentiometer hardware is completely tight before installation.

THIS COMPLETES ASSEMBLY OF THE PAIA 4711 MIXER.

## TESTING

Before beginning testing, thoroughly check the bottom of the circuit board for solder bridges and cold solder joints. Check parts placement and orientation or polarization. Pay particular attention to the extremely tight area between the upper and lower rows of potentiometers to make sure that none of the solder lugs on the lower row of potentiometers are touching the bodies of the potentiometers above them.

Begin testing by applying power to the flea clips on the rear edge of the circuit board; "+" to a source of +9 volts, "-" to -9 volts and the connector at the ground symbol " $\frac{+}{-}$ " to the common point of the two voltage sources. If a stereo power amplifier is available, use shielded cable to connect the left and right outputs of the 4711 to the left and right inputs of the amplifier. If only a mono amplifier is available the procedure to be outlined can be followed but it will require that the amplifier's single input be moved back and forth between the two outputs of the mixer.

Connect a signal source with an output level between .1 and 1 volt peak to peak to input 1 of the 4711. The triangle output of a PAIA Voltage Controlled Oscillator works well for these purposes. If the 4711 Mixer and the signal source that you are using for testing do not share a common power supply it will be necessary to use shielded cable to connect the two, otherwise the common ground is established through the power supply.

NOTE: The bottom of the circuit board can pick up 60 Hz. hum from the work surface. If excessive hum is observed during testing place the mixer on a sheet of aluminum foil connected to the amplifier ground. A piece of paper or other insulator must be placed between the 4711 and the foil to prevent shorts from the bottom of the board. This hum should be eliminated when the unit is installed in its normal housing.

Set the channel 1 level control to "max." and the left and right Master Gains to "max." Turn the channel 1 "Pan" control from fully left to fully right and observe that the sound coming from the amplifier's speakers follows the action of the pot first coming fully from the left channel then fully from the right. With the pan pot knob pointer aligned with the dot under the "pan" designation observe that the sound comes from both channels of the amplifier.

With the pan pot set fully left, rotate the left Master Gain control from "max." to "min." and observe that the volume of the tone from the left channel of the amplifier is attenuated to the point that it is almost inaudible (NOTE: the master gain controls are not designed to turn the respective channels completely off). Repeat this procedure for the right channel and observe equivalent results.

Once again align the pan pot with the center dot and set the left and right master gain controls to "max." Rotate the channel 1 level control from "max." to "min." and observe that at the "min." setting the tone is completely inaudible from either channel of the amplifier.

Repeat these procedures for each input channel of the mixer.

## USING

As the name implies, a mixer is used to mix signals together in such a way that the output contains only the information presented to the inputs without adding any harmonic distortion or spurious signals of its own. But, as we shall shortly see, a mixer can also be used as a signal routing device allowing the user to select from a number of different input signals and route them to various destinations.

Operation of the controls is as follows:

**INPUTS 1, 2, 3 & 4** The four miniature phone jacks along the lower edge of the module provide 10K ohm inputs to the mixer. These inputs are direct coupled to the mixer's internal amplifiers and any signal applied to them should not have a significant d.c. component. All PAIA 2720 & 4700 series synthesizer modules meet these requirements.

**LEVEL CONTROLS** Above each input jack is the level control for that input. At the "min." setting of these controls the associated input is considered to be turned off and signals at that input will not appear in the output. Clockwise rotation of the control increases the percentage of signal from the corresponding input that will appear in the output.

**PAN POTS** The pan pots above each channel's level control allows the corresponding input to be assigned either to the left or right outputs or split in any proportion between the two. The pan pots are arranged so that the mid-range of the control splits the signal equally between the left and right channels. Rotation to the left or right of center causes a much greater attenuation of the unused channel than it does boost to the selected channel. For example, as the pan pot is

rotated from the center to the left it produces only about a 1 db. gain in the left channel while attenuating the right channel by 60 db. A system without this provision would produce excessive apparent volume changes as a sound source was panned from one side to the other.

**MASTER GAIN** The master gain controls on the right end of the panel control the overall gain of the respective outputs without altering the percentage of each input present. These controls have a 30 db operating range and are not designed to turn the output signal off completely.

**OUTPUTS** The output jacks on the right edge of the panel provide a low impedance source for driving external amplifiers or additional processing modules.

Anyone using the 4711 Mixer for other than synthesizer work will already have a good idea of what they hope to do and the means of accomplishing it. It is sufficient to say here that mixers are required in the amateur or professional production of slide and film shows to mix together background music with narration or in adding sound effects of various kinds to the program material. The ultimate mixers for these purposes have built in, adjustable equalizing (eq.) networks and such niceties as echo send busses and Cue buttons to allow the user to listen to each channel individually. All of these features are great to have but add significantly to the cost of the console.

Synthesists are in a little different position. To them a mixer is another processing module and its ultimate usefulness will depend to a large extent on the creativity of the user. To get you started here are some examples.

#### PANNING

One of the current fads in a lot of Rock and Roll music is to mix the master tape so that various instruments seem to jump or glide from one side of the room to the other. Using this technique a single instrument can seem to be two instruments as when a lead guitarist plays a riff with one setting of tone controls on the left and then switches tone control settings to play a second line on the right. As will be explained shortly this can also be done with a synthesizer set to produce two entirely different voices. Drums also work well at this and it is currently common practice to mike each drum or small group of drums individually for placement later in the final mix. Slowly panning a tom-tom or snare drum from left to right (or around the room in quad) produces striking effects.

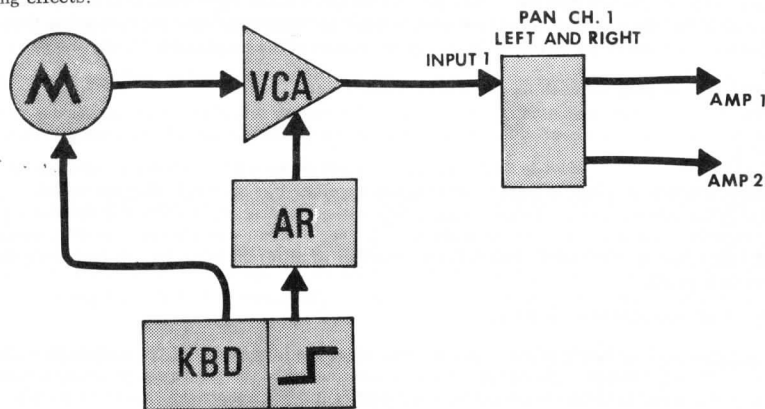


Figure 8

To observe panning in action set up the simple voice shown in figure 8. Route the output of the VCA into channel 1 of the 4711 and set the level control for that channel and the left and right master gains to "max." Oscillator and function generator parameters are not important here, set them to something that pleases you and while playing the keyboard with one hand run the channel 1 pan pot from left to right to cause the sound of the synthesizer to glide from one end of the room to the other. Two amplifiers are nice here but a stereo hi-fi amplifier can be used equally well.

#### VOICE MIXING

Popular groups famous for their synthesizer work rarely use a single oscillator waveform in building a sound. Different waveforms from the same oscillator can be mixed together to produce new sounds or the output of two oscillators can be mixed to produce striking effects. Mixing the outputs of two oscillators produces much more life-like effects than mixing two outputs of the same oscillator because no matter how precise and stable an oscillator is it will never be entirely identical with another oscillator even of the same type. It is these slight differences that produce the very slow time varying timbral changes in the sound of a natural instrument as well as a synthesizer. (Some oscillators can be locked together with "synch." inputs but this is not relevant to this discussion).

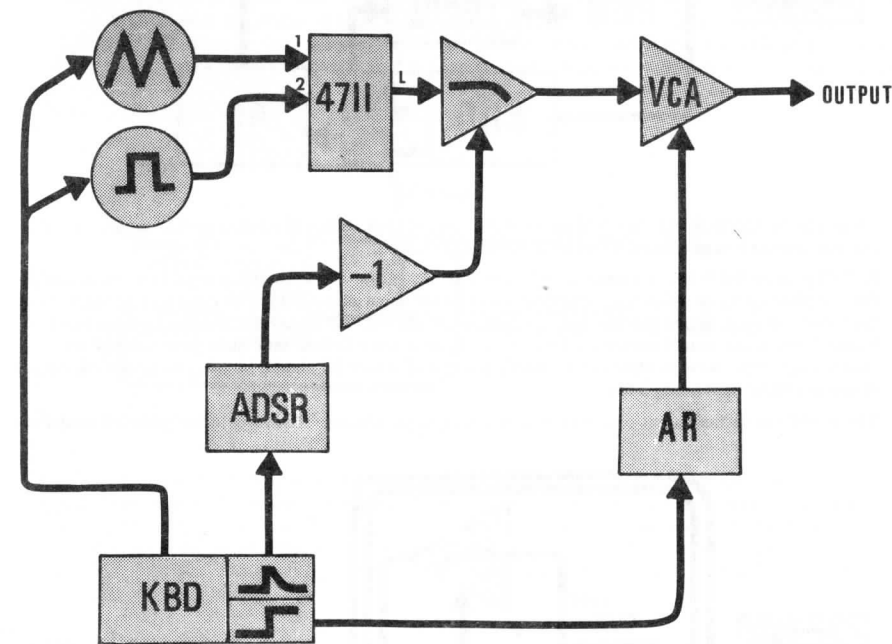


Figure 9

Figure 9 shows a voice that has been described as a "berserk electronic trumpet" and its main feature is the mixing of the outputs of two oscillators\*. The ADSR is set for moderately fast attack and decay, about 3/4 sustain and moderately long release. The AR controlling the VCA is set for moderately fast attack and decay. Note in particular in this connection that the two input channels that are being used should be panned fully to the left so that none of their signal appears in the right channel. This leaves half of the 4711 unused and by panning the two remaining inputs fully right they can be used as an independent mixer.

**"SUBPATCHING"** While modular synthesizers are without question more versatile than equipment with "normalized" controls, the extensive patching required limits their use in live performance work. There is really no way to get around this inconvenience completely but a mixer can help by allowing two or more voices to be set up in advance and selected with a single knob.

In principle this is a simple concept but in practice it can place great demands on the imagination of the user. Figure 10 shows a patch that Richard Bugg used on the PAIA "Epsilon Bootis" demonstration record. The first voice is the manually swept VCO with a triangle output and this voice is selected by bringing up the level on input channel #1 of the mixer. The second voice is the pulse width modulated VCO under keyboard control and is selected by bringing up the level of channel #2 of the mixer. The balanced modulator here is used simply as a VCA and note that with this patch a keyboard key must be held down even if the manually swept triangle is the selected voice.

\* PAIA 2720-2 VCO's can be used in this connection but lack the necessary stability to keep in tune with one another for long periods of time. Better choices would be PAIA 2720-2A and 4720.

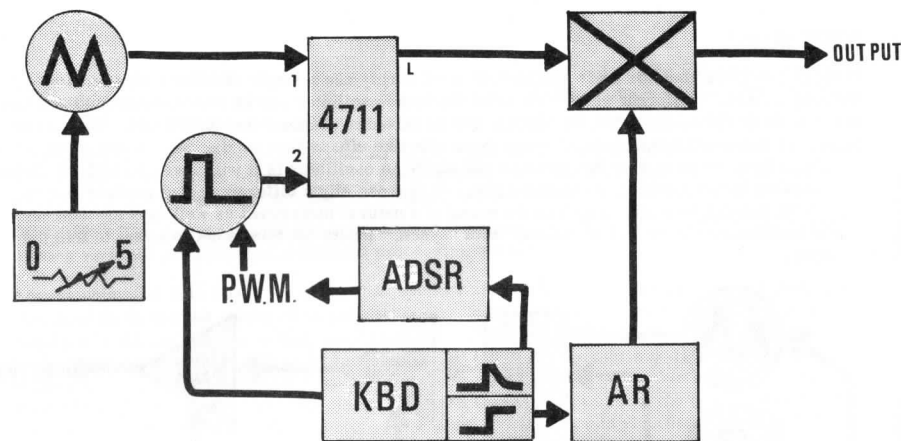


Figure 10

As an example of how far this sort of thing can be carried, figure 11 uses two 4711 mixers to allow any one (or combinations) of 6 voices to be knob selected.

By bringing up the level on inputs 1 or 2 of mixer #1, either the triangle or square wave output of the oscillator may be selected. Panning the selected input channel to either the left or right routes the signal through either the low pass or band pass filters. At mixer #2, bringing up the level on inputs 1 and 2 can select either the triangle or square wave before they have gone through any processing. The level controls of channels 3 and 4 of mixer #2 should be used to select the output of the modifier path being used.

The modifiers at the output of mixer #1 don't have to be filters. They could be balanced modulators,

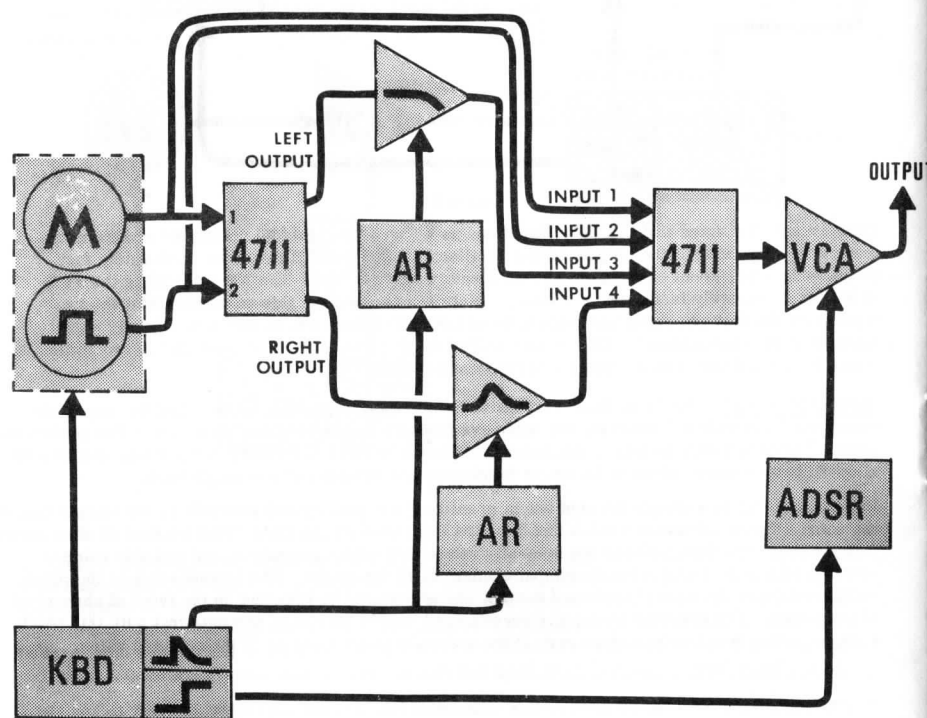


Figure 11

VCA's or other processing elements. Similarly, the signal sources can be from separate oscillators or noise sources and up to four can be input to the first mixer and selected as required. Finally, the channels of the mixers don't have to be either on or off and many pleasing results can be obtained by varying the percentage of each input signal that goes through each modifier group.

#### SOME THINGS TO WATCH OUT FOR

There is very little that you can do to the 4711 Mixer to damage it but there are some configurations of the module that will produce unpredictable results.

Be careful of feed-back loops external to the mixer. Some interesting sounds can be created by picking up a signal from near the output of a patch and mixing it back in near the input but this can lead to oscillation of the mixer. For example; figure 12 shows a mixer patch that will definitely oscillate. Here the right channel output drives one of the inputs which is panned fully left while the left output drives an input panned fully right. This turns the 4711 into a very slow astable multivibrator with 15 volt square waves appearing at both outputs.

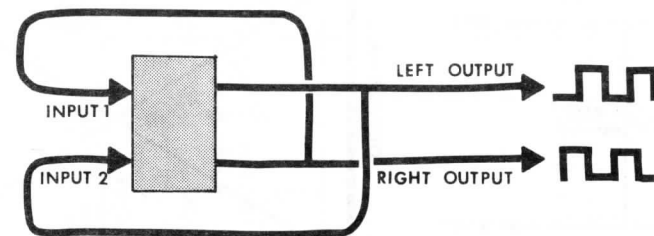


Figure 12

Within a single synthesizer system a common ground should be established through the power supplies and because of the low output impedances of the processing elements short signal runs (less than 2 ft.) can be made without using shielded wire. But if the signal source is external to the synthesizer (and the synthesizer's ground system) co-axial shielded cable must be used for the input connection. Similarly, shielded co-ax. must be used for the final connection between synthesizer and amplifier.

#### DESIGN ANALYSIS

At the heart of the 4711 mixer are two integrated circuit operational amplifiers, IC1 and IC2. The configuration of these amplifiers is as simple summing circuits as shown in figure 13. Because of feed-back the negative input of the amplifier is at a virtual ground and since there is no voltage variation at this point there can be no interaction between the two inputs  $e_1$  and  $e_2$ .

Gain in this configuration is inversely proportional to the amount of output signal that is fed back to input. Master gain controls R43 and R44 (figure 16) increase the gain of the amplifiers by attenuating the amount of signal that returns to the input as feedback.

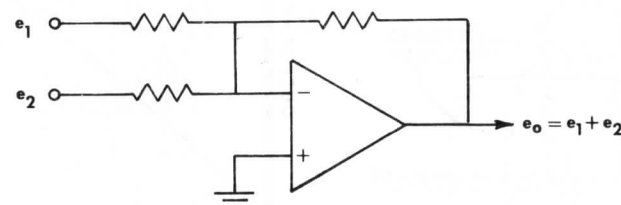


Figure 13

Figure 14 shows a simplified schematic of the pan pots. Operation is simple, when the wiper of the pan pot is set to mid-range  $R_a$  and the top half of the pot  $R_c$  form a voltage divider as do  $R_b$  and the lower half of  $R_c$ . At mid-range of the pot the respective resistance in each branch are the same so that equal signal levels appear at the left and right output lines. The attenuation that occurs because of the voltage divider action is compensated in the gain of the mixing amplifiers. As the wiper is rotated more toward the upper end of  $R_c$  the signal present on the left output line decreases until finally when the grounded wiper is all the way toward the high end the left output line is grounded, eliminating any signal from this line. At the same time more and more resistance is appearing in the lower branch of the  $R_b$ - $R_c$  voltage divider so the signal level on the right output line is increasing. The network as shown in figure 14 (a) produces the output response shown in figure 14 (b), rotation of the pan pot produces attenuation in the left output that is equal to the increase in gain in the right channel. While this may seem ideal it has some serious disadvantages because when the

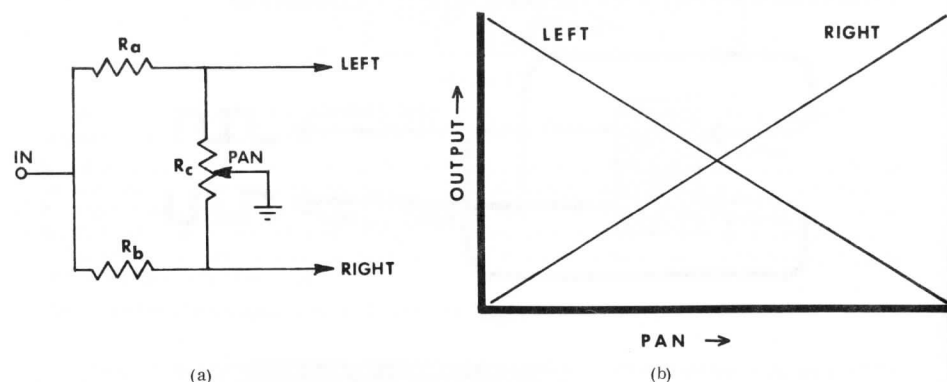


Figure 14

pan pot is in the middle, the two mixer outputs will not seem as loud as either single output does when the pan pot is either fully left or fully right. Ideally we would like to have a more or less constant apparent total volume regardless of the setting of the pan pots. To get around this problem "tapering" resistors are added from each side of the pan pot to ground as shown in figure 15 (a). With this modification we produce the response curves shown in figure 15 (b), the output from either channel is very nearly the same with the pan pot in the center as it is when the signal is routed fully to that channel. Here the panning effect is as it should be with most of the change taking place in attenuation of the lower level channel while very little boost occurs in the selected channel.

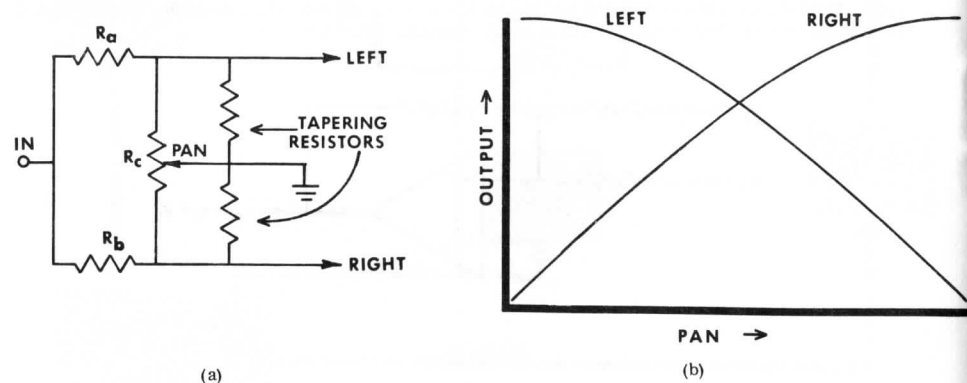


Figure 15

Figure 16 shows the complete mixer. The resistor capacitor combinations  $R33 - C1$  and  $R34 - C2$  are power supply filtering and decoupling while capacitors  $C3$  and  $C4$  provide d. c. isolation of the outputs.

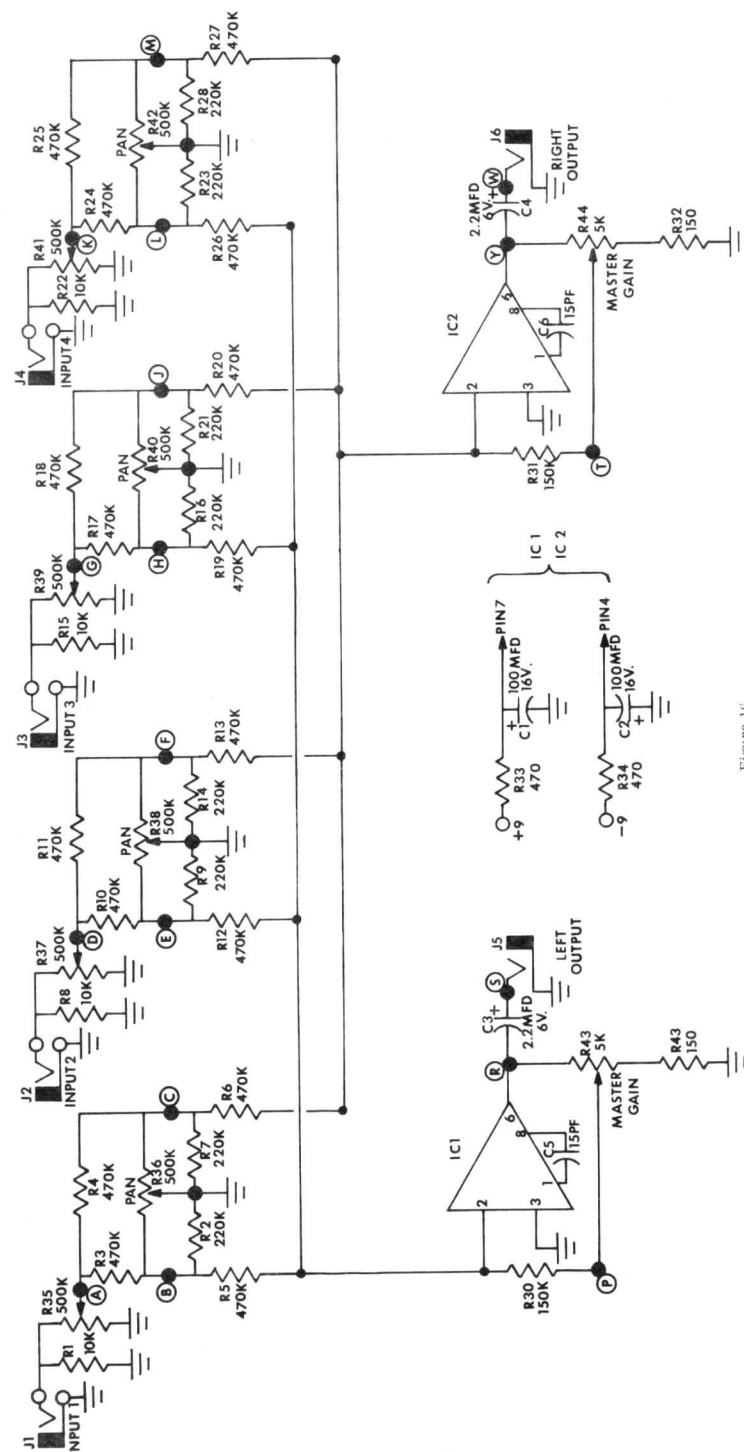


Figure 16