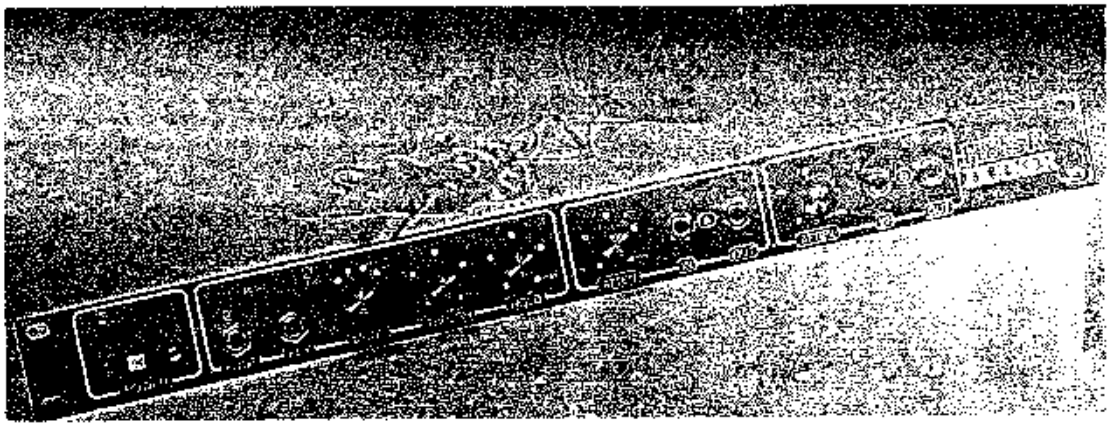
PAiA Electronics, Inc.

DUCKER +

MODEL NO 9280

ASSEMBLY & USING MANUAL



If you've ever mixed stereo music and a narration track, you know that lowering the music level each time the narration comes on and then raising it again when the Voice-Over ends is tricky to do manually. A DUCKER makes it easy.

A DUCKER automatically controls the amplitude of one signal in response to the presence of another signal. "Program" channels, such as stereo music tracks can be automatically "ducked" (decreased in level) when a "key" signal (the narration) is present.

The PAiA DUCKER+ provides features not usually found on these devices. For example, the program inputs and outputs can be processed either as a stereo pair or independently. The unit provides either Ducking and Gating (increasing the program level when the key is present) and you can Gate one channel while Ducking the other for automatic pan effects. A front panel foot switch jack gives hands-free manual control.

ASSEMBLING THE DUCKER+

Before beginning assembly, go through the manual. Look at the drawings. Feel the parts. We know that you're anxious 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:

() 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. This page may be removed for easy reference during assembly.

THE CIRCUIT BOARD

The DUCKER+ 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 must be bright and shiny before beginning assembly.

Once you begin putting parts on the circuit board, it's a good idea not to stop until all the parts are mounted. Stopping overnight may allow the copper to oxidize and making 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.

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This product originated as a Do-It-Yourself article by Randy Morter *in* Home & Studio Recording *magazine. There may be some differences between what appeared in the article and what is supplied with the kit. These differences, and any discussion of them, will be set aside with this italicized type.*

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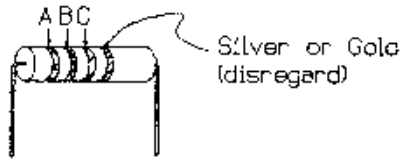
RESISTORS

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 provided. Before mounting each resistor, bend its leads so that they are at a right angle to the body of the part. Put the lead 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.



DESIGNATION	VALUE	COLOR CODE A-B-C
( ) R2	1500 ohm	brown-green-red
( ) R3	10k	brown-black-orange
( ) R4	330 ohm	orange-orange-brown
( ) R5	100k	brown-black-yellow
( ) R6	22k	red-red-orange
( ) R8	10k	brown-black-orange
( ) R9	330k	orange-orange-yellow
( ) R10	3300 ohm	orange-orange-red
( ) R12	3300 ohm	orange-orange-red
( ) R13	10k	brown-black-orange
( ) R14	1500 ohm	brown-green-red
( ) R15	100k	brown-black-yellow
( ) R16	470 ohm	yellow-violet-brown
( ) R17	3300 ohm	orange-orange-red
( ) R19	470 ohm	yellow-violet-brown
( ) R20	3300 ohm	orange-orange-red
( ) R21	100k	brown-black-yellow
( ) R22	330k	orange-orange-yellow

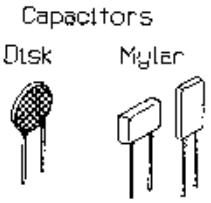
CERAMIC DISK AND MYLAR CAPACITORS

Two of the capacitors used in the DUCKER+ are nonpolarized ceramic disk and Mylar types, either lead can go in either of the holes on the circuit board. Leads are already parallel to each other 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 rarely marked with something so simple as their values these days; instead component manufacturers prefer obscure codes. Since there is only one ceramic disk and one Mylar capacitor used in the **DUCKER+**, this should not be a problem.

DESIGNATION	VALUE/TYPE		MARKING
() C2	.01	ceramic	103
() C10	.1	Mylar	104



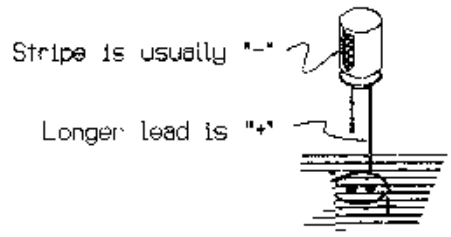
ELECTROLYTIC CAPACITORS

The remaining capacitors 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	10 uF / 15V.
listed below: () C3 () C4 () C5 () C6 () C7	100 uF / 15V.
listed below: () C8 () C9	1 uF / 15V



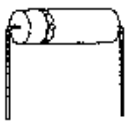
DIODES

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.

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

DESIGNATION	TYPE
() D3	1N914 or 1N4148

Note colored band



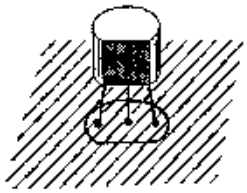
JUMPERS

() Using the excess leads clipped from resistors, form and install the two circuit board jumpers which are designated by bold lines. Be careful that the jumpers do not touch nearby component leads.

FETs

Install the two MPF102 Junction Field Effect Transistors (J-FETs) being careful that they are oriented according to the placement designators printed on the circuit board. On each transistor, solder all three leads and clip the excess of flush with the solder joint.

DESIGNATION	TYPE
() Q1	MPF102
() Q2	MPF102



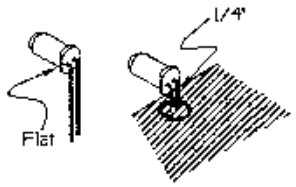
LEDs

Prepare the two red LEDs for installation by bending their leads perpendicular to the body of the part as shown in the illustration below. Note that LEDs are polarized and that when viewed from the back with the leads down, the polarization flat must be to the left, as shown.

Push the two leads through the holes provided in the circuit board and space the LED above the board so that 1/4" of the lead is on the component side

of the board. If you look carefully at the LEDs you will notice that there is a "shoulder" on the leads where they meet the part. 1/4" is about the length of this shoulder. Solder both leads and check the spacing from the board to the LED before trimming the leads of flush with the solder joint.

DESIGNATION	PART
() D1	red LED
() D2	red LED



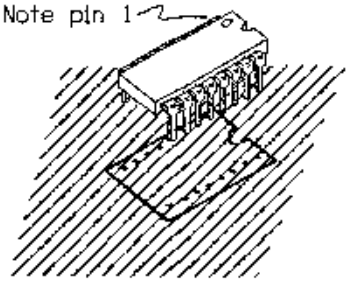
INTEGRATED CIRCUITS

Of all the parts, the ICs are the most easily damaged and should be treated with some respect. In particular, they may be damaged 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 IC.

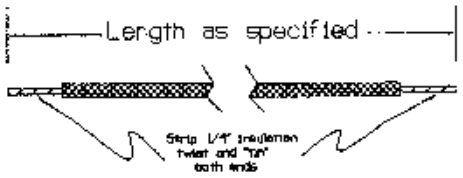
The pins of the ICs may be splayed and not match exactly the holes they're to go through. Carefully re-form the leads if necessary so that they are at right angles to the part.

DESIGNATOR	PART NO.	DESCRIPTION
() IC1	339/ 3302	quad comparator
() IC2	555	timer



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

In the following steps, wires will be soldered to the DUCKER+ circuit board which in later steps will be connected to the front panel controls and phone jacks. At each step, cut a piece of wire to the specified length and strip 1/4" of the insulation from each end. Twist the exposed wire strands together and "tin" them by melting a small amount of 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 the holes.



Notice that there will be some circuit board points that will not have wires connected to them until later.

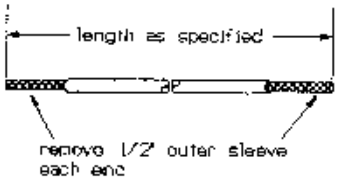
Solder each connection as it is made and clip any excess wire from the solder side of the board.

PC POINT/Length			PC POINT/Length		
( ) "A"	/	6"	( ) "G2"	/	13-1/2"
( ) "B"	/	9"	( ) "P"	/	6"
( ) "C"	/	10"	( ) "R"	/	6"
( ) "D"	/	9-3/4"	( ) "S"	/	6"
( ) "E"	/	9-3/4"	( ) "T"	/	6"
( ) "F"	/	8-1/2"	( ) "U"	/	8-1/2"
( ) "G"	/	6"	( ) "+"	/	6"

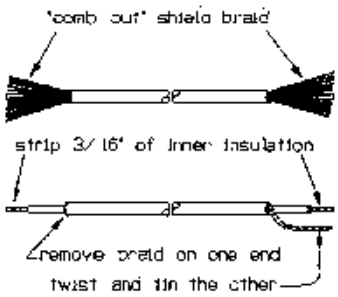
SHIELDED CABLE

RG-174/U coaxial cable will be used to make shielded connections between the circuit board and input/output jacks. Each piece of co-ax should be prepared in the same way:

Cut a section of co-ax to the length specified and 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 ballpoint pen. This will expose the separately insulated inner conductor.



On one end cut the strands of the shield off even with the outer sleeve. On the other end, pull the strands of the shield to one side and twist them together. Tin this pigtail by melting a small amount of solder into it.

Strip about 3/16" of the insulation from the inner conductor and twist and tin the exposed strands.

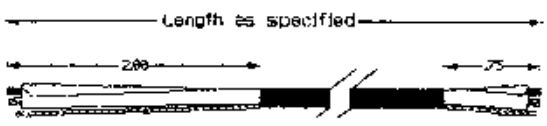
Using the specified lengths of co-ax prepared as above, solder the inner conductor of the end with the shield entirely removed to the circuit board points listed on the opposite page.

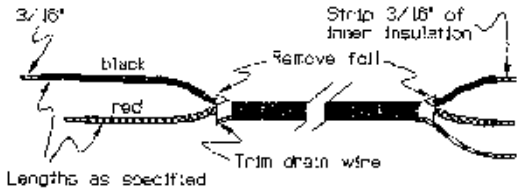
PC POINT/Length	PC POINT/Length
() "K" / 10-1/2"	() "N" / 15"
() "L" / 11-1/2"	() "O" / 13-1/2

TWIN-AXIAL CABLE

Belden 9501 twin-ax will be used to make shielded connections between the circuit board and the ATTENuator pots. Cut a length of the cable as specified in the steps and prepare the ends as follows:

On one end of the cable, remove 3/4" of the outer insulating sleeve. On the other end, remove 2" of the sleeve. On each end cut off the exposed foil layer flush with the outer insulation.





On the shorter end, strip 3/16" inch of insulation from both the red and black leads. Twist and tin the expose wire strands. Tin about 1/4" of the drain wire

On the longer end, clip the drain wire off flush with the outer insulation. Do not cut the red and black wires until given the length in the step. The length given for the wires is measured from the end of the outer sleeve. See Fig 3.

CABLE LENGTH	WIRE Color/length	PC point
() 11-1/4"	red / 2" (no cut)	"H"
()	black / 3/4"	"J"
() 14-1/2"	red / 1-3/4"	"I"
()	black / 3/4"	"M"

Now we will put the circuit board aside temporarily and mount the jacks and controls on the front panel.

PANEL CONTROLS

If you have the optional panel available from PAiA, you will be installing these parts as shown in Fig 2. Note that this figure shows the panel from the rear.

() Using the flat washers and nuts provided, mount the 4 potentiometers as shown in Fig 2. Note that a 1 megohm pot is used for R1, 5k ohms for R7 and 100k for R11 and R18, Orient the pots as shown in Fig 3 and fully tighten the nuts to secure these parts.

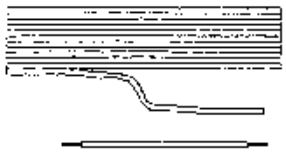
() In a similar manner mount the 6 open circuits jacks J1-J6. Orient as shown in Fig 3 and tighten the hardware.

() In a similar manner mount the 4 position 2 pole rotary switch S2 and orient as shown in Fig 3.

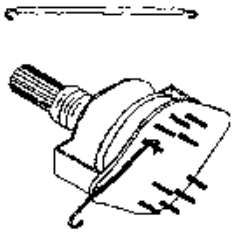
() Using the 4-40 X 3/4" and one of the 4-40 X 1/4" machine screws, two #4 nuts, and two #4 flatwashers, mount the DPDT slide switch and cable clamp as shown in Fig 2. Fully tighten the hardware.

PANEL WIRING

Remove wires from ribbon cable provided.



Cut to length specified
Strip 1/4" of insulation
each end. Tin wire strands.
Form hooks in tinned ends



Crimp hook over pin.
DO NOT SOLDER until
instructed to do so.

The first front panel wiring we'll do is pre-wiring of pins of the MODE switch S2. These connections will use wires from the 2" length of ribbon cable supplied. Prepare the wires as shown. At each step crimp the hook in the end of the wire over the solder pin. DO NOT SOLDER the connection if the step is followed by the instruction (NS), for No Solder. If the connection is to be soldered, the number of wires that should appear at the joint will be part of the step, e.g. (S-3) meaning that there will be 3 wires at the lug being soldered. This convention will be followed throughout this manual.

FROM PIN#	TO PIN#	WIRE LENGTH
() 3 (S-1)	1 (NS)	1"
() 1 (S-2)	8 (NS)	2"
() 2 (S-1)	6 (NS)	1-1/4"
() 6 (S-2)	7 (NS)	3/4"

Continue wiring the front panel using the #22 stranded hook-up wire provided. At each step cut the wire to the length specified, strip 3/16" of insulation and tin each end.

Many of these connections will not be soldered immediately, so for now simply push the end of the wire through the lug and crimp it back to mechanically secure it. See Fig 3 for details

FROM	TO	LENGTH
() J4-G (NS)	J5-G (NS)	1-1/2"
() J5-G (NS)	J3-G (NS)	3-1/4"
() J3-G (NS)	J2-G (NS)	1-1/2"
() R18-3 (NS)	R11-3 (NS)	4-1/4"
() R7-3 (S-1)	J1-G (NS)	2-3/4"
() J1-G (S-2)	J6-G (NS)	1-3/4"

() Connect the 10k ohm fixed resistor R23 (brown-black-orange) between lugs 1 (NS) and 2 (S-1) of potentiometer R1.

The circuit board should now be mounted to the rear of the front panel as shown in Fig 4.

() Using the (2) "L" brackets, (2) #4 nuts and (4) 4-40 X 1/4" machine screws provided, attach the partially wired circuit board to the rear of the rack panel as shown in Fig 4. Notice that the "L" brackets have both threaded and unthreaded holes. Use the unthreaded holes and machine nuts to attach the bracket to the circuit board and the threaded holes to attach the bracket to the panel. Notice that the LEDs protrude through their respective holes in the panel.

We can now continue wiring to the front panel using the wires previously soldered to the circuit board, starting with the twin-ax as shown in Fig 3.

	ORIGIN	WIRE	TO
()	"I/M"	black	R18-1 (S-1)
()	"	red	R18-2 (S-1)
()	"	drain	R18-3 (S-2)
()	"H/J"	black	R11-1 (S-1)
()	"	red	R11-2 (S-1)
()	"	drain	R11-3 (NS)

The following connections are made using the center and shield conductors of the 4 co-ax sections. See Fig 5.

	ORIGIN	WIRE	TO
()	"O"	shield	J5-G (S-2)
()	"	center	J5-H (S-1)
()	"N"	shield	J4-G (S-2)
()	"	center	J4-H (S-1)
()	"K"	shield	J2-G (NS) - no solder
()	"	center	J2-H (S-1)
()	"L"	shield	J3-G (S-2)
()	"	center	J3-H (S-1)

And finally the connections using the #22 hook-up wire. See Fig 6.

	ORIGIN	TO
()	"F"	R11-3 (S-3)
()	"E"	R1-3 (S-1)

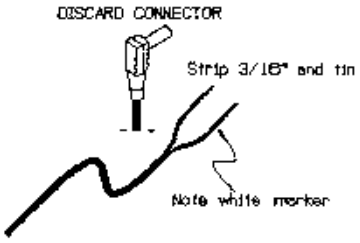
ORIGIN	TO
() "D"	R1-1 (S-2)
() "C"	R7-2 (S-1)
() "B"	R7-1 (S-1)
() "G2"	J2-G (S-3)

Reference Fig 7 for the following steps.

() "T"	S2-5 (S-1)
() "R"	S2-10 (S-1)
() "U"	J6-H (S-1)
() "P"	S2-7 (S-2)
() "S"	S2-8 (S-2)
() "A"	J1-H (S-1)
() "+"	S1-3 (S-1)
() "G"	J6-G (NS) no solder

POWER SUPPLY

The final connections are made using the wires from the wall-mount power supply PWR1. If this part has a connector on the end of its cable, remove and discard it as shown. Separate the two wires and strip 3/16" of insulation from the ends. Twist and tin the exposed wire strands.



() Loop the cord from the power supply through the cable clamp attached to power switch S1. Connect the wire with the colored stripe to J6-G (S-3). See Fig 8.

() Connect the unmarked wire from the power supply to S1-2 (S-1).

() Install the knobs. Rotate the shaft of the control on which the knob will be placed fully CCW and align the pointer with the marking at the extreme counterclockwise end of the dial. Push the knob on only slightly and rotate it back and forth to see how well it's range of rotation is balance with the panel graphic. Reorient if not satisfied and then push the knob firmly in place on the shaft.

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

TESTING AND USING 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 power supply into a 120-VAC outlet and slide the DUCKER+ power switch to "ON." The LED above the 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. Reversed power connections or solder bridges on the circuit board may be the cause. Check the orientation of the Integrated Circuits.

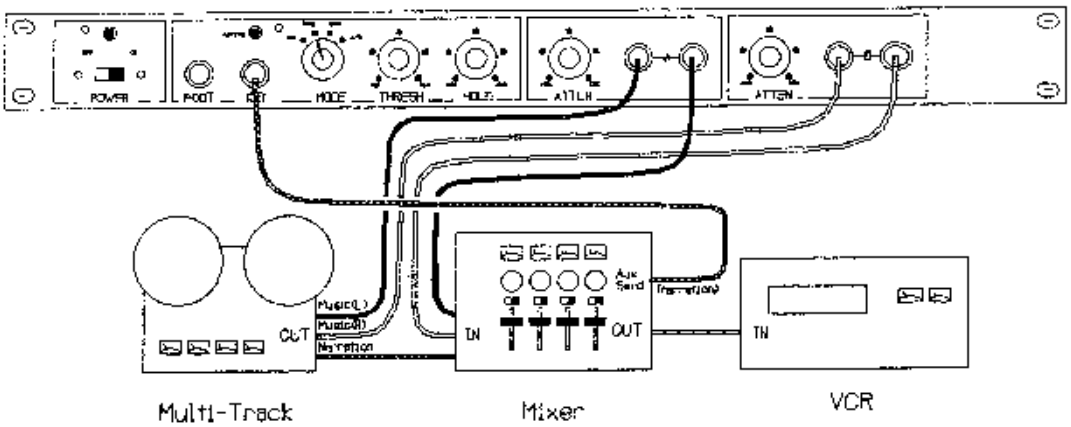
When the LED lights. Let the unit idle for a few minutes while you check for parts that may be getting hot (IC1 or IC2 in particular) or any unusual smell, smoke, etc.

If nothing seems out of place after a few minutes, do a quick initial test of the DUCKER+. Rotate the THRESHold control R7 fully ClockWise (CW) and use a short piece of wire or test lead to short between the "H" and "G" lugs of the FOOT jack J6. The ACTIVE LED should turn on when these lugs are shorted and extinguish some time after the connection is removed.

The time between the removal of the short and the LED going out should be adjustable with the HOLD control R1. At the CounterClockWise (CCW) extreme of its rotation the holding time should be none-at-all and at the other end, much longer than you think you'll ever need (10 seconds or so.) If these things are not happening correctly it may indicate a problem in the circuitry around the 555 timer IC2. Things like soldering, polarity of D3, D2 and C1 and connections to the foot jack should all be checked.

DUCKING

A typical configuration for a DUCKER+, mixer, multitrack and video deck appears on the facing page. As shown, the stereo music tracks are fed into the DUCKER+ channel A and B INputs, and the DUCKER+ channel A and B OUTputs go to mixer inputs. The narration track output from the multitrack is fed directly to the mixer, with an auxiliary send from the mixer going into the DUCKER+ KEY input. Finally, the mixer output feeds the video deck inputs.



A typical DUCKER configuration may also include a Multi-track recorder, Mixer and VCR.

Set the MODE switch to the BYPASS position and set the THRESHold, HOLD and both ATTENuator controls fully CCW. Start the multitrack and adjust the narration track on the mixer as desired. Set the AUX send level feeding the DUCKER+ KEY input to its maximum level and adjust the DUCKER+ THRESHold control so that the ACTIVE indicator LED lights when the narration is present but goes off when the narration is silent. Some adjustment of the AUX level on the mixer may also be needed to get a proper trigger action. If you can't get the unit to trigger properly on the KEY signal, it may indicate problems in the circuitry associated with IC1:A or the wiring to the jack J1 or THRESH control R7.

Adjust the HOLD control to keep the circuit active during the silent pauses between words and paragraphs in the narration. Set the nonducked music level as desired on the mixer. Switch the MODE to DUCK and adjust the A and B ATTENuator controls for the desired gain reduction when narration is present. Play your multitrack again from beginning to end to verify that the levels are where you want them, and then you're ready to lay down the master video sound track!

GATING

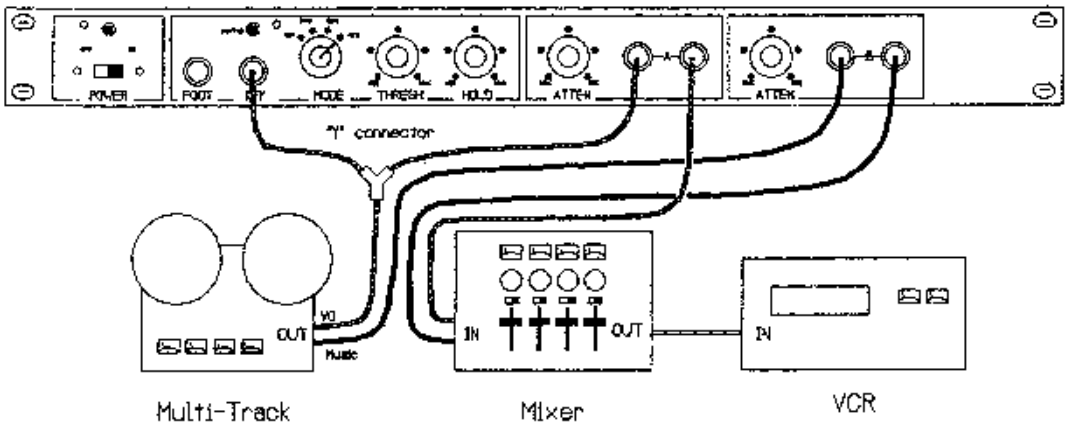
The DUCKER+ also provides a GATE mode which allows the Channel A and B signals to pass through at full volume when a Key signal is present and reduces their level when the Key falls below the THRESHold - the opposite of the DUCK mode. This function can

be used as a noise gate or for simple gated reverbs. It's also useful for tricks like gating a synth tone to put an edge on a kick drum or sonically synchronizing a bass and kick by gating one with the other.

For gating, feed in the KEY signal and set MODE to BYPASS. Adjust the THRESHold and HOLD controls so that the ACTIVE LED is on during the times that you want the GATE to be on. Adjust the mixer levels of the signals coming from the DUCKER+ channels A and B outputs for their maximum level. Switch the MODE to GATE and set the DUCKER+ ATTENuator controls for the desired gain reduction when the key signal is quiet. Normally, this will be the MAX attenuation setting to completely block the program when the gate is off.

A/B TOGGLE MODE

In this mode the Ducker+ is acting like a two-position audio switch. Channel A GATEs while channel B DUCKs. In the figure below, this mode is used to gate a narration track to prevent it contributing any noise to the final mix and duck a mono music track to make space for the narration. In this setup, Channel A ATTENuator should be set to max and Channel B ATTEN set for the amount of ducking desired.



This configuration noise-gates the voice-over while ducking the mono music track.

For video sequences that have repetitive cuts between two scenes, the A/B MODE can be used to switch back and forth between two different sound effect tracks. Since there may not be a distinct KEY signal to use, a footswitch may be the way to control switching.

FOOT SWITCH INPUT

The FOOT switch input is particularly useful when A/B switching; for example, to switch a guitar between two processing or effects chains. In the foot switch, the contacts close between the tip and ground lugs of a 1/4" mono phone plug. Either momentary or push-on/push-off switches can be used and of course you don't have to operate them with your feet.

Many synchronizing devices have outputs that simulate the action of a switch and these can be used with the Ducker+'s FOOT switch input to synchronize it to SMPTE addresses or MIDI data steams.

HOW IT WORKS

The Ducker+ electronics consists of three major sections; a *comparator* that senses when a key signal exceeds a settable threshold, a *timer* that keeps the circuit activated during pauses in narration or short quiet sections in the keying source and a pair of variable audio *attenuators* which can be switched on and off electrically.

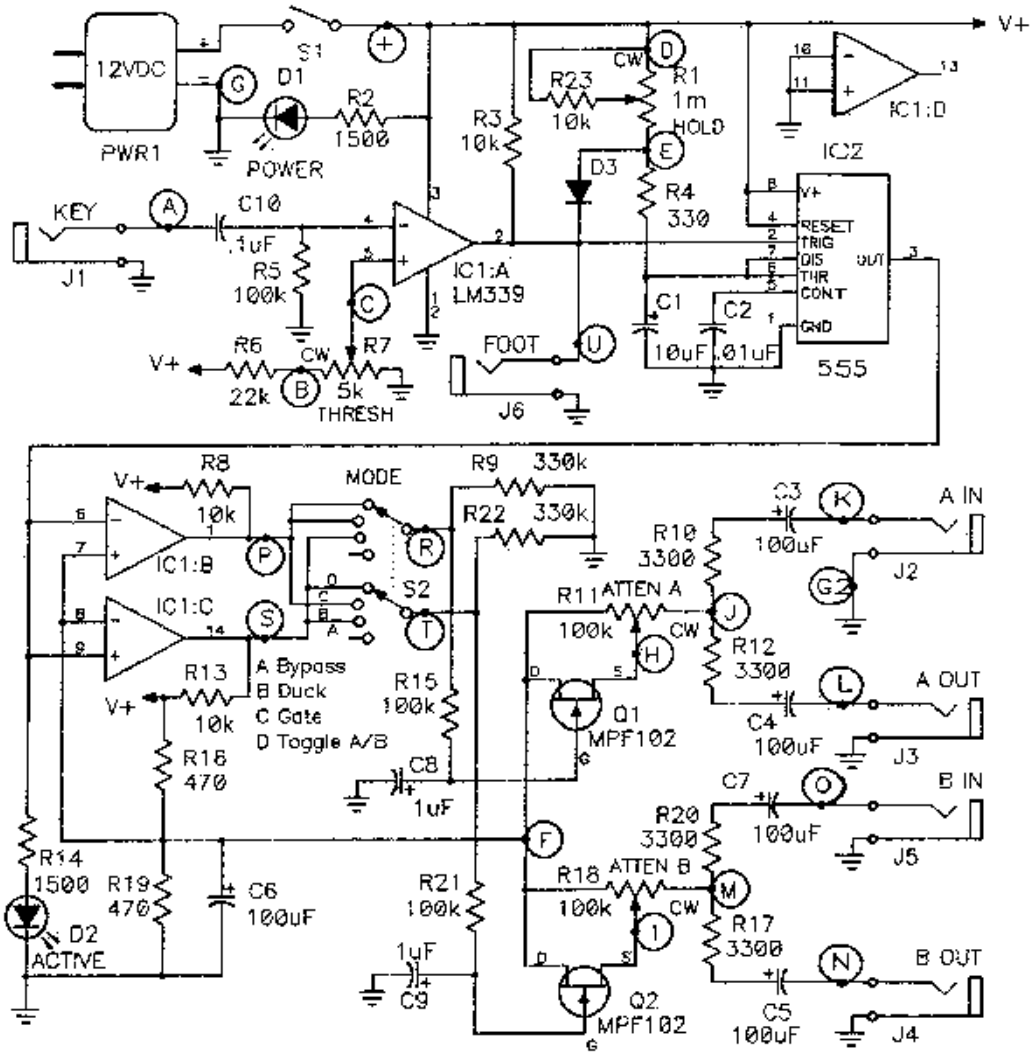
In IC1:a, one of four identical comparators in an LM339, the signal from the KEY input is compared to the voltage set by the THRESHOLD control R7. When the keying signal exceeds this threshold, the output of the comparator (pin 2) changes state from a high voltage to a low voltage and this starts the timer IC2, a 555 type.

Once the timer is triggered, capacitor C1 begins to charge at a rate determined by the setting of the HOLD control, R1. The timer will remain on until this capacitor charges to a preset voltage and then resets itself. Diode D3 is added to the circuit so that the output of the KEY comparator discharges the capacitor every time a cycle in the input signal exceeds the threshold, assuring that the time-out period will not start until there is a quiet space in the KEY signal.

When the timer starts, it's output (pin 3) goes high turning on the ACTIVE indicator Light Emitting Diode D2. This output also connects to two of the remaining comparator stages in IC1. IC1:c is arranged to be non-inverting and simply buffers the output of the timer to provide a *ducking* control signal that is high when a KEY is present and low when the KEY is quiet. IC1:b also provides buffering but is configured as an inverter; its output is a *gating* control that is low when keyed and high when quiet. The double section, 4 position switch S2 is wired to route these ducking and gating signals to the appropriate switchable attenuator.

The two attenuators are identical and use MPF102 J-FET transistors (Q1 and Q2) as switches. Taking the circuitry around Q1 as typical and assuming that A1 is being used as an input, R10 and the ATTENuation control R11 form a voltage divider in the signal path. When the voltage on the gate of Q1 is low, it is turned off and effectively removed from the circuit so that there is negligible attenuation from the R10/R11 voltage divider. When the gate voltage is taken high, Q1 switches on and

shorts out a section of R11. How much of R11 is shorted out, and consequently the amount of signal reduction, is dependent on the setting of this control.



DUCKER+
PACKING LIST

1	10 uF 15v. electrolytic capacitor
5	100 uF " " "
2	1 uF " " "
1	.01 uF ceramic disk capacitor
1	.1 uF mylar capacitor
2	RED LED
1	1N4148 or 1N914 silicon diode
2	MPF102 JFET
1	LM339 Quad Comparator IC
1	LM555 Timer IC
6	1/4" Phone Jacks (w/washers/nuts)
1	12VDC 100 mA. Wall-Mount power supply
1	DPDT Switch
1	2P4T rotary switch
1	1 megOhm potentiometer (w/washers/nuts)
1	5k Ohm " (w/washers/nuts)
2	100k Ohm " (w/washers/nuts)
2	1500 all fixed resistor 1/4w 5%
4	10k Values in Ohms
1	330
3	100k
1	22k
2	330k
4	3300
2	470
2	"L" brackets
1	#4 X 5/16" standoff
2	#4 flat washers
5	4-40 X 1/4 machine screws
1	4-40 X 3/4 machine screws
4	#4 nuts
5	push-on knobs
1	small cable clamp
5	small cable ties
10.5'	#22 Ga stranded
2.5'	Belden 9501 twin-ax
4.5'	RG-174/U co-ax
2"	8 strands of ribbon
1	9209 Etched Circuit Board

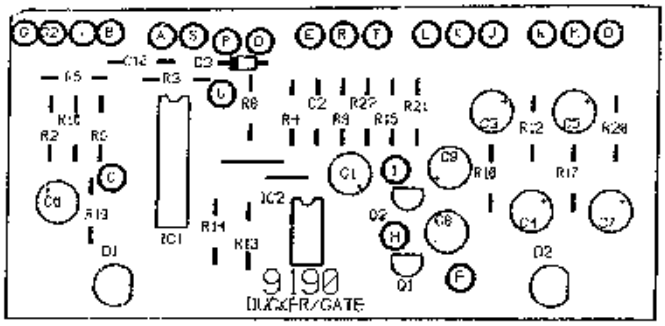


Fig 1a. Parts Placement. Components mount on the circuit board at the locations shown above.

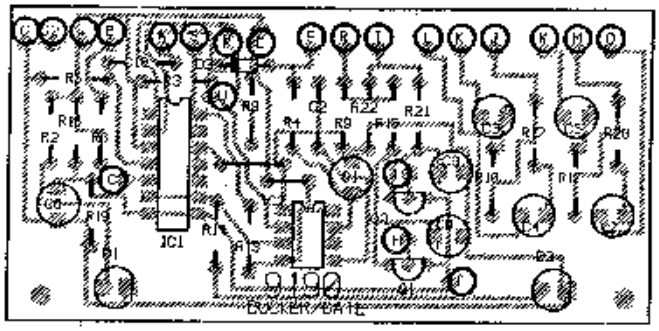


Fig 1b. This parts placment drawing with phantom circuit board conductors may be useful if you have to trace out the circuit.

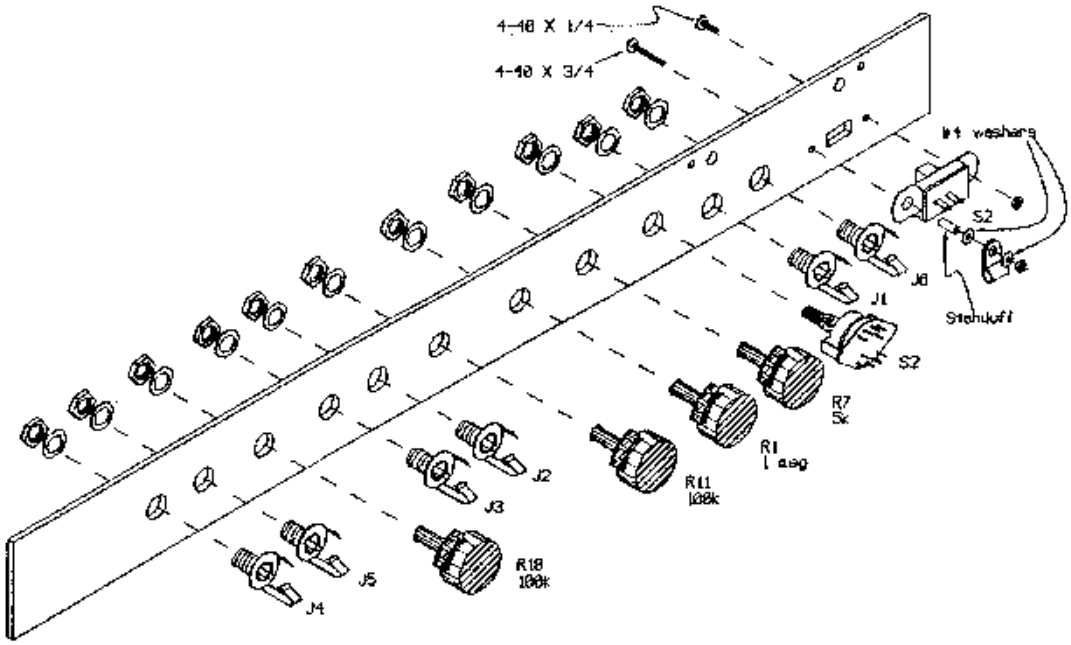


Fig 2. Mount the Jacks, Potentiometers and Power Switch in the locations shown. Before fully tightening the nuts on the Jacks and Pots, orient their solder lugs as shown in Fig 3.

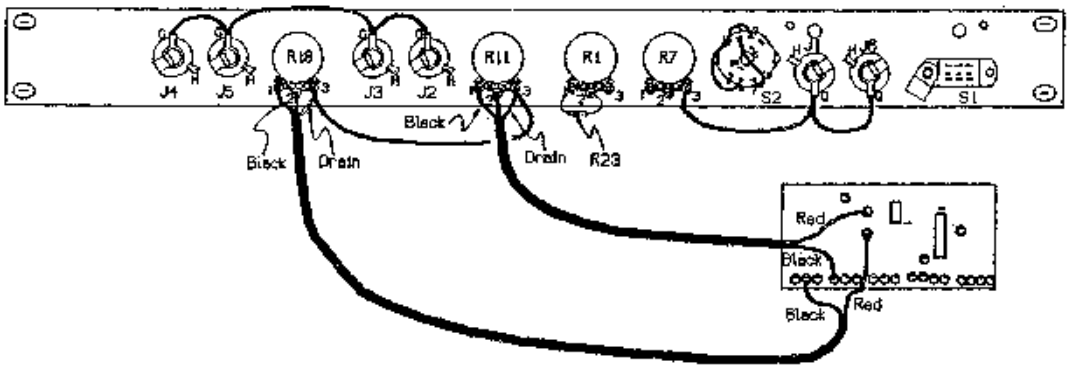


Fig 3. Preliminary wiring on the front panel includes the fixed resistor R23 on the lugs of pot R1. Shielded twin-ax makes the connections between the circuit board and R11 and R18.

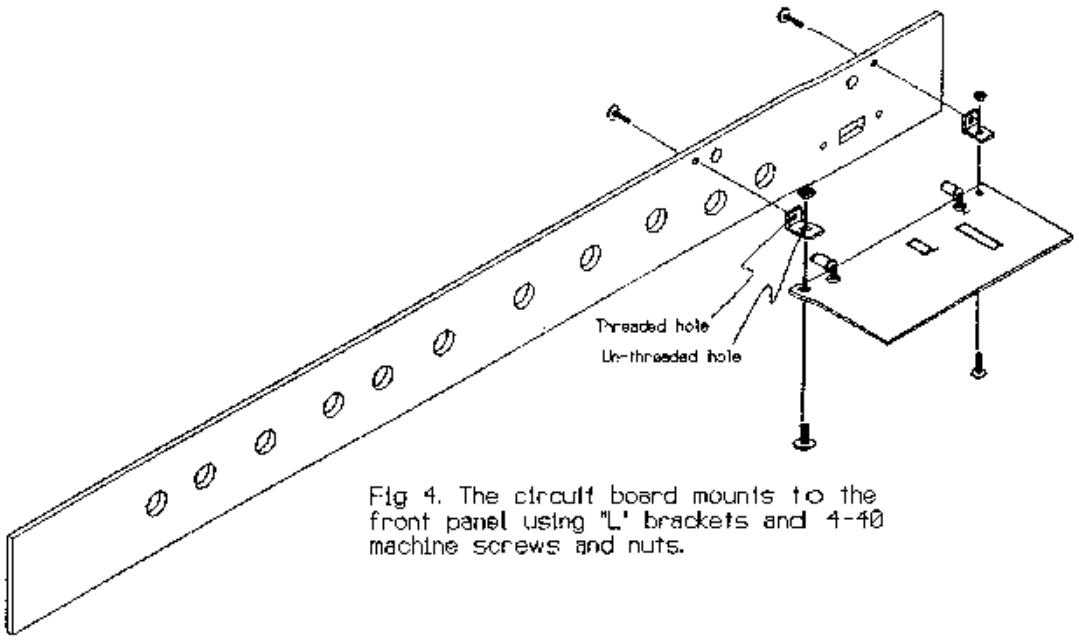


Fig 4. The circuit board mounts to the front panel using "L" brackets and 4-40 machine screws and nuts.

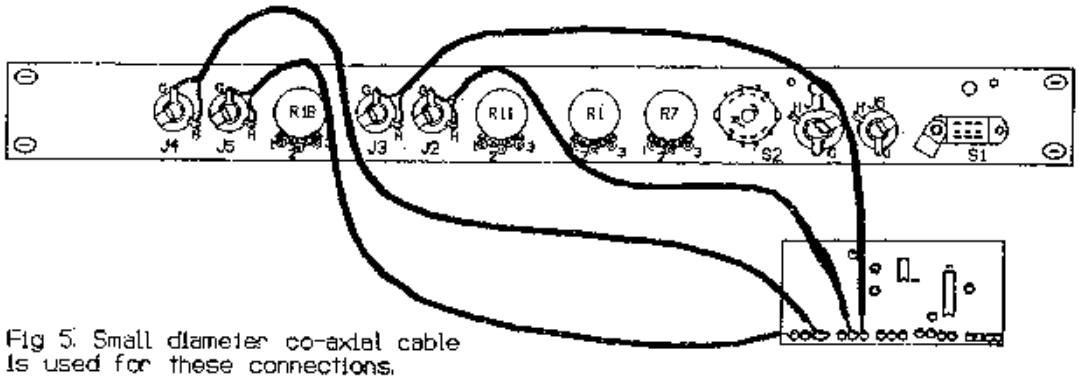


Fig 5. Small diameter co-axial cable is used for these connections.

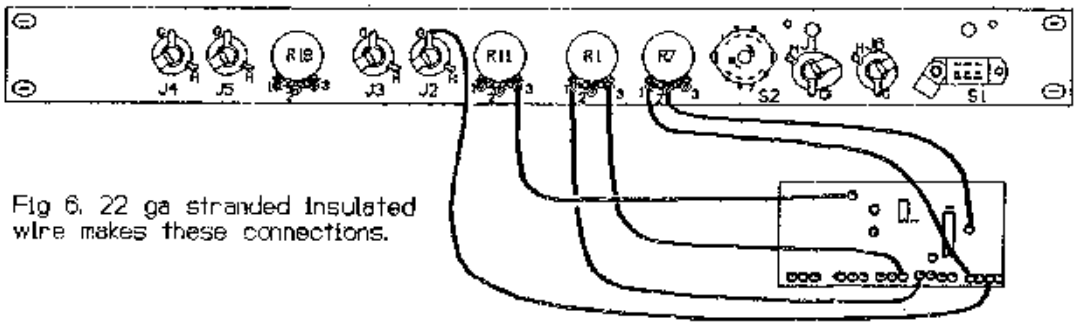


Fig 6. 22 ga stranded insulated wire makes these connections.

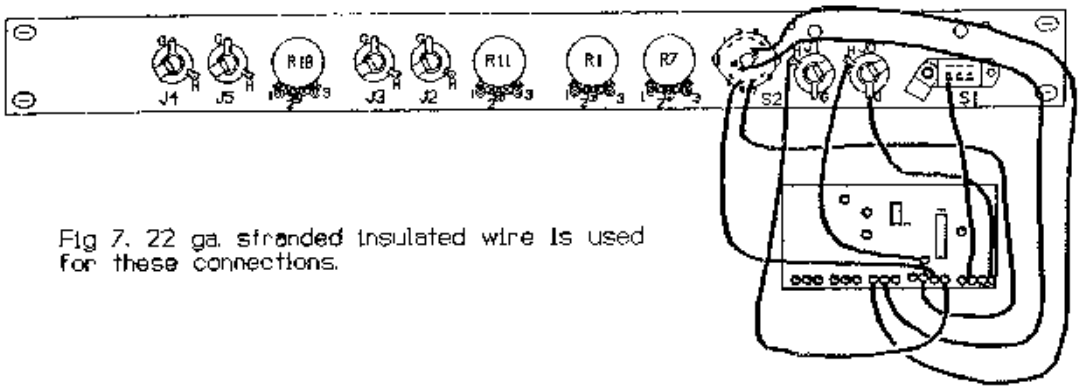


Fig 7. 22 ga. stranded insulated wire is used for these connections.

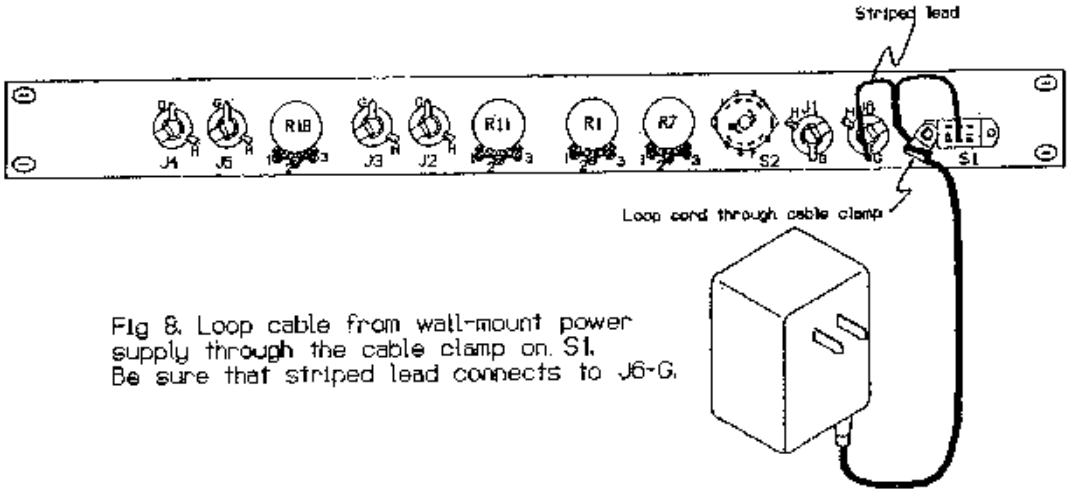


Fig 8. Loop cable from wall-mount power supply through the cable clamp on S1. Be sure that striped lead connects to J6-G.