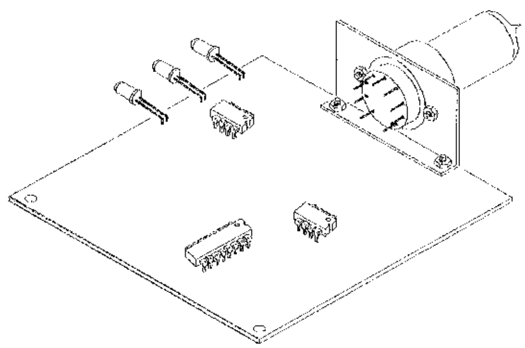
Tube Mic Pre

Model 9407
Assembly and Using Manual



The Project-r Tube Mic Pre is an extraordinarily versatile microphone preamplifier based on hybrid vacuum tube and solid state circuitry. Beyond such expected characteristics as quiet operation, a balanced input with phantom power and balanced output this unit has features not found on other microphone preamplifiers.

Starving the tube circuitry with low plate supply voltage produces a warm caricature of valve sound and the unique BLEND control allows as much or as little tube coloration as desired to be mixed into a completely clean and linear solid state preamp. Separate input and output level controls allow tube drive to be varied while still maintaining optimum output signal level.

Please disregard instructions to clean or shine the copper on this printed circuit board. There is a coating on them to prevent oxidization.

ASSEMBLING THE TUBE MIC PRE

Before beginning assembly, go through the manual. Look at the drawings. Feel the parts. You're naturally eager to plunge right in, but take a few deep breaths first.

Notice that each step in the manual is marked with a checkoff box like this:

DESIGNATION	VALUE	COLOR CODE
( ) R27	100 ohm	brown-black-brown

Checking off each step as you do it may seem silly and ritualistic, but it greatly decreases the chance of omitting a step and also provides some gratification and reward as each step is completed.

Numbered figures are printed in the Illustrations Supplement in the center of this manual. These pages may be removed for easy reference during assembly.

THE CIRCUIT BOARD

The Tube Mic Pre is built on a single-sided circuit board. Before beginning assembly, clean oxidation from the copper side of the circuit board using scouring cleanser and water. The copper should be bright and shiny before beginning assembly.

Once you begin putting parts on the circuit board, it's a good idea to continue until all the parts are mounted. Stopping overnight may allow the copper to oxidize and make soldering more difficult.

TOOLS

You'll need a minimum of tools to assemble the kit - a small pair of diagonal wire cutters and pliers, screwdriver, sharp knife, ruler, soldering iron and solder.

Modern electronic components are small (in case you hadn't noticed) and values marked on the part are often difficult to see. Another handy tool for your bench will be a good magnifying glass. Also use the magnifier to examine each solder joint as it is made to make sure that it doesn't have any of the problems described in the SOLDERING section which follows.

SOLDERING

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

Use only rosin core solder (acid core solder is for plumbing, not electronics work). A proper solder joint has just enough solder to cover the soldering pad and about 1/16-inch of 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 when actually there is a layer of flux insulating the component lead from the solder bead. This situation can be cured by reheating 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. Accidental bridges can be cleaned off by holding the board upside down and flowing the excess solder off onto a clean, hot soldering iron.

Use care when mounting all components. Never force a component into place.

Special thanks to Jules Ryckebusch whose Phanton Power Preamp design in the April 1993 issue of Electroic Musician provided the basis for the differential input stage used in the Tube Mic Pre.

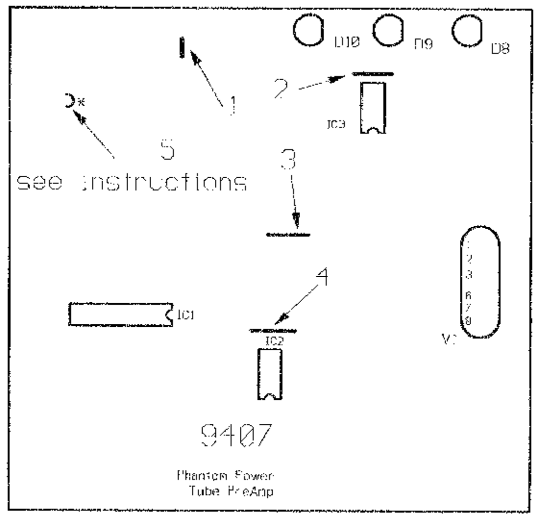
ABOUT THIS MANUAL

When two or more Tube Mic Preamps share a common power transformer and switch there are slight wiring differences between the "first" amp and all the remaining amplifiers. These differences have to do with the distribution of power to the boards, but even more importantly with maintaining the proper "star" grounding between the amplifiers. (see illustration on pg. 21).

Instructions that have to do with differences in wiring between the first amplifier and subsequent circuit boards will be called to your attention with this bold italic type face.

WIRE JUMPERS

Assembly begins by forming and installing the four wire jumpers indicated by the straight bold lines on the circuit board parts placement designators and the illustration to the right. For each jumper, cut a length of the bare wire supplied by measuring it against the distance between the circuit board holes and adding about 1/2". Bend 1/4" of each end down and push through the circuit board holes. Press the jumper fully against the board and solder both ends. Trim off excess wire flush with the solder joint.



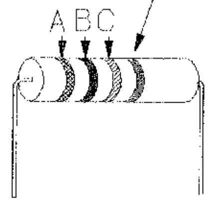
Notice that a fifth jumper, indicated on the board with a curved bold line and marked " * ", should be installed only on the FIRST channel in a system. DO NOT INSTALL this jumper on any other board in a system.

( ) As outlined above, form and install the four wire jumpers used on the circuit board.

( ) If the preamp board will be the first or only channel in a system install the fifth jumper.

RESISTORS

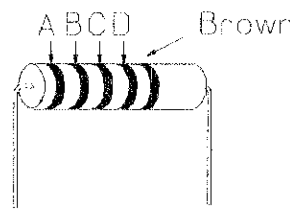
Solder each resistor in place following the parts placement designators printed on the circuit board and the assembly drawing Fig 1. Note that resistors are nonpolarized and may be mounted with either lead in either of the holes in the circuit board. Before mounting each resistor, bend its leads so that they are at a right angle to the body of the part. Put the leads through the holes and then push the resistor firmly into place. Cinch the resistor in place by bending the leads on the solder side of the board out to an angle of about 45 degrees. Solder both ends of each resistor in place as you install it. Clip each lead flush with the solder joint as the joint is made.



The Tube Mic Pre uses 1% film resistors in critical audio path circuitry and 5% carbon film resistors in non-critical locations. First we'll install the 5% resistors. These resistors are identified by their 4 color bands.

DESIGNATION	VALUE	COLOR CODE A-B-C
( ) R1	100 ohm	brown-black-brown
( ) R2	100 ohm	brown-black-brown
( ) R3	330 ohm	orange-orange-brown
( ) R4	33k	orange-orange-orange
( ) R5	33k	orange-orange-orange
( ) R6	470k	yellow-violet-yellow
( ) R7	100 ohm	brown-black-brown
( ) R8	4700 ohm	yellow-violet-red
( ) R9	10k	brown-black-orange
( ) R10	100k	brown-black-yellow
( ) R11	270k	red-violet-yellow
( ) R12	270k	red-violet-yellow
( ) R13	82k	grey-red-orange
( ) R14	100k	brown-black-yellow
( ) R15	270 ohm	red-violet-brown

DESIGNATION	VALUE	COLOR CODE A-B-C
( ) R16	82k	grey-red-orange
( ) R17	100k	brown-black-yellow
( ) R18	100k	brown-black-yellow
( ) R21	470 ohm	yellow-violet-brown
( ) R23	39k	orange-white-orange
( ) R24	150k	brown-green-yellow
( ) R28	47k	yellow-violet-orange
( ) R29	22k	red-red-orange
( ) R30	470 ohm	yellow-violet-brown
( ) R32	2700 ohm	red-violet-red
( ) R33	2700 ohm	red-violet-red
( ) R44	270k	red-violet-yellow



1% FILM RESISTORS

The 1% metal film resistors are identified by their 5 color bands.

DESIGNATION	VALUE	COLOR CODE A-B-C-D	
( ) R19	1k	brown-black-black-brown	
listed below:	10k	brown-black-black-red	
( ) R26	( ) R27	( ) R31	( ) R37
( ) R20	33k	orange-orange-black-red	
( ) R25	6.81k	blue-grey-brown-brown	
( ) R36	6.81k	blue-grey-brown-brown	
( ) R38	1k	brown-black-black-brown	
( ) R39	33k	orange-orange-black-red	

CERAMIC DISK CAPACITORS

Some of the capacitors used in the Tube Mic Pre are non-polarized ceramic disks, either lead can go in either of the holes on the circuit board. Leads are already parallel to one another but still may need to be bent slightly to match the spacing of the circuit board holes. Like the resistors, push the leads through the holes in the board and push the part against the circuit board as far as it wants to go. Don't force it, it's OK if it sits a little off the board.

Capacitors are often marked with obscure codes that indicate their values. The 3 digit number that specifies value may be preceded or followed by letters indicating such things as tolerance.

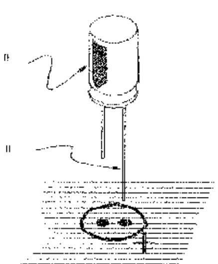
DESIGNATION	VALUE	MARKING
( ) C5	.05 uF	503
( ) C6	220 pF	221 or 220
( ) C13	.01 uF	103
( ) C18	47 pF	47

ELECTROLYTIC CAPACITORS

Some of the capacitors used in the Tube Mic Pre are electrolytic types. Unlike the previous components, electrolytic capacitors are polarized and the leads are not interchangeable. Leads are marked "+" and/or "-" and the "+" lead must go through the "+" hole in the circuit board. Frequently the positive lead of the capacitor is significantly longer than the negative lead.

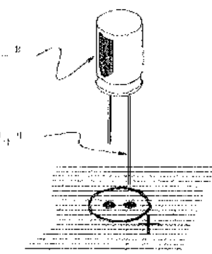
Usually the Negative lead of the capacitor is marked rather than the positive. It naturally goes through the hole not marked "+".

Capacitors supplied with specific kits may have a higher Voltage (V) rating than the minimum specified below.

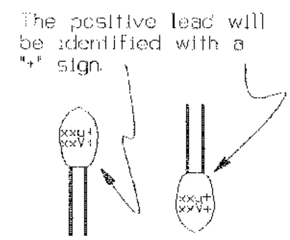


DESIGNATION	VALUE
( ) C1	470 uF/25V
( ) C2	220 uF/25V
( ) C3	470 uF/25V
( ) C4	220 uF/25V

DESIGNATION	VALUE		
listed below:	33 uF/16V		
( ) C7	( ) C8	( ) C9	( ) C10
( ) C11	( ) C21	( ) C22	
( ) C12	47 uF/50V		
listed below:	1 uF/50V		
( ) C14	( ) C15	( ) C16	( ) C17
( ) C20			

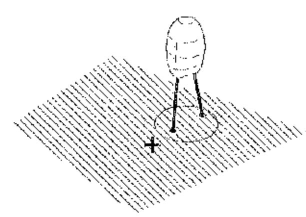


TANTALUM CAPACITORS



Two of the capacitors used in the Tube Mic Pre are low-noise, low-leakage tantalum types that can be recognized by their distinctive balloon shape. Tantalum capacitors are generally marked with their values (in very tiny type) and since both tantalum caps are the same value there is little chance of confusion.

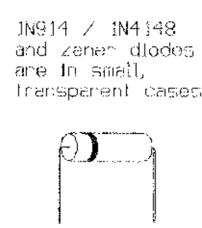
Tantalum capacitors are usually polarized with a "+" mark associated with one of the leads and like the other polarized components this "+" lead should be put in the similarly marked circuit board hole.

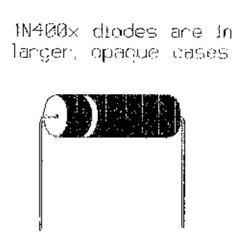


DESIGNATION	VALUE
( ) C19	4.7 uF/50V (may be marked 4u7)
( ) C23	4.7 uF/50V "

DIODES

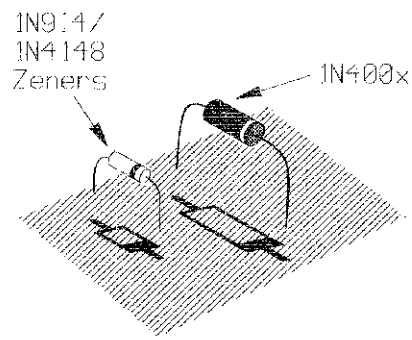
Three types of diodes are used in the Tube Mic Pre, six 1N4148 silicon signal diodes in small transparent glass cases, five zener diodes also in small transparent cases and two 1N400x power diodes in larger opaque cases.





When you receive your kit, these parts will be separately packed. Do not remove them from their packing until you're ready to install them; if they get mixed up you will have a hard time sorting them back into types.

Diodes are polarized and must be installed so that the lead on the banded end of the part corresponds to the banded end of the designator on the circuit board. Bend the leads so they are at right angles to the body of the part and insert them through the holes provided in the circuit board.



The polarizing color band corresponds to the filled end of the circuit board graphic.

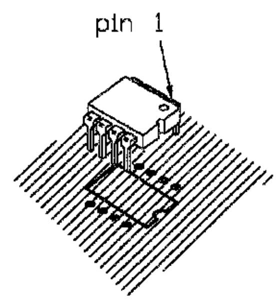
Diodes are also somewhat heat sensitive so the soldering operation should be done as quickly as possible.

DESIGNATION	TYPE		
( ) D1	1N400x		
( ) D2	1N400x		
listed below:	1N914/1N4148 Silicon Diodes		
( ) D3	( ) D4	( ) D5	( ) D6
( ) D7	( ) D11		
listed below:	6.8V Zener Diodes		
( ) D12	( ) D13	( ) D14	( ) D15
( ) D16	51V Zener Diode		

INTEGRATED CIRCUITS

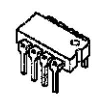
Of all the parts, the ICs are the most easily damaged and should be treated with some respect. In particular, they may be destroyed by discharges of static electricity. Modern ICs are not nearly as sensitive to this kind of damage as were earlier versions, but it is still good practice to handle these parts as little as possible. Also good practice: don't wear nylon during assembly. Don't shuffle around on the carpet immediately before assembly (or if you do, touch a lamp or something to make sure you're discharged). Don't be intimidated. It's rare for parts to be damaged this way.

ICs are polarized in one or both of two ways; A dot formed into the case of the IC corresponding to pin 1 or a semicircular notch that indicates the end of the package with pin 1. Take care that this polarizing indicator corresponds to the similar indicator on the circuit board graphics.

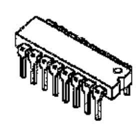


The pins of the ICs may be splayed somewhat and not match up exactly with the holes in the circuit board. Carefully re-form the leads if necessary so that they are at right angles to the part. Solder each IC in place as it is installed by initially soldering two pins in diagonal corners of the pattern. Make sure that the part is seated firmly against the circuit board by pressing it down while re-melting the solder joint at first one corner, then the other. Finally, solder the remaining connections.

5532



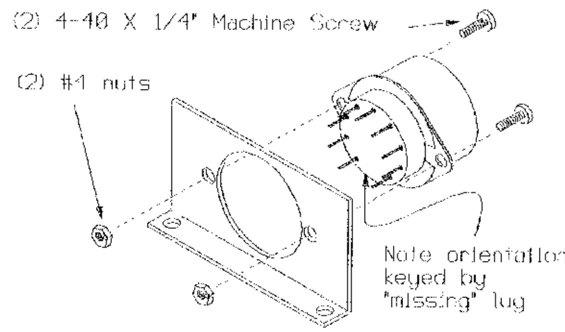
4049



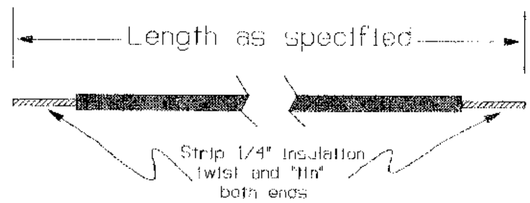
DESIGNATION	TYPE
( ) IC1	4049 CMOS Hex Inverter
( ) IC2	5532 Dual Low Noise Opamp
( ) IC3	5532 Dual Low Noise Opamp

TUBE SOCKET

( ) Attach the tube socket to the aluminum mounting bracket with two 4-40 X 1/4" machine screws and two 4-40 nuts as shown in the illustration. Notice that the socket mounts from the "front" side (the mounting tab that will attach the bracket to the circuit board bends toward the "back"). Also note that the socket is polarized by the open space between lugs 1 and 9 and that this space should be adjacent to the bend in the bracket (see fig 2). When you're satisfied that the socket is properly oriented, fully tighten the hardware. The bracket will attach to the circuit board later.



Pieces of the #22 single stranded insulated wire ("stranded wire") provided with the kit are used to make connections to the tube's filament.



( ) Cut two 6" lengths of the #22 insulated wire and prepare both ends of both pieces by stripping off 1/4" of insulation. Twist the exposed wire strands together and "tin" them by melting a little solder into the strands. This will make soldering easier when the wires are installed and prevents fraying of the wire strands when they are pushed through holes in the circuit board.

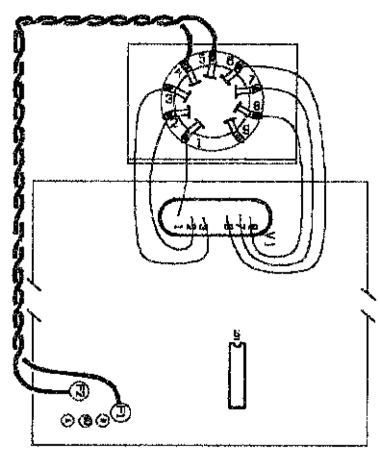
( ) Form the two wires from the above step into a "twisted pair" and solder one end of the pair to lug #4 and lug #5 of the socket V1 (see illustration on following page).

Now we'll solder lengths of the bare wire to the tube socket lugs. In later steps these wires will have insulation slipped over them and then connect to the circuit board.

( ) Cut six 1-3/4" lengths of bare wire and solder one piece to each of the tube socket lugs 1, 2, 3, 6, 7 and 8. Notice that there will be no wire connected to lug 9 of the socket.

The socket and bracket can be temporarily attached to the circuit board. This is the time to connect the bare wires from the tube socket to the appropriate circuit board holes. These connections are made on a "one-to-one" basis with the wire coming from lug #1 of the tube to the hole marked #1 on the circuit board graphic for the tube. The wires will each have a length of insulated sleeving slid over them. Cut the length of sleeving as specified in the step, slide it over the wire and then push the wire through the appropriate hole in the circuit board. Do not solder any of these connections yet.

WIRE NUMBER	SLEEVE LENGTH
( ) 1	1/2"
( ) 2	3/4"
( ) 3	1"
( ) 6	1"
( ) 7	7/8"
( ) 8	3/4"



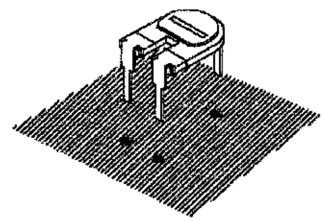
( ) Temporarily attach the tube bracket to the circuit board using two 4-40 X 1/2" machine screws and two #4 machine nuts as shown in fig 2. When the completed circuit board is mounted in the case, this same hardware and spacers will be used so do not fully tighten these screws yet.

( ) Verify that the wires from the tube properly engage the holes in the circuit board and solder all six connections. There will be a good bit of excess wire on each connection which should be cut off flush with the solder joint as the joint is soldered.

( ) Connect the free end of the twisted pair coming from lugs #4 and #5 of V1 to the two holes designated "F1" and "F2" on the circuit board. The wires are interchangeable. Solder both connections and clip any excess wire off flush with the joint.

TRIMMER POTENTIOMETER

Mount the trimmer potentiometer by inserting it's three pins into the holes provided. Press it down until the "shoulders" of the solder pins are resting on the surface of the circuit board. Solder all three pins.



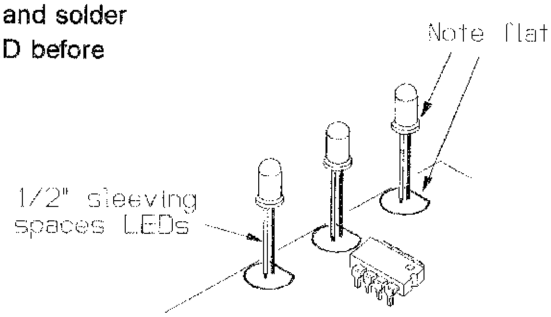
DESIGNATION	VALUE
( ) R22	100K

LEDs

When the Tube Mic Pre is installed in its case, the three LEDs will engage the holes in the front panel and be supported by their leads.

Note that the LEDs are polarized by the flat in the collar at the base of the part. When properly installed, this flat will align with the corresponding flat in the LED symbol printed on the circuit board.

On each LED, slip a 1/2" length of the insulated sleeving supplied over one lead to space them so they stand off from the board by a little more than 1/2" as shown. Push the two leads through the holes in the circuit board and solder both leads and confirm the orientation of the LED before trimming the leads off flush with the solder joint.



DESIGNATION	TYPE
( ) D8	Red LED
( ) D9	Red LED
( ) D10	Red LED

"Flying" Wires

(i.e. those which go from circuit board to panel mounted parts.)

In the following steps, wires will be soldered to the circuit board which in later steps will be connected to the front panel controls and switches. At each step, cut a piece of wire to the specified length and strip 1/4" of insulation from each end. Twist the exposed wire strands together and "tin" them by melting a small amount of solder into the strands. Solder each connection as it is made and clip any excess wire from the solder side of the board.

Note that points "A", "G" and "SG" each have two holes associated with them.

Board Point	Length	notes
( ) "D"	3-1/2"	
( ) "E"	5-1/2""	
( ) "N"	6"	
( ) "O"	6"	
( ) "SG"	9"	***either hole may be used***

Install this wire on the FIRST board in a sysem only

( ) "A"	7"	***either hole may be used***

Add the following wires to the first amp in a system only if you KNOW you will be adding a second amp.

( ) "A"	***12"***	
( ) "G"	***12"***	***use the larger hole***
( ) "SG"	***12"***	

SHIELDED CABLE

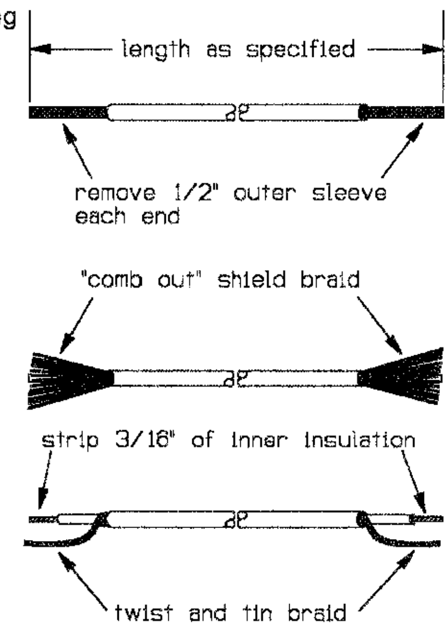
RG-174/U coaxial cable is used to make shielded connections between the circuit board and two of the potentiometers. Make two cable sections by cutting 7" from the single piece supplied . Prepare the ends of the two pieces as follows:

Strip 1/2" of the outer insulation at each end to expose the braided shield beneath it.

Unbraid the shield by "combing" it with the dull edge of a knife blade or a ball-point pen. This will expose the separately insulated inner conductor.

On each end, pull the strands of shield to one side and twist them together. Tin these pigtails by melting a small amount of solder into them.

On each end, strip about 3/16" of the insulation from the inner conductor and twist and tin the exposed strands.



Using the pieces of co-ax prepared above, solder the inner conductor and shield to the circuit board points listed in the following steps (see fig 4).

WIRE PC POINT

Cable #1 (shorter piece)

( ) (inner) "H"

( ) (shield) "F"

Cable #2 (longer piece)

( ) (inner) "L"

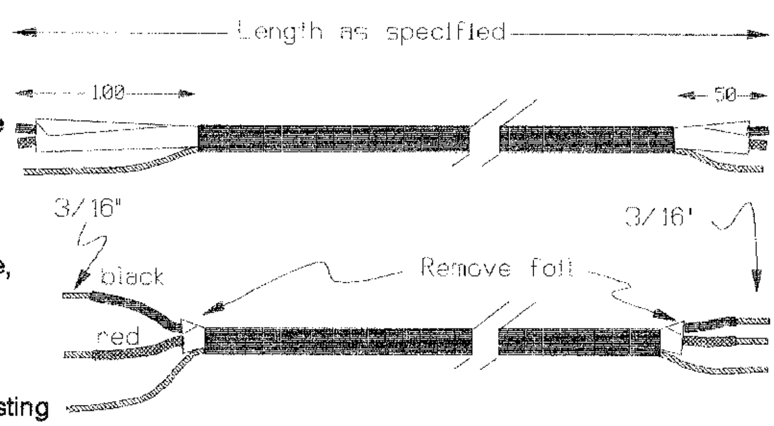
( ) (shield) "M"

TWIN-AXIAL CABLE

Belden 9501 twin-ax will be used to make shielded connections between the circuit board and panel controls. Make two cable sections by cutting 6" from the single piece supplied . Prepare the ends of the two pieces as follows:

On one end of each cable, remove 1/2" of the outer insulating sleeve. Bend the uninsulated drain wire out of the way and cut off the exposed foil layer flush with the outer insulation. Remove 3/16" of insulation from both the red and black leads and twist and tin each of the three wires. Be careful not to pull the wires out of the cable when stripping the ends.

On the other end of each cable, strip 1" of the outer insulation, remove the foil and remove 3/16" of insulation from the red and black leads before twisting and tinning all three wire ends.



Use the "shorter" ends of the cables to make these connections to the circuit board.

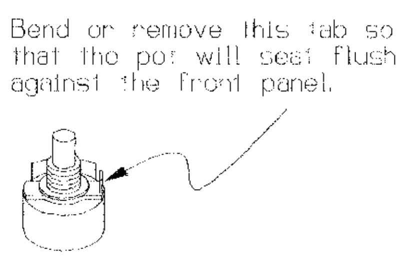
WIRE	PC POINT
Cable #1 (shorter piece)	
( ) black	"B"
( ) red	"C"
( ) drain	"P"
Cable #2 (longer piece)	
( ) black	"J"
( ) red	"K"
( ) drain	"R"

We can now put the circuit board assembly aside while we do some pre-wiring to the front panel controls. This would be a good time to check your work on the circuit board to this point. Make sure polarized components are placed properly and be critical of all your soldering joints.

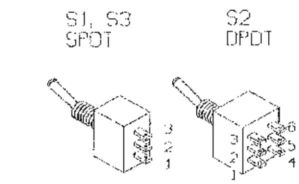
PANEL CONTROLS

If you have the optional Rack Case, controls and connectors mount in it as shown in fig 3. Notice that the Front Panel is attached to the Case Bottom by the same hardware that holds the controls and connectors in place. Since some alignment of Case Bottom and Front Panel may be required during final assembly, do not fully tighten the hardware at this time.

( ) Using the flat washer and nuts supplied, mount the three potentiometers to the rear of the panel as shown in fig 3. Orient the control so the solder lugs are positioned as shown in fig 4. Hand-tighten the nuts so they will be easy to loosen during later alignment of metal parts.

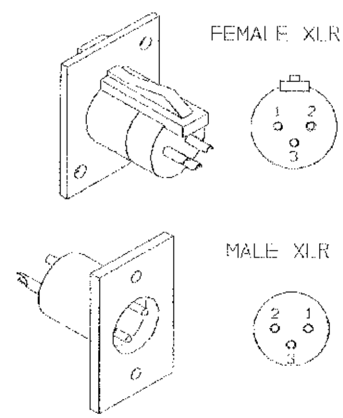


( ) Using the flat washers and nuts provided, mount the three miniature toggle switches S1, S2 and S3 as shown. Note the location of the DPDT Polarity switch S2.



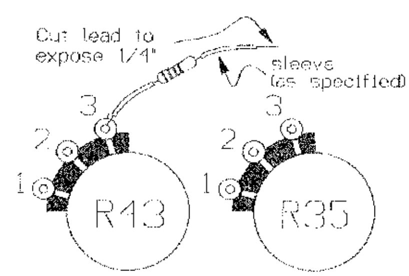
When installing panel components for a second Preamp in the Rack Case there will be no POWER switch S3.

( ) Using the 4-40 X 1/2" Machine Screws and #4 Nuts supplied, mount the Female XLR Mic In connector J3 to the front panel and the Male XLR Bal Out connector J2 to the rear panel.



( ) Using the nuts and washers supplied, mount the 1/4" Phone Jack to the rear apron of the case. Orient the jack so that the solder lugs are easily accessible from the open top of the case as shown.

Four resistors (R34, R40, R41 and R45) mount directly on the lugs of the controls (see fig 4). All four resistors are prepared for installation by slipping a length of sleeving as specified over each lead and cutting each lead so that 1/4" is exposed beyond the end of the insulation.



Note that individual solder lugs are identified by part number and lug number. For example, R43-3 means the lug labeled "3" of the Potentiometer R43.

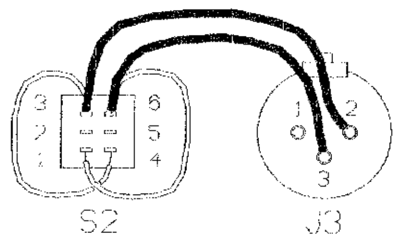
Each connection is followed by either (**s1**), which means to **s**older the **1** wire attached to the lug, or (**ns**), which means DO **n**OT **s**OLDER (later connections will be made to these lugs). You may form a small hook in the end of the resistor lead and crimp it through the solder lug to secure it mechanically. At lug 1 of J3, push the lead into the solder cup.

DES / VALUE / COLOR CODE	FROM	TO	SLEEVE
( ) R34 10k / brown-black-orange	R43-3 (ns)	R35-2 (ns)	1/2"
( ) R40 220 ohm / red-red-brown	R35-1 (s1)	R43-2 (ns)	5/8"
( ) R41 330 ohm / orng-orng-brwn	R42-3 (s1)	R43-2 (ns)	1/2"
( ) R45 10k / brown-black-orange	S1-3 (s1)	J3-1 (ns)	3/4"

Wire the DPDT Polarity Switch (S2) as follows:

These connections are made using two 1-1/2" lengths of bare wire with 1" pieces of the insulated sleeving supplied slid over them

FROM	TO
( ) S2-1 (s1)	S2-6 (ns)
( ) S2-4 (s1)	S2-3 (ns)

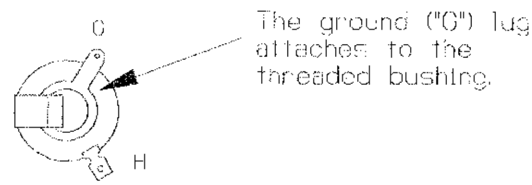


These connections are made using two 3" lengths of stranded wire with 1/4" stripped and tinned ends.

FROM	TO
( ) S2-3 (s2)	J3-2 (s1)
( ) S2-6 (s2)	J3-3 (s1)

( ) Prepare a 3-1/2" length of stranded wire and solder one end to lug #1 of the Bal OUT XLR Connector J2.

( ) Form a small hook in the free end of the wire above and cinch it over lug "G" of the OUTPUT Jack J1.
DO NOT SOLDER THIS CONNECTION.



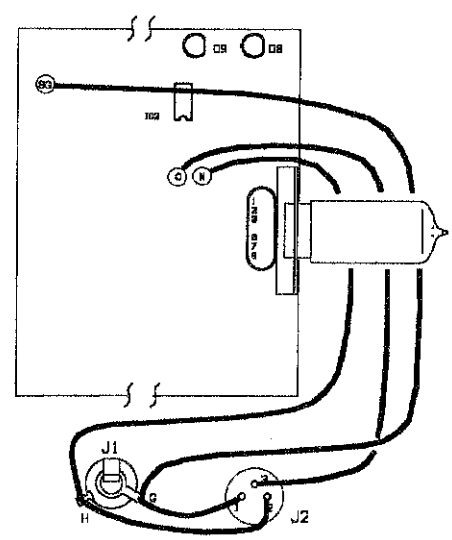
( ) Prepare a 5" length of stranded wire and solder one end to lug #2 of the Bal OUT XLR Connector J2.

( ) Form a small hook in the free end of the wire above and cinch it over lug "H" of the OUTPUT Jack J1.
DO NOT SOLDER THIS CONNECTION.

Now we're ready to begin connecting the ends of wires and cables originating at the circuit board to the panel controls.

These connections should all be soldered as they are made. If there are not the number of wires specified at the lug when you get ready to solder, recheck to see what has gone wrong.

The first connections use the stranded wire



wires from circuit board points "N", "O" and "SG" should be routed under the tube as shown.

ORIGIN	TO
( ) "N"	J1-H (s2)
( ) "O"	J2-3 (s1)
( ) "SG"	J1-G (s2)
( ) "D"	S1-2 (s1)
( ) "E"	S1-1 (s1)

The following connection is made on the FIRST board in a system only.
( ) "A"   S3-1(s1)   if two wires, use shorter.

These connections use the co-ax.

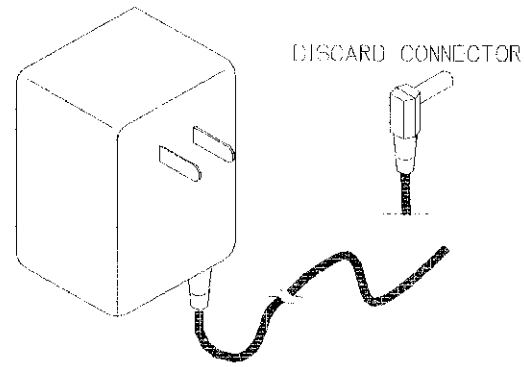
Cable #1
( ) "F" (shield)   R35-3 (s1)
( ) "H" (inner)   R35-2 (s2)
Cable #2
( ) "M" (shield)   R42-1(s1)
( ) "L" (inner)   R42-2 (s1)

These connections use the twin-ax.

Cable #1
( ) "B"(black)   S2-2 (s1)
( ) "C"(red)   S2-5 (s1)
( ) "P"(drain)   J3-1 (s2)
Cable #2
( ) "K" (red)   R43-1 (s1)
( ) "J" (black)   R43-3 (s2)
( ) "R"(drain)   R43-2 (s3)

At this point, the only remaining wiring involves power distribution.
Only one transformer is used for each pair of Tube Mic Pres.
If you are presently assembling the second amplifier, skip to the bold section of the facing page.

Locate the Wall Mount Transformer (PWR1). If this part has a connector on the end of its cable, remove and discard it as shown.



( ) Install the rubber grommet in the power supply cord hole as shown in fig 5. A pen point or small screwdriver may be helpful in deforming the grommet into the hole.

( ) Pass the Transformer cord through the grommet from the outside of the case and put a knot in the cord 11" from the end. Separate the two wires from the loose end back to the knot.

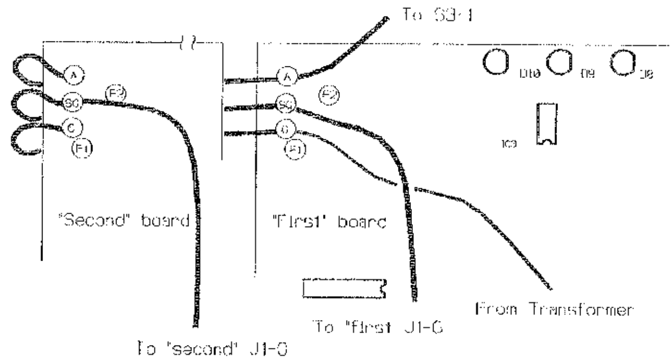
( ) Cut one of the two wires from the transformer to a length of 6" from the end. Strip 3/16" of insulation from ends of both wires and twist and tin the exposed wire strands.

( ) Connect the shorter wire of the Transformer to circuit board point "G" and solder. ***In this step use the smaller of the two holes associated with point "G".***

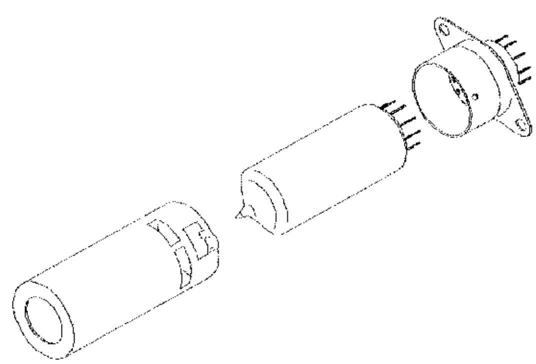
( ) Connect the free wire from the Transformer to lug #2 of the Power Switch S3 and solder.

If you are installing the second Tube Mic Pre in a case, substitute the following wiring for the transformer installation on the facing page. Make the following connections between the two boards using the wires previously soldered to the first board.

ORIGIN	***TO***
( ) "A"	***"A"***
( ) "G"	***"G"***
( ) "SG"	***"SG"***



Route inter-board power and ground wiring under the "second" board.



The Tube fits tightly in its socket. It will be easier to insert it now than when the circuit board is completely installed. Be careful of orientation and cover the tube with its shield to prevent damage during final assembly.

While placing the circuit board in its final position, also align the three LEDs so that they engage the holes provided for them in the Case and Panel. Adjust the relative positions of these parts as necessary.

( ) Mount the circuit board and Tube Mounting Bracket to the case bottom using four 4-40 X 1/2" machine screws, four #4 X 3/16" spacers and four #4 nuts as shown in fig 5. Two of the screws and nuts required in this step are presently being used to secure the Tube Mounting Bracket.

THIS COMPLETES THE ELECTRONIC ASSEMBLY OF THE Tube Mic Pre. Before plugging the unit in and testing it, take a break then come back and check your work completely.

TESTING IT

After rechecking your work, it's time for the all important smoke test. If anything unfortunate is going to happen, this is the most likely time.

Plug the wall-mount transformer into a 120VAC outlet and toggle the TubeHead to "ON." The LED to the right of the Power Switch should light and if it doesn't, you should immediately unplug the unit from the wall and find out why. The problem could be nothing more than a dead wall outlet. Improperly placed components or solder bridges on the circuit board may be the cause. Check the orientation of the Integrated Circuits.

When the LED lights, let the unit idle for a few minutes while you check for parts that may be getting hot (other than the tube, of course) or any unusual smell, smoke, etc. Observe the tube filaments to make sure they're glowing - if not, check solder connections on the tube socket and the twisted pair that connects the filament circuit to the power supply.

Toggle the Phantom Power on and off with the PP ON switch and observe that the Phantom LED goes on and off. The LED indicates the presence of phantom power, not just switch position, so if the LED goes on and off Phantom Power is probably OK.

If nothing seems out of place after a few minutes, plug a mic into the input jack and set up to listen to the output. Set the TUBE DRIVE, BLEND and OUTPUT controls on the front panel and the internal SYMMETRY trimmer on the circuit board to midrange and confirm that there is signal flow through the unit. While speaking or singing, advance the TUBE DRIVE control and observe the Drive LED. At some point the LED should glow as the tube is driven harder. Leaving the tube drive at a high level, BLEND back and forth between pre and post and observe the change in coloration. Use the OUTPUT control to compensate for level variations that accompany driving the tube harder. Change the settings of the controls and observe how each affects the sound.

( ) When you're satisfied that everything is working properly, complete assembly by installing the Case Top as shown in fig 5. Four #4 self-tap screws secure the front edge and side panels of the top. The "L" bracket that fastens the rear edge of the top is attached to the rear apron of the Case Bottom using a #4 X 1/4" Machine Screw and #4 Nut.

USING THE Tube Mic Pre.

While testing the Tube Mic Pre, we've covered some details about what the controls do, but to summarize: the DRIVE level control sets how hard the tube is driven and consequently how much the signal is squashed (see TUBE SOUND? on the following page). The Drive LED gives a quick indication of this by glowing more brightly as the tube begins operating in its nonlinear region.

The BLEND control sets the relative amounts of Clean and Tube sound in the output. With the control fully CCW (the "pre" setting) only the clean signal appears in the output. Turning the control fully CW (to the "post" setting) makes the output consist only of tube sound. You may find that you always work with this control set all the way to "post" and adjust the coloration of the signal with the DRIVE control, but it's also handy to be able to turn down the heat by mixing in a little dry signal.

The final panel control for each channel is OUTPUT level. After setting the coloration of the signal using the DRIVE and BLEND controls, set output LEVEL as needed for best balance and lowest overall noise in the signal path.

The SYMMETRY trimmer is so important it could almost be a front panel control. It's arranged so that at the CounterClockwise end of its rotation the output of the Preamp is approximately symmetrical. Clockwise rotation increases the asymmetry, and as discussed on the following page, this controls the relative amounts of odd and even order harmonics generated. You may feel that the amplifier is "punchier" when SYMMETRY is CCW and "warmer" when this control is CW. You will notice that less DRIVE is needed to light the Drive LED when the control is CW

In addition to warming, the preamp's squashing action makes it useful in many of the places you might use a Compressor or Sustainer. Unlike compressors, which act on the average level of a signal over a relatively long time, the tube's action is on a cycle-by-cycle basis, but with the exception of the more-or-less subtle harmonic distortion that this produces, other effects are very similar. In particular, the average value of the signal stays at a more constant level, adding more sustain and "presence" to the sound being processed.

Tube Sound?

John Simonton

If you've done any reading about tube amps you've probably noticed that much of the legendary "warmth" is attributed to the differences in the way tubes and transistors respond to overload signals. I believe this is true, as far as it goes, but it doesn't tell the whole story. Let me explain.

In the old analog days EVERY link in the signal chain, from tape to vinyl to tubes to transformers, had one interesting common characteristic: When driven to their limits they don't just suddenly splat up against a brick wall and clip, first they gracefully compress the signal.

For lack of a better term I'm going to refer to these compressing nonlinearites at the fringe of the operating range as "squashing", which in the field of Computational Neurodynamics is hip slang for the "S" shaped transfer functions of brain cells. In nerve cells squashing increases dynamic range; but it's even more interesting because without it multi-layer networks of neurons can't do anything that can't be done with a single layer, which isn't much. In a very real way, without squashing we wouldn't have brains at all. But I digress.

In audio, squashing nonlinearities have interesting properties too. In contrast to the strong high order harmonics that result from clipping, the harmonic series produced by squashing falls off rapidly in amplitude at higher frequencies. Another useful thing to know is that when the distorted waveform is asymmetrical, which is to say more squashed on the top or the bottom, the harmonic series will not only be of low order, it will also consist of musically benign even harmonics (octaves and other justly-intoned intervals) while potentially dissonant odd harmonics go away.

One by one these squashing characteristics have been removed. The first improvement was transistors. It's difficult and expensive to make tube circuitry linear, they just really don't want to do it. Individual transistors are no more linear than tubes, but they're cheap so you can afford to use lots of them. One or more can be used in various ways to cancel out the nonlinearities of others without heavy economic or power usage penalties.

Silicon being less expensive than steel, coupling and output transformers were eliminated as higher power transistors and altered circuit topologies evolved to drive speakers directly. Enthusiasts began whispering the heresy that the new super linear SS amps didn't sound quite as good somehow as the old VT space heaters.

The next to go was vinyl, replaced by CDs. The murmuring grew louder. Net surfers began to see apocryphal messages reporting vacuum tube DACs that dramatically improved the sound of CDs. Friends confided to friends that they really preferred their "personal use" (wink, nudge) tape copies of CDs to the CDs themselves.

Analog tape has been the final squashing element to be cleansed as the editing and duplicating advantages of DAT and HD recording have made them the medium of choice among serious artists and engineers. Of course there are the renegades who still insist on going to analog tape for source recording even if they wind up in the digital domain for editing. And those that feed their DATs with Vacuum Tube pre's. Sounds better, they say, warmer, fuller.

What's going on here? You want me to stop all this self indulgent mental masturbation and take a position, don't you? OK, I will: When loafing along within their design envelopes, there is no discernible difference between SS and VT amplifiers. This has been shown again and again in well designed double blind tests. But, when asked to give just a little more than they were designed for, perfectly linear (read SS/digital) gives you garbage every time and squashing sometimes hands you magic.

Can you design a solid state circuit that models squashing? Sure, but this isn't the only difference between VT and SS, only the steady-state one. Common tube designs respond to strong transients with dynamic nonlinearities caused by DC level shifts that are missing in op-amp circuitry. These transient nonlinearities must be duplicated too, because they're responsible for "punch". Your model will get pretty hairy by the time you're done, and it still won't have the neat rosy glow of a filament.

Why does this added complexity sound better to many professional ears? There are a lot of ideas: All natural musical instrument add harmonics when played fortissimo, maybe we expect the signal chain to do the same thing. We've all grown up with at least some of these anomalies of sound reinforcement and recording and perhaps we've learned to expect them.

It's impossible to record and reproduce anything without some artifacts of the process; and if you don't think that a learned preference for an artifact is important start counting the lens flares in photorealistically" rendered computer graphics. Maybe further evolution will select out those cro-magnon types that like tubes, but maybe even when we're able to jack-in direct to our brains the audio part of the experience will be better if it's been run through glass.

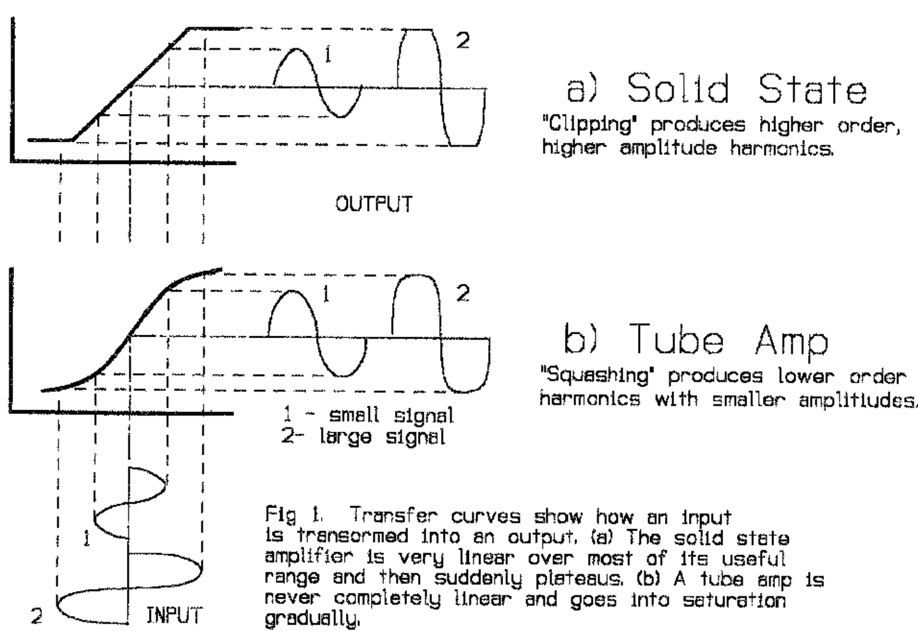


Fig 1. Transfer curves show how an input is transormed into an output. (a) The solid state amplifier is very linear over most of its useful range and then suddenly plateaus. (b) A tube amp is never completely linear and goes into saturation gradually.

Tube Mic Pre Design Analysis

The Tube Microphone Preamp uses several design tricks to produce an extraordinarily versatile, but low cost, tube processor. A unique BLEND control allows continuous panning between a completely linear solid state preamp and tube stages that can be driven hard or soft to get as much or as little tube coloration as desired.

Most tube circuits operate with hundreds of Volts of plate supply voltage, and components for these voltages are often difficult to find and expensive. But the trick that we use to make the tube really SOUND LIKE a tube is to starve it with low plate voltage so we get a big break in component cost and availability. And rather than use a custom multiwinding power transformer, clever design derives all the voltages necessary from a single 12VAC transformer.

The schematic is shown on the facing page. Power from the 12 VAC transformer PWR1 is positive half-wave rectified by D1 and filtered by C1, C2 and R1 for a +15V supply rail. A -15V supply is provided by D2, C3, C4 and R2.

A voltage multiplier produces the 48 Volts for phantom power and tube plate supply. C6, R4 and R5 together with three of the six inverters in IC1 form a 60 kHz., 16V p-p square wave oscillator. Two of the buffers in IC1 are wired in parallel to provide greater output current to drive the network of diodes (D3 - D7) and capacitors (C7-C11) that multiply the 16V square wave up to 48VDC. The phantom power and plate voltage are isolated from one another and filtered with the R/C combinations R7/C12 and R9/C14 respectively. Phantom power to the input XLR connector can be switched on and off with S1. The final buffer in IC1 is used to sense the presence of phantom power and light LED D9 when phantom power is available.

The signal path begins with a differential amplifier (IC2:A, R19, R20, R38 and R39) that converts the balanced input to single ended to drive the tube stages. Phantom power is delivered to the input XLR connector through R25 and R36 and blocked from the amplifier inputs by C19 and C23. Back to back zener diode pairs D12/D13 and D14/D15 prevent stray static charges or transients from damaging the input amp or microphone and zener D16 similarly protects the phantom supply lines. The output of the differential amp appears across the potentiometer R35.

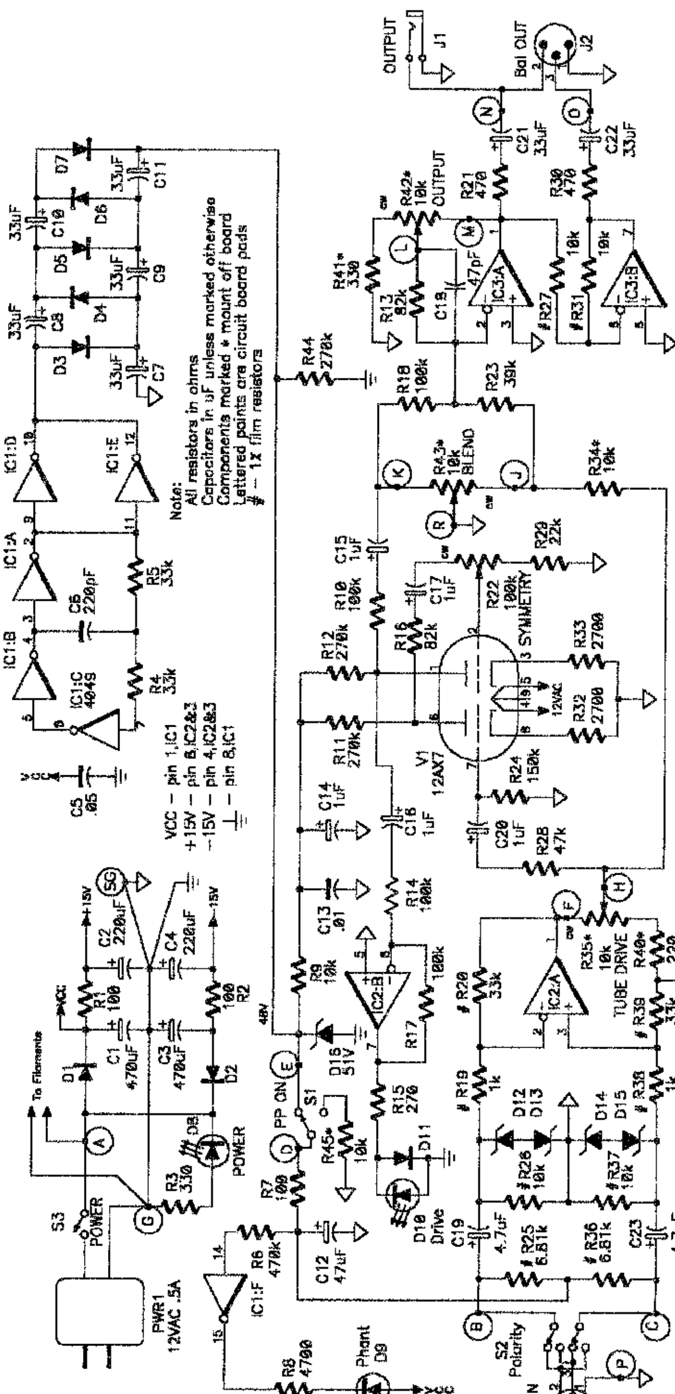
Two tube stages contained within V1, a 12AX7 Dual Triode, are cascaded to provide maximum control of asymmetry and dynamic nonlinearities on strong transients. The diff. amp output at the wiper of the TUBE DRIVE control R35 is coupled by R28 and C20 to the grid resistor of the first tube stage, R24. The output of this stage appears across the plate load resistor R11 and is coupled by R16 and C17 to the SYMMETRY trimmer R22, which sets the amount of signal applied to the grid of the second stage. The output of the second stage appears across plate load resistor R12.

The IC2:B opamp monitors the output of the tube by way of C16 and R14 and lights Drive LED D10 to visually indicate how hard the tube is working. Diode D11 provides a dummy load to equalize the current drawn from the amp on positive and negative half-cycles.

A final output buffer stage built around opamp IC3:A converts the relatively high impedance output of the tubes to a more reasonable lower impedance consistent with contemporary audio gear and provides the in-phase leg of the balanced output. The out-of-phase leg is supplied by the simple inverter consisting of IC3:B and resistors R27 and R31.

The IC3:A amp also allows mixing of the dry (pre-tube) signal with post-tube processed signal using the BLEND pot R43. At the CW end of the rotation of this control the final amplifier is fed exclusively with the output of the tube and at the CCW end it's fed by the output of the diff. amp. Intermediate settings mix the two.

Finally, IC3:A provides variable gain to compensate for how hard or soft the tube is being driven and to bring the final output up to line levels. The OUTPUT control, R42, in combination with R13 and R41 sets the amount of feedback for the stage and consequently its gain. Capacitor C18 rolls off the high frequency response at a corner frequency of about 30 kHz.



Tube Microphone Preamp

Packing list 95.4.4

Tube, Semiconductors:

1	12AX7 Vacuum Tube	V1
1	4049 CMOS Hex Inverter	IC1
2	5532 Dual Low Noise OpAmp	IC2,IC3
2	1N4001 Power Diodes	D1,D2
6	1N4148 Signal Diodes	D3-D7,D11
3	Red LED	D8, D9, D10
4	6.8V Zener Diodes	D12-D15
1	51V Zener Diode	D16

Capacitors, Ceramic disks:

1	.01 uF	C13
1	.05 uF	C5
1	220 pF	C6
1	47 pF	C18

Capacitors, Electrolytic:

5	1 uF 50V	C14-C17, C20
2	220 uF 25V	C2,C4
7	33uF 16V	C7-C11, C21,C22
2	470uF 25V	C1,C3
1	47uF 50V	C12

Capacitors, Tantalum:

2	4.7uF 50V	C19,C23

Potentiometers:

1	100k Ohm Trimmer	R22
3	10k Ohm Panel Mount	R35*,R42*, R43*

Resistors, 1/4W 5%; values in ohms:

3	100	brown-black-brown	R1,R2,R7
4	100k	brown-black-yellow	R10,R14, R17, R18
3	10K	brown-black-orange	R9,R34*, R45*
1	150k	brown-green-yellow	R24
1	220	red-red-brown	R40*
1	22k	red-red-orange	R29
1	270	red-violet-brown	R15
2	2700	red-violet-red	R32,R33
3	270k	red-violet-yellow	R11,R12 R44
2	330	orange-orange-brown	R3,R41*
2	33k	orange-orange-orange	R4,R5
1	39k	orange-white-orange	R23
2	470	yellow-violet-brown	R21,R30
1	4700	yellow-violet-red	R8
1	47k	yellow-violet-orange	R28
1	470k	yellow-violet-yellow	R6
2	82k	grey-red-orange	R13,R16

Resistors, 1/4W 1% film; values in ohms:

2	1k	brown-black-black-brown	R19,R38
4	10k	brown-black-black-red	R26,R27, R31,R37
2	33k	orange-orange-black-red	R20,R39
2	6.81k	blue-grey-brown-brown	R25,R36

Switches, connectors, etc:

1	SPDT Miniature Toggle Switch	S1
1	DPDT Miniature Toggle Switch	S2
1	1/4" Open Circuit Phone Jack	J1
1	Panel Mount Male XLR Conn.	J2
1	Panel Mount Fml XLR Conn.	J3

Other stuff:

1	9407pc Circuit Board
3	Set Screw Knobs
1	9 pin Miniature Tube Socket
1	Tube Mounting Bracket
3	36" lengths #22 Stranded Wire
1	14" length Small Diameter Tubing
1	18" length small bare wire
1	11" length RG-174/U Co-ax Cable
1	11" length Belden 9501 Twin-ax Cable
10	#4 Machine Nuts
8	4-40 X 1/2" Machine Screws
2	4-40 X 1/4" Machine Screws
4	#4 X 3/16" Spacers

WITH FIRST AMP

1	12VAC 500 mA Wall Transformer	PWR1
1	SPDT Miniature Toggle Switch	S3
1	1/4" Rubber Grommet	

9407 CASE (optional)

1	9407 Rack Panel
1	9407 Case Bottom
1	9407 Case Top
2	#4 Machine Nuts
4	4-40 X 1/4" Machine Screws
4	#4 X 1/4" Self-tap Screws
2	#4 "L" Brackets

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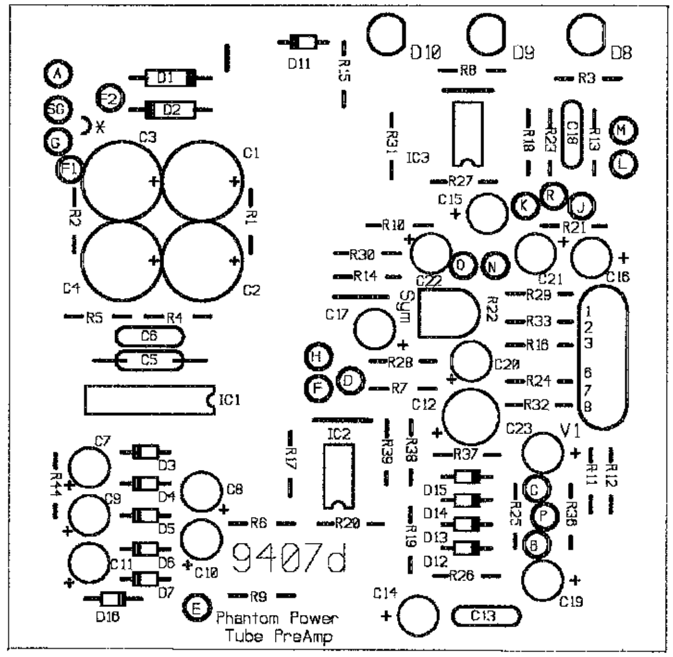
Fig 1a. Components mount on the circuit board at the locations shown in this parts placement diagram.



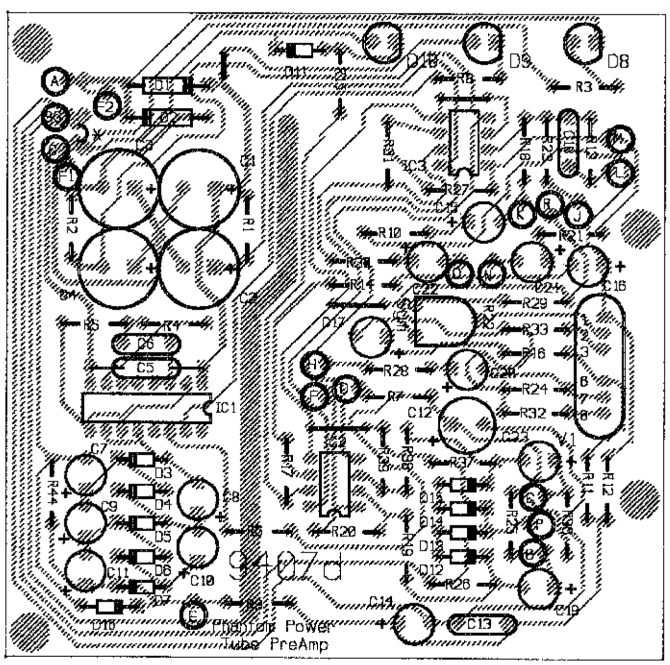


Fig 1b. This phantom view of the circuit board traces will be useful if you need to trace out the circuit.

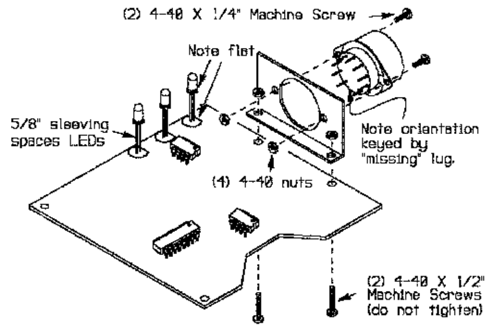


Fig 2. lengths of sleeving slipped over one of the leads properly spaces the LEDs to engage panel holes when the circuit board is installed in the case. The 1/2" long Screws which mount the tube bracket will mount the circuit board in the case in later steps.

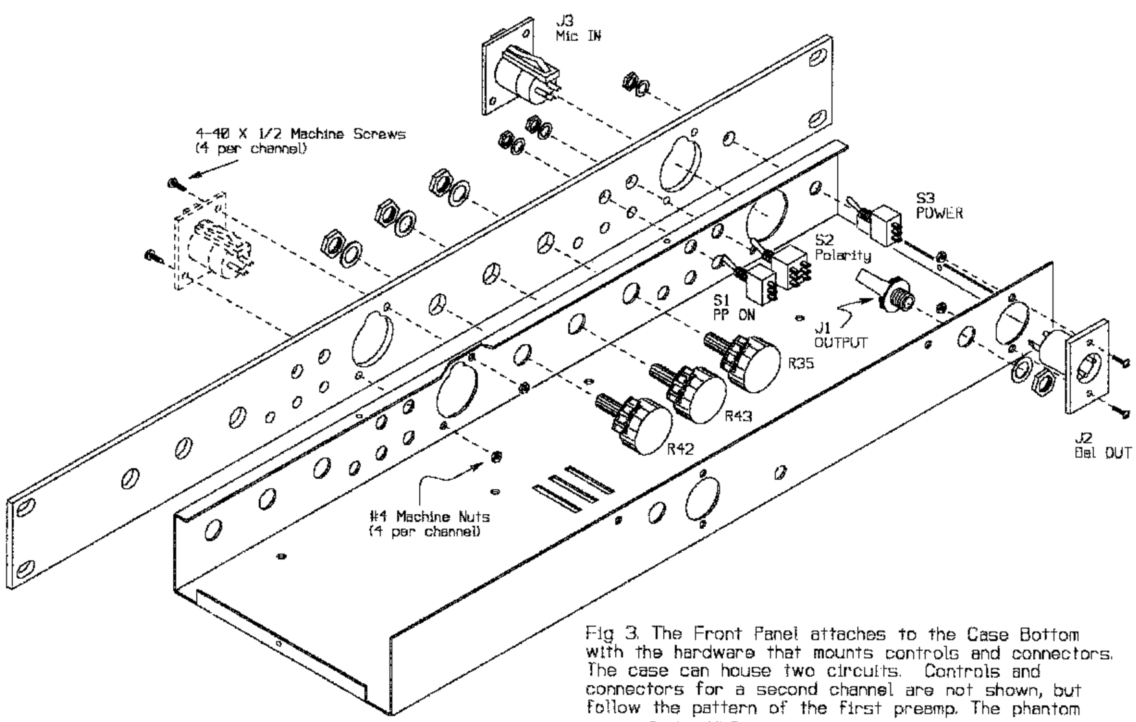


Fig 3. The Front Panel attaches to the Case Bottom with the hardware that mounts controls and connectors. The case can house two circuits. Controls and connectors for a second channel are not shown, but follow the pattern of the first preamp. The phantom view of the XLR connector illustrates hardware usage.

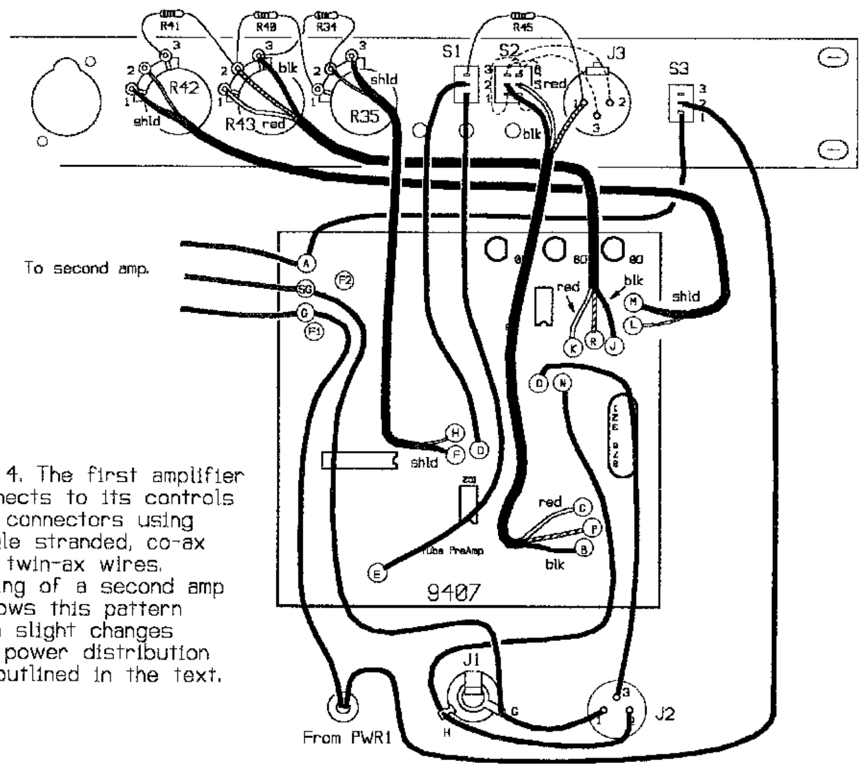


Fig 4. The first amplifier connects to its controls and connectors using single stranded, co-ax and twin-ax wires. Wiring of a second amp follows this pattern with slight changes for power distribution as outlined in the text.

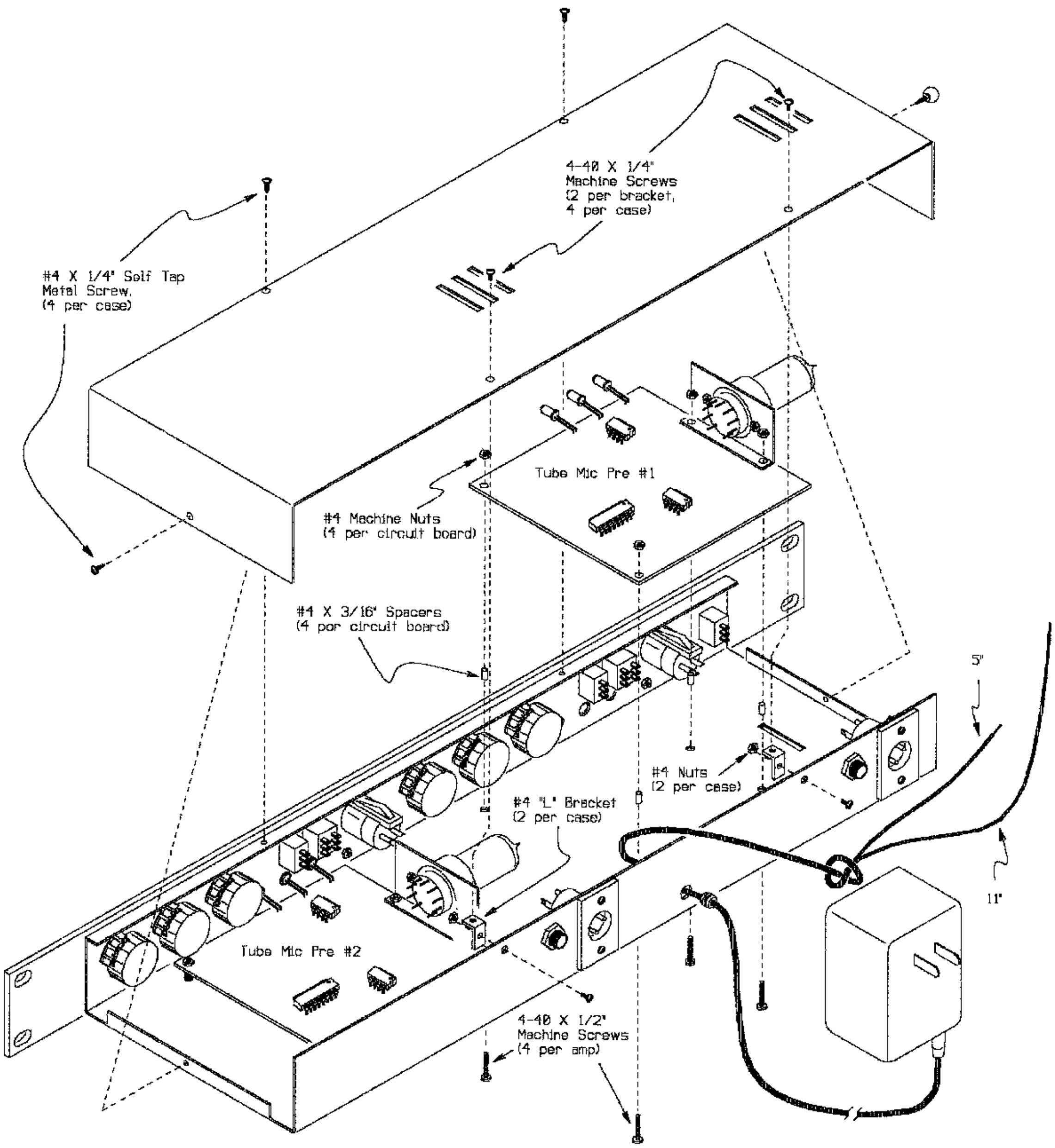


Fig 5. Circuit boards are mounted on 3/16 spacers and LEDs are bent over to engage their front panel holes. Both self tap and machine screws are used to secure the top.