HOW I BUILT...

The Design and Construction of a Thermionic Valve Stringed Instrument Amplification Device, The Coppertone 5cl

...AN ALL-TUBE GUITAR AMP...

~ or ~

A Seat-of-the-Pants Engineering Escapade Thoroughly Documented in the Fervent Hope that it May Inspire Fellow Members of the Human Race To Attempt Similarly Creative Undertakings

...WITHOUT REALLY KNOWING WHAT I WAS DOING...

... WITH LOTS OF PICTURES TO ENCOURAGE OTHER PEOPLE TO DO COOL STUFF TOO

SOME GUY IN HIS GARAGE

Historical Perspective

The Coppertone Amplification Society (founded in memory of Edwin M. Cheswick, 1802-1863, inventor of the Cheswick Resonator, who was unexpectedly lost to the world in his prime due to an unfortunate encounter with an overcharged flux-capacitor) has to-date manufactured five acoustic amplification devices based on the designs surviving Dr. Cheswick and further developed by his son, Edsel Ford Cheswick, who courageously took up his pater's mantle shortly after the controversial memorial service (the body, as you may recall, was never found):

PURE FICTION IN THE FORM OF A RUN-ON SENTENCE

Sold on eBay $576

Model 101
Thermionic with octo-linear transducer array

RE-PACKAGED MOD 102 AMP KIT W/ 3-INCH SPKRS

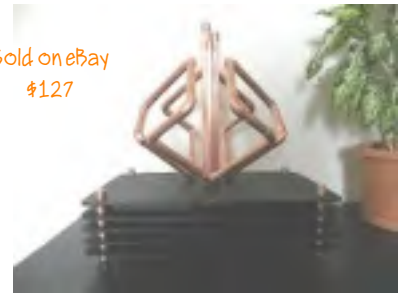
Sold on eBay $638

Model 201
Pseudo-thermionic with Cheswick Resonator

RE-PACKAGED KUSTOM KG112, SPKR BACKSIDE-UP

ALL ARE GUITAR AMPS EXCEPT THIS ONE (AN MP3 PLAYER)

Sold on eBay $127



Model 301
Solid state with equalized actual and passive radiators

RE-PACKAGED BOSE COMPANION II COMPUTER SPEAKERS

Sold on eBay $218

Model 201-B
Pseudo-thermionic with Cheswick Half-Resonator

SHORT VERSION OF THE MODEL 201

Sold on eBay $152

Model 802
Solid state with Cheswick Twin Resonator

RE-PACKAGED KUSTOM KG1 W/ TWO 8-INCH SPEAKERS

Familial Resemblances

FAMILY TRAITS

Certain aesthetic and engineering principles distinguish the several members of the Coppertone line. The six fundamental characteristics are described below, using the Model 101 as an example.

1. A wooden encasement, painted or stained ebony

(BLACK BOX)

2. Ample ductile malleable reddish-brown corrosion-resistant diamagnetic metallic piping, panels, and trim

(LOTS OF COPPER)

3. An extraordinary number and/or arrangement of transducer devices

(UNUSUAL SPEAKERS)

4. A plethora of fully operational hand-actuated toggles, rotary controls, and gauges

(LOTS OF KNOBS AND STUFF - THAT ACTUALLY WORK)

5. Relaxed tolerances in both manufacture and finishing

(HAND MADE WITH HAND TOOLS - AND IT SHOWS)

6. "Minimalist Steampunk"

OVERLY ELABORATE BUT NOT OVERLY SO

WHAT WE'RE GONNA DO

Intended End and Proposed Means

HOW WE'RE GONNA DO IT

Our intent at this juncture is to design and construct an amplification device, suitable for use with electronic guitars, that will take its rightful place as the sixth and youngest member of the Coppertone family line. Similar to its five siblings, it will possess the six unmistakable genetic markers described in the preceding article -- but its circuits will also be fully thermionic.

BUILD AN ALL-TUBE GUITAR AMP THAT LOOKS KIND OF LIKE THE OTHERS

The design phase of the project revolves around three important decisions that must be considered, jointly and severally, at this point in the process. Specifically, we must:

I.
Choose a fitting thermionic circuit for the amplifier.

(PICK A CIRCUIT)

II.
Select a compatible electromagnetic transducer.

(PICK A SPEAKER)

III.
Envisage a functionally and economically practical enclosure.

(DREAM UP A CABINET)

On the subsequent pages of this document we will discuss each of these matters in minute detail, including, of course, the determinations actually made regarding this particular undertaking. We will also elaborate further on both the decision-making process, and the effects of the decisions made, as we proceed through the construction phase of the project. But at present we must content ourselves with a brief overview and general summary in the interest of establishing our bearings.

BLAH, BLAH, BLAH - I'M PRETTY SURE HE JUST NEEDED SOMETHING TO FILL OUT THE PAGE

TO SAVE MONEY AND MAKE IT EASY TO BUILD (NOT TO MENTION LIKELY TO ACTUALLY WORK)...

The Circuit

...WE LOOK AROUND...

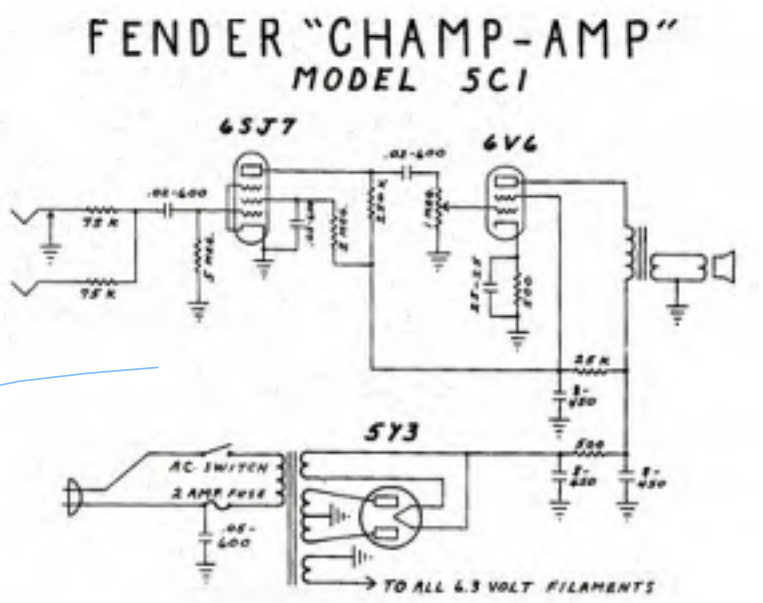
To minimize monitary outlay, to simplify synthesis, and to insure reliability, we begin by searching the Inter-Web for a widely-employed circuit, of untarnished reputation and acclaimed acoustical character, that is nonetheless uncommonly rudimentary.

...FOR A POPULAR CIRCUIT...

...THAT LOOKS REALLY, REALLY SIMPLE

After thorough investigation, the decision is taken to employ an early version of Leo Fender's famous 5c1:

We considered this circuit especially appealing in that it utilizes only three thermionic valves, all of which fit in easily manipulated octal sockets.



As trivial as this circuit appears, it is our intention to further simplify it by eliminating unnecessary components (like the secondary stimulus receptacle) and by dissevering it into discrete modules, each serving but a singular, well-defined purpose.

ONLY THREE TUBES WITH NICE BIG EASY-TO-SOLDER SOCKETS

NOT SIMPLE ENOUGH? STAY TUNED...

The Electromagnetic Transducer.

THE SPEAKER

Since the circuit we have chosen describes a device capable of generating no more than 0.005 joules per millisecond, it will behoove us to pay due attention to the various sensitivity ratings of the several electromagnetic transducers under consideration.

SINCE THE AMP IS ONLY FIVE WATTS, WE NEED A REALLY EFFICIENT SPEAKER

Now, if we assume that our amplifier ought to be capable of producing a sustained sound pressure level of 100 decibels (approximately as loud as a subway train), and we remember that one must double the output power to realize a gain of just 3 audible decibels (all other things being equal), we can quickly see that the kind of speaker typically used in amplifiers of this class - such as a Jensen MOD 8-20 with a sensitivity rating of 93.2 dB with 1 watt at 1 meter - will just barely make the grade. That is, at 1 watt we'll hear, at best, 93.2 decibels; at 2 watts (a doubling) we'll realize 96.2 decibels; and at 4 watts (a second doubling, approaching the upper limit of the circuit) we'll reach 99.2 decibels.

SOMETHING LIKE A JENSEN MOD 8-20 MIGHT BE OKAY...

But if we choose a more efficient speaker, like the Jensen Falcon 12, with a rated sensitivity of 98.7 dB with 1 watt at 1 meter, we will be able to realize 98.7 decibels with just 1 watt of output, 101.7 with 2 watts (approximately half-power, with ample headroom remaining), and 104.7 decibels or more at peak. In other words, choosing the Falcon 12 over the MOD 8-20 will more than double the effective output of our device. And we'll have the added aesthetic benefit of the Falcon's uniquely coloured cone.

...BUT A FALCON 12 WOULD BE MUCH LOUDER

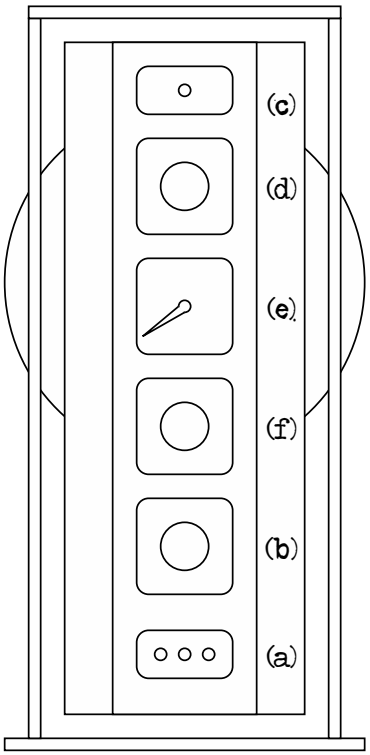
AND THE FALCON HAS A REALLY COOL-LOOKING GREEN CONE

The Enclosure.

We suspect, at this point, that the circuit will divide into at least a half-dozen modules: (a) power source connection with fuse and switch, (b) power transformation with rectification and filtering, (c) input receptacle, (d) pre-amplification unit, (e) volume control, and (f) power amplification; the enclosure must be large enough to comfortably accommodate all of these modules, and must, in addition, provide (g) a unique and functional mounting for the chosen electromatic transducer. Brief cogitation suggests an enclosure analogous to the sketches below.

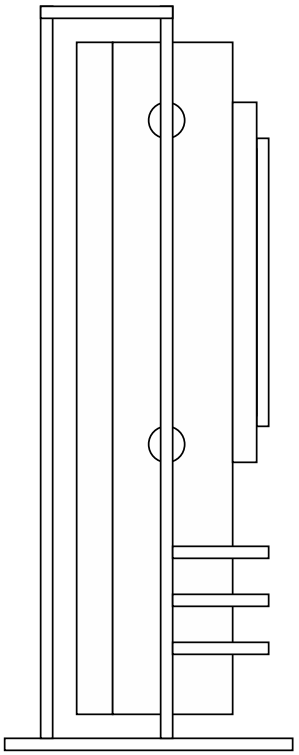
YEAH, RIGHT. I BET HE THOUGHT ABOUT IT FOR DAYS

WE NEED ROOM FOR A LOT OF CONTROL PANELS, PLUS SOME KIND OF UNUSUAL SPEAKER MOUNTING



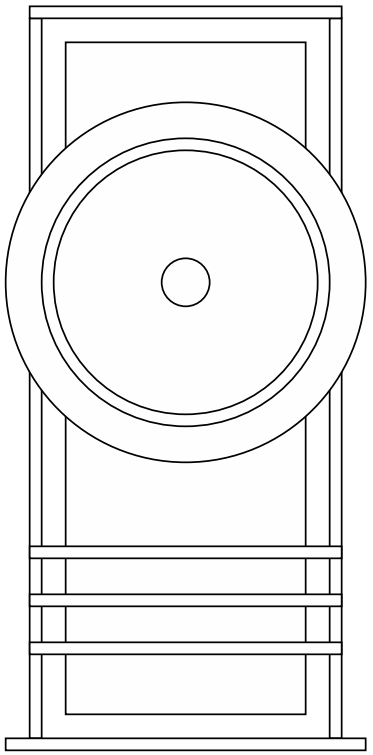
Posterior View

(REAR)



Profile.

(SIDE)



Anterior View

(FRONT)

(g) Transducer enclosure to include internal baffles forming a 1/4-wave Cheswick resonator tuned to approx. 80 hertz.

FOR BETTER-THAN-AVERAGE BASS RESPONSE

An Initial Component Enumeration

PARTS LIST

It is desirable, at this juncture in the process, to acquire the major components and prefabricated sub-assemblies specified in our design for closer inspection and exact measurement. The subscribed Bill of Particulars was employed to facilitate our efforts. Some of the pieces were found in inventory, and the remainer were available from but a single supply source, fortuituously minimizing lading expenditures.

WE NEED TO GET SOME ACTUAL PARTS TO SEE WHAT THEY'RE ACTUALLY LIKE

WE BUY THEM ALL FROM ONE PLACE SO WE ONLY HAVE ONE SHIPPING CHARGE

PART	SUPPLIER	PRICE	QTY	EXT
Jensen Falcon 12 Transducer, 8 ohm	CE Dist	58.20	1	58.20
Transformer, 7000 ohms to 8 ohms, 25 watts	CE Dist	22.95	1	22.95
Transformer, 022772 equivalent	CE Dist	38.95	1	38.95
Thermionic Rectifier, 5Y3	CE Dist	12.95	1	12.95
Thermionic Valve, 6V6	CE Dist	12.45	1	12.45
Thermionic Valve, 6SJ7	CE Dist	5.85	1	5.85
Thermionic Valve Socket, Octal	CE Dist	1.95	3	5.85
Stimulus Receptacle, 1/4-inch	Inventory	0.74	1	0.74
Potentiometer, 1 megaohm, audio taper	Inventory	1.20	1	1.20
Hand-actuated Toggle, SPST	Inventory	0.87	1	0.87
Fuse receptacle, 3AG	Inventory	1.10	1	1.10
Power Conduit, 12-foot	Inventory	5.99	1	5.99

THIS PAGE: $167.10

Miscellaneous Diminutive Electronic Parts & Supplies

Certain lilliputian devices, owing to their modest size, do not significantly affect the design of the enclosure, and their acquisition can thus be safely delayed until a point in time later in the development process. To simplify inventory control and to minimize lading charges, however, we found it advantageous to include the following items on our initial purchase order.

BOUGHT EARLY TO SAVE ON SHIPPING

SMALL PARTS WE REALLY DON'T NEED RIGHT AWAY

PART	SUPPLIER	PRICE	QTY	EXT
Capacitive Storage Device, 25 uF, 25 v	CE Dist	0.20	1	0.20
Capacitive Storage Device, 8 uF, 450 v	CE Dist	1.09	3	3.27
Capacitive Storage Device, 0.022 uF, 630 v	CE Dist	0.61	2	1.22
Capacitive Storage Device, 0.047 uF, 630 v	CE Dist	0.52	1	0.52
Resistive Device, 75 kOhm, 1/2 watt	CE Dist	0.25	2	0.50
Resistive Device, 250 kOhm, 1/2 watt	CE Dist	0.25	1	0.25
Resistive Device, 2 mOhm, 1/2 watt	CE Dist	0.25	1	0.25
Resistive Device, 5 mOhm, 1/2 watt	CE Dist	0.25	1	0.25
Resistive Device, 25 kOhm, 2 watt	CE Dist	0.40	1	0.40
Resistive Device, 500 ohm, 10 watt	CE Dist	1.30	2	1.30
Fuse, 2 amp, delayed response	CE Dist	0.43	1	0.43
Wire, 20 ga, 50-ft, blk, red, grn, yel, wht	CE Dist	7.50	4	37.50

SHIPPING, THIS AND PREV PAGE: $25.39

THIS PAGE: $46.09

RUNNING TOTAL: $237.58

A Prompt but Imprecise Enclosure Paradigm

The time that would otherwise be spent unproductively awaiting the arrival of the several purchased components and pre-assembled sub-assemblies can be reclaimed via the mock-construction of the imagined enclosure. Below is a photograph of the result of such an activity, employing only parts fortuitously on hand.

QUICK AND DIRTY PROTOTYPE

The synthesis of such constructions permit one to experience, both visually and kinesthetically, something akin to the actual configuration of the as yet fantastical, device.

GIVES US A FEEL FOR THE REAL THING

The wonders of modern technology also enable us to simulate various alternative presentations that may be used if and when the Apple Computer Corporation branches out into musical instrument amplification and purchases the patents pending on our several devices. See, for example, the "Artist's Conception" immediately below:

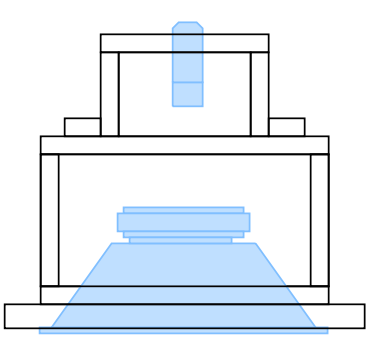
GROOVY RENDITION FOR MARKETING

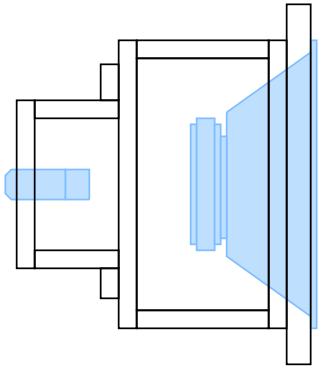
(I HOPE THOSE PARTS GET HERE SOON)

Graduated Draughtings

SCALE DRAWINGS

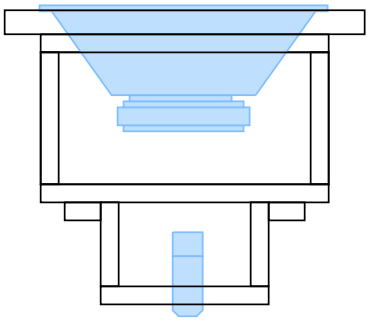
Once the actual components are in hand, a more exacting rendering of the enclosure, drawn to scale, is possible.

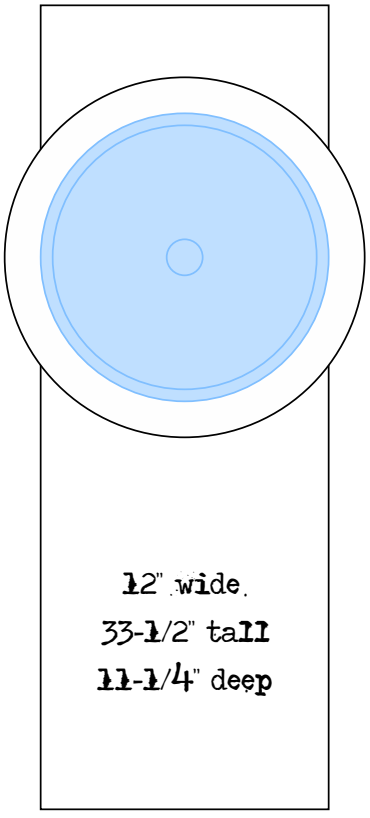


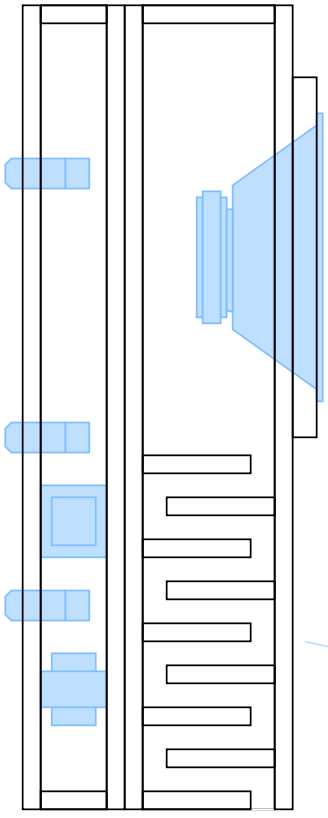


Features of these drawings of special note include:

(a) major components - the transducer, the thermionic valves, and the transformers - shown in blue;



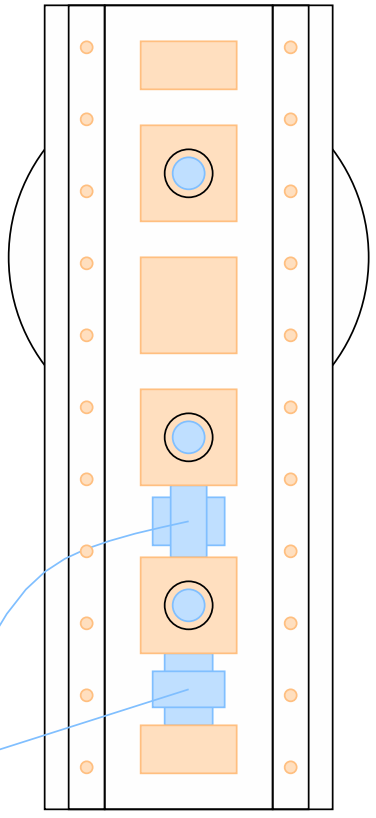




(b) the visible copper plates and fasteners, sans framing - shown in tan; and

(c) the Cheswick Resonator, equivalent to a 54-inch pipe of 2-inch diameter, with an anticipated resonant quarter-wave freqency of approximately 62.78 cycles per second.

TUNED PORT



TRANSFORMERS INSIDE

WOOD

Materials from Naturally-Occurring Deciduous Growths

The graduated draughtings make possible an enumeration of the materials required for the construction of the enclosure. Items below were purchased from a small local vendor to avoid incurring additional lading charges.

Edge-glued laminated pine sub-assemblies resist warping, and are soft, light, and easy to machine.

PRE-GLUED PANELS SAVE US LOTS OF WORK

Dimensional lumber is available in various widths and its use eliminates the need for most rip-cuts.

NICE FEATURE SINCE I DON'T HAVE A TABLE SAW

PART	SUPPLIER	PRICE	QTY	EXT
Stain-Grade Laminated Pine Round, 15" x 1"	Lowes	6.97	1	6.97
Stain-Grade Laminated Pine Sheet, 12" x 3/4" x 4'	Lowes	11.34	3	34.02
Select Pine Nominal Dimensional Lumber, 1 x 6 x 8	Lowes	12.54	2	25.08
Select Pine Nominal Dimensional Lumber, 1 x 4 x 6'	Lowes	6.76	1	6.76
Select Pine Nominal Dimensional Lumber, 1 x 4 x 4'	Lowes	4.35	1	4.35

THIS PAGE: $77.18

RUNNING TOTAL: $314.76

The Synthesis Phase.

Having successfully concluded the design stage of the project, we now proceed to the construction of the device. Several steps are required for complete synthesis, each of which is described, in brief, below.

TIME TO BUILD AN AMP!

I. Fashion the enclosure by cutting, gluing, drilling, sanding, and finishing the appropriate cellulose and metallic pieces.

(BUILD THE BOX)

II. Assemble the amplifier by installing and connecting the various electronic and electro-mechanical components.

(HOOK UP THE AMP PARTS)

III. Fabricate the supporting scaffolding by cutting, bonding, and otherwise attaching the required pipes and fittings

(MAKE THE FRAME)

On the subsequent pages of this document we will discuss each of these steps in minute detail, including, of course, the methods actually employed in this particular undertaking. We will also elaborate further on both the decision-making process, and the effects of the decisions made, as we proceed through the remaining portions of the project. But at present we must content ourselves with this brief overview and general summary in the interest of establishing our bearings.

I am fully aware of the banality of the superceding remarks; unfortunately, the page needed to be filled.

I KNEW IT!

Preparation of Cellulose Materials

CUTTING UP THE WOOD

We begin with sawyer's labors, fashioning each of our wooden pieces to correspond with the specified dimensions.

MODULE	COMPONENT		LENGTH	WIDTH	DEPTH	PCS
Transducer.	Anterior & Posterior.	(FRONT & BACK)	33-1/2"	12"	3/4"	2
Transducer.	Laterals	(SIDES)	33-1/2"	5-1/2"	3/4"	2
Transducer.	Pate.	(TOP)	10-1/2"	5-1/2"	3/4"	1
Transducer.	Internal Baffles & Sole.	(INSIDE & BOTTOM)	10-1/2"	4-1/2"	3/4"	9
Amplifier.	Mounting Cleat	(FLANGE)	33-1/2"	1-1/2"	3/4"	2
Amplifier.	Laterals	(SIDES)	33-1/2"	3-1/2"	3/4"	2
Amplifier.	Pate & Sole.	(TOP & BOTTOM)	5-1/2"	3-1/2"	3/4"	2
Amplifier.	Anterior.	(BACK)	33-1/2"	7"	3/4"	1

Ripping Instrument, Engaged

(WISH I HAD A TABLE SAW)

Method Employed for Cross-Cutting

(WISH I HAD A RADIAL ARM SAW)

Orbital Evacuation Procedure.

(WISH I HAD A CIRCLE CUTTER)

Assembly of Cellulose Materials

CUT UP BOARDS

BUILDING THE BOXES

GLUE

BUCKET

WATER

RAG

With our sawn constituents in hand, we equip ourselves -- colloidal adhesive agent, rectangular vessel filled with the universal solvent (heated to 180 degrees Fahrenheit), 100% pure cotton tatter, a handful of ring-shank pressure-activated fastening devices, hickory-grip manually-actuated impact instrument, tub of makeweight dough -- and proceed to synthesize the enclosure, attending carefully to the previously described specifications.

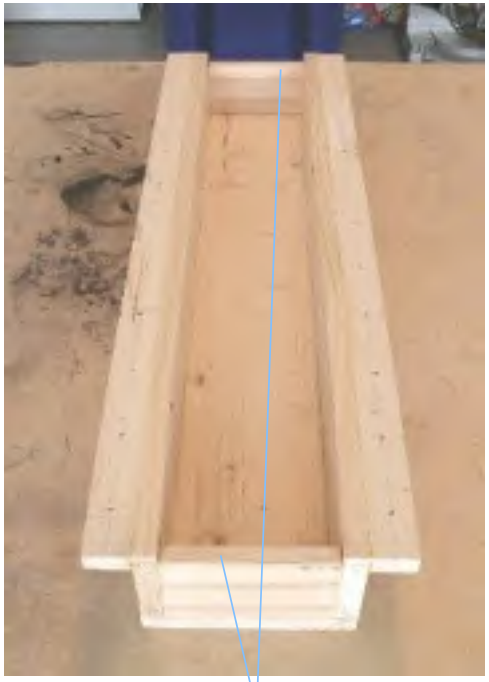
PUTTY

NAILS

HAMMER

The Interior of the Posterior Instrument Casing

(AMP "CHASSIS")



NOTE CONVECTION VENTS

The Interior of the Anterior Transducer Carapace

(INSIDE OF SPEAKER BOX)

NOTE CHESWICK BAFFLES

The Colligated Assembly (Right Posterior Viewpoint)

(ALL SCREWED UP - IN A GOOD WAY)

NOTE NIFTY ROW OF SCREWS

Preliminary Visual Inspection and Proofing

STAND BACK AND SEE WHAT WE'VE GOT

It is appropriate in the course of a development such as this to place one's self, from time to time, at a moderate distance from the creation in the interest of studying the overall effect; and, if the necessary conditions precipitate, conduct scientific tests suitable to the current stage of the device's maturation process.

Three-Point Perspective Survey

(BIRD'S EYE VIEW)

NOTE THE INTERESTING SHAPE

Two-Point Perspective.

(CORNER VIEW)

NOTE THAT IT WEIGHS ABOUT A TON

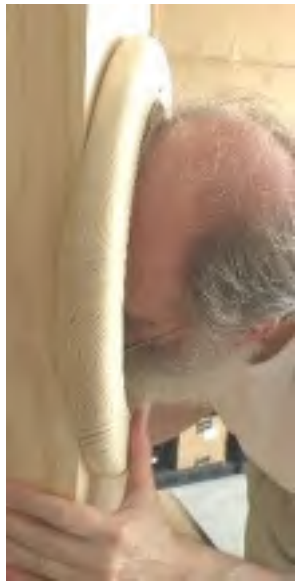
Apex and Undersurface.

(TOP & BOTTOM)

NOTE CONVECTION VENTS & BASS PORT

Low Frequency Resonance Testing

(BASS TEST)



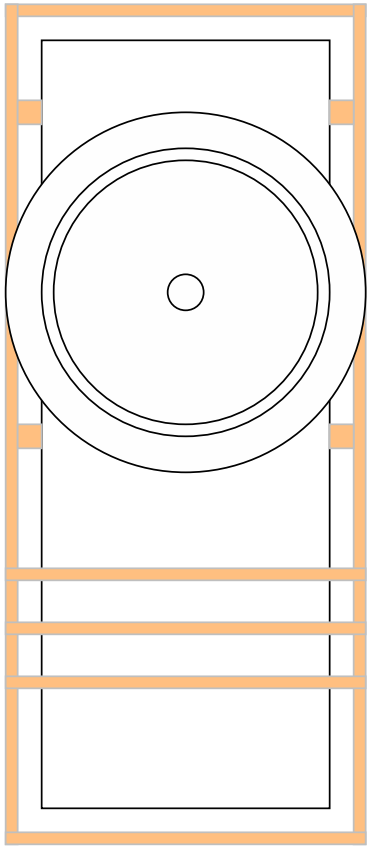
THE AUTHOR BELLOWS "BLUE MOON"

High Frequency Resonance Testing

(TREBLE TEST)

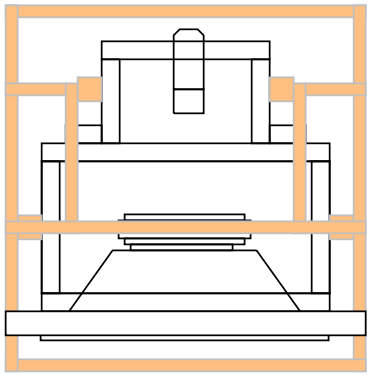
THE WIFE CHIRPS "TWEEDLE-DE-DEE"

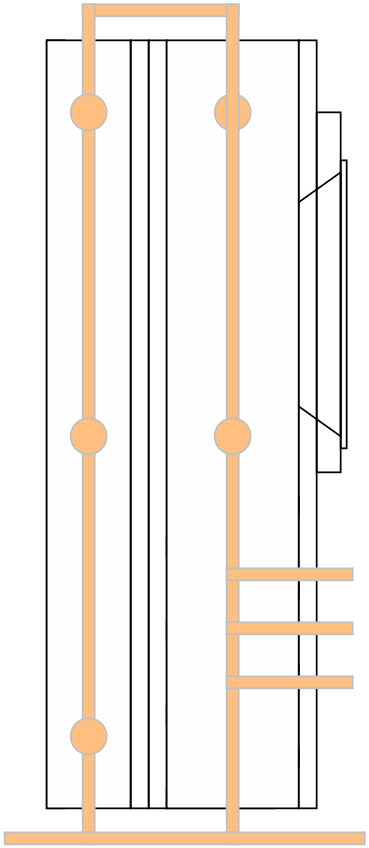
Design of Frame and Enumeration of Frame Components



Ofttimes, an unintended occurrence in the manufacture of certain parts causes a disruption in the intended succession of project events. Such an occurrence has made it desirable to deviate from the planned sequence and to labor on the enclosure's aesthetically contributory supporting frame prematurely.

(I SCREWED UP A SHEET OF COPPER SO I DECIDED TO WORK ON THE FRAME WHILE WAITING FOR A REPLACEMENT)





PART		SUPPLIER	PRICE	QTY	EXT
Diagmagnetic Malleable Fitting 90°	(COPPER CORNER)	Lowes	0.36	16	5.76
Diagmagnetic Malleable Fitting 90°/180°	(COPPER TEE)	Lowes	0.94	12	11.28
Plated Bell Support	(STEEL HANGER)	eBay	0.65	10	6.50
Diagmagnetic Malleable Rigid Tubing	(COPPER PIPE)	Lowes	0.80	24	19.20

THIS PAGE: $42.74

RUNNING TOTAL: $357.50

Fabrication of the Aesthetic Scaffolding

MAKING THE FRAME

The creation and synthesis of the unit's aesthetical scaffolding is accomplished in three steps: (1) discerping the raw materials, (2) cleansing the resulting components, and (3) affixing the pieces with a dilating adhesive.

Discerping Tool
(PIPE CUTTER)

Cleansing Agents
(WIRE BRUSHES)

Dilating Adhesive
(GORILLA GLUE)

Prepared Components
(ALL 62 OF THEM)

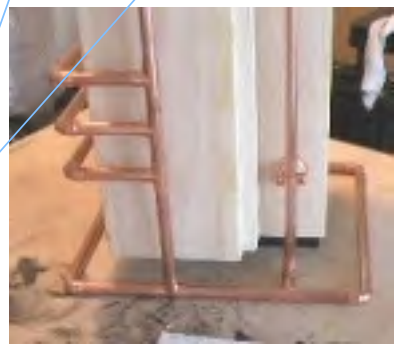
Dilating Effect
GLUE IN FITTING,
WATER ON PIPE:
REALLY "SWELL" JOINTS

Dry Fit
(TESTING 1, 2 ... 62)

Service to be Referred to a Qualified Technician

FRAME LEFT UNGLUED AT FOUR POINTS SO THE AMP CHASSIS CAN BE REMOVED

Dry Fit
(DITTO)



Fashioning the Malleable Metallics

MAKING THE COPPER PLATES

The several amplifier panels in the specified design are now fashioned from a somewhat larger sheet of mill-finished diamagnetic metallic sheet, twenty-one thousandths of an inch in thickness. The various implements required, and typical applications of same, are illustrated immediately below.

Scoring Implement
(KNIFE)

Bending Brake.
(TABLE EDGE)

Corner Round
(SCISSORS)

Guidework
(PATTERNS)

MASKING TAPE WORKS BETTER

Precision Dimpler.
(PUNCH)

Boring Tools
(DRILL)

Blander.
(FILE)

Polishing Device.
(SANDER)

PART	SUPPLIER	PRICE	QTY	EXT
Diamagnetic Sheet, 12" x 12" x 0.021" (COPPER SHEET)	Amazon	17.15	1	17.15

RUNNING TOTAL: $374.65

Tincting Miscellaneous Hardware Elements

COLORING UP THE SCREWS

Twain methods are employed to adjust the natural colourings of the various exposed fasteners for maximum visual aesthetic appeal, as illustrated below, since cost and availability factors preclude alternative solutions.

Non-alchemic Method of Transmogrification, Zinc-Plated Steel to Copper.

(SPRAY PAINT)

Alchemic Method of Transmutation using Selenious and Nitric Acids, Zinc-Plated Steel to Jet Steel

(GUN BLUE)

(ANY BRAND)

Concluding Fabrication of the Enclosure.

FINISHING UP THE BOXES

Once the necessary clearances have been made for the various control panel devices, visible defects are corrected, and the surface is smoothed, a protective oil-based coating, black as jet, is hand-rubbed into the material.

Bored Exposed Component Passageways
(HOLES FOR JACKS, SWITCHES, TUBES, ETC)

Impelling a Protective Coating into the Cellulose Components
(STAINING THE CABINETS)

Applying Makeweight Dough
(WOOD FILLER)

Power-Assisted Abradation of Exposed Surfaces
(SANDING)

A Significant Milepost

The creation of a new entity via the simple colligation of pre-fabricated parts can be a gratifying experience. Since at this point the required components and sub-assemblies for this project have been either purchased or synthesized, it is thus, with delightful anticipation, that we now proceed.

(THIS IS WHAT THE COPPERTONE 5c1 WOULD LOOK LIKE AS AN EASY-TO-ASSEMBLE KIT)

PRE-ASSEMBLED CABINETS

TOTALLY SWEET FOREST GREEN FALCON 12 SPEAKER

PRE-ASSEMBLED CIRCUITS

(DETAILS ON THE FOLLOWING PAGES)

PARTIALLY ASSEMBLED FRAME PARTS

SUPER-LONG POWER CORD

Ensconcing the Transducer.

MOUNTING THE SPEAKER

We now permanently conjoin the exceptionally efficient Falcon 12 transducer and the Cheswick Resonator, validating the happy union via close audio examination employing standard appraisal equipment.

Securing the Ring
(GLUE & CLAMP)

Preparing the Conduits
(CRIMP & SOLDER)

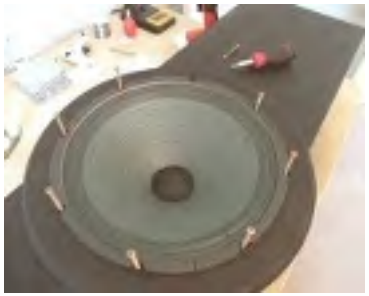
The Terminal Contacts
(CUT, PUNCH, ATTACH)

Transducer Connexions
(SOLDER)

Acoustical Damping
(STUFFING)

QUILT PADDING FROM WALMART

Binding the Transducer.
(TWIST & TWIST MORE)



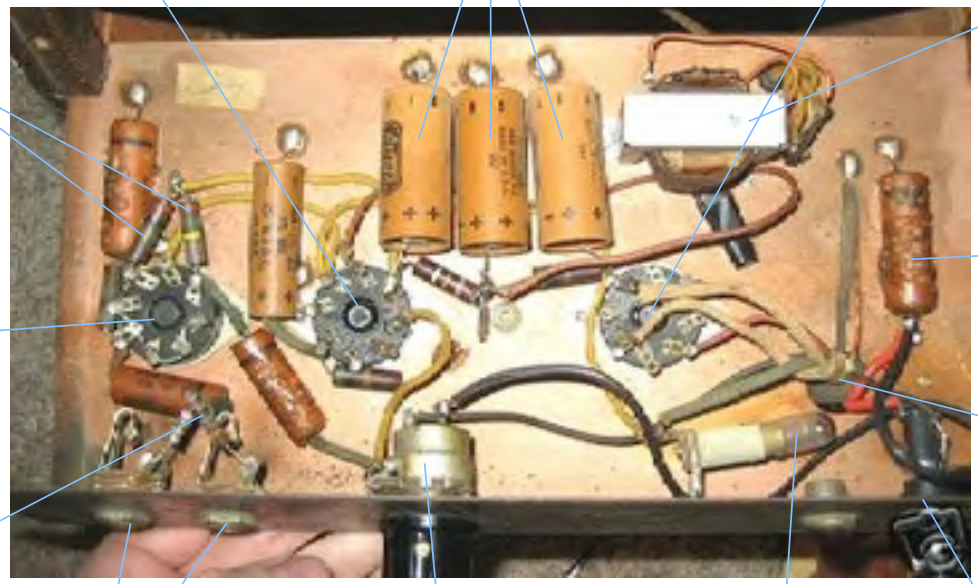
The Completed Unit
(LOVELY)

Verification
(TESTING)

TRYING OUT THE SPEAKER WITH THE TELECOUSTIC AND THE SOLID-STATE VOX. AS ANTICIPATED, REMARKABLE BASS RESPONSE FROM THE CHESWICK RESONATOR. HOPE IT SOUNDS AS GOOD WITH A TUBE AMP!

The Original Leo Fender 5c1 Layout

As one can plainly see from but a brief perusal of the photograph displayed below, the layout of the 5c1 circuit is non-critical. Simplicity and efficiency were apparently the order of the day when the original was devised.

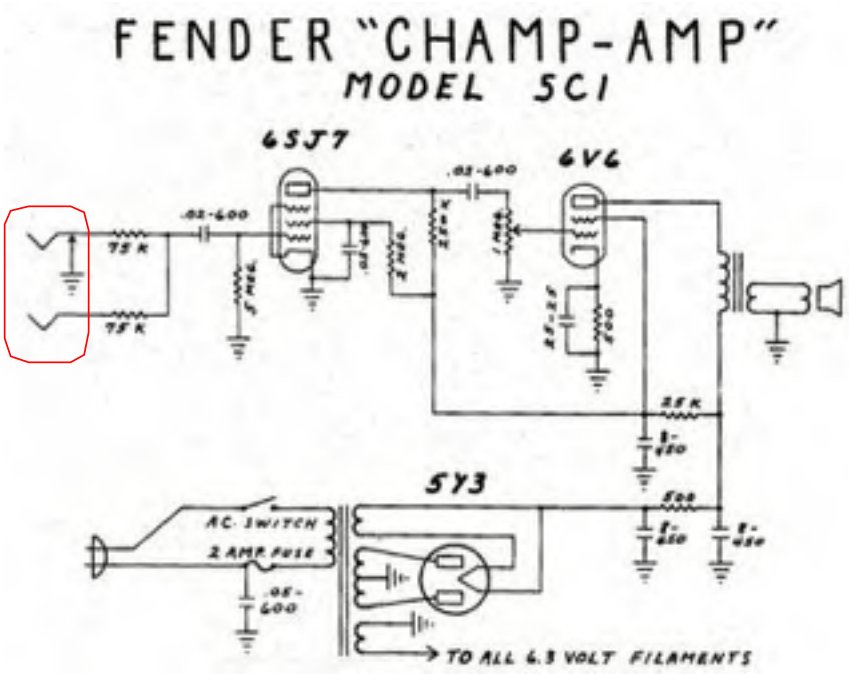


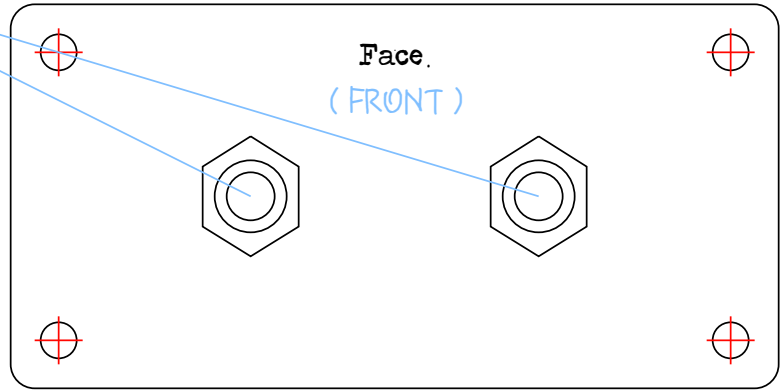
The following pages describe, in detail, our modular treatment of the circuit. We begin with the simpler units.

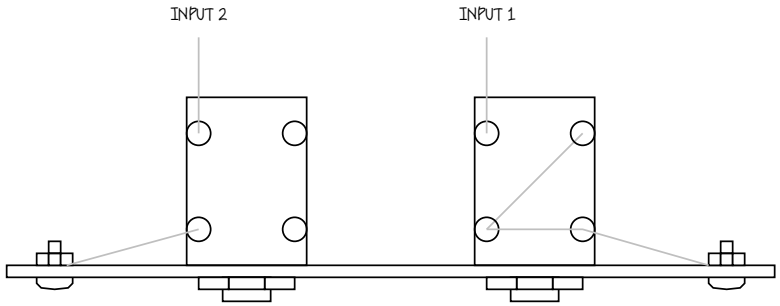
The Stimulus Receptacle Panel

The portion of the original circuit implemented on this panel is encircled in the diagram below left. Modifications to the archetype (if any) are indicated therein using crimson ink.

I DECIDED TO KEEP BOTH INPUTS
BECAUSE THEY MADE THE PANEL LOOK COOLER







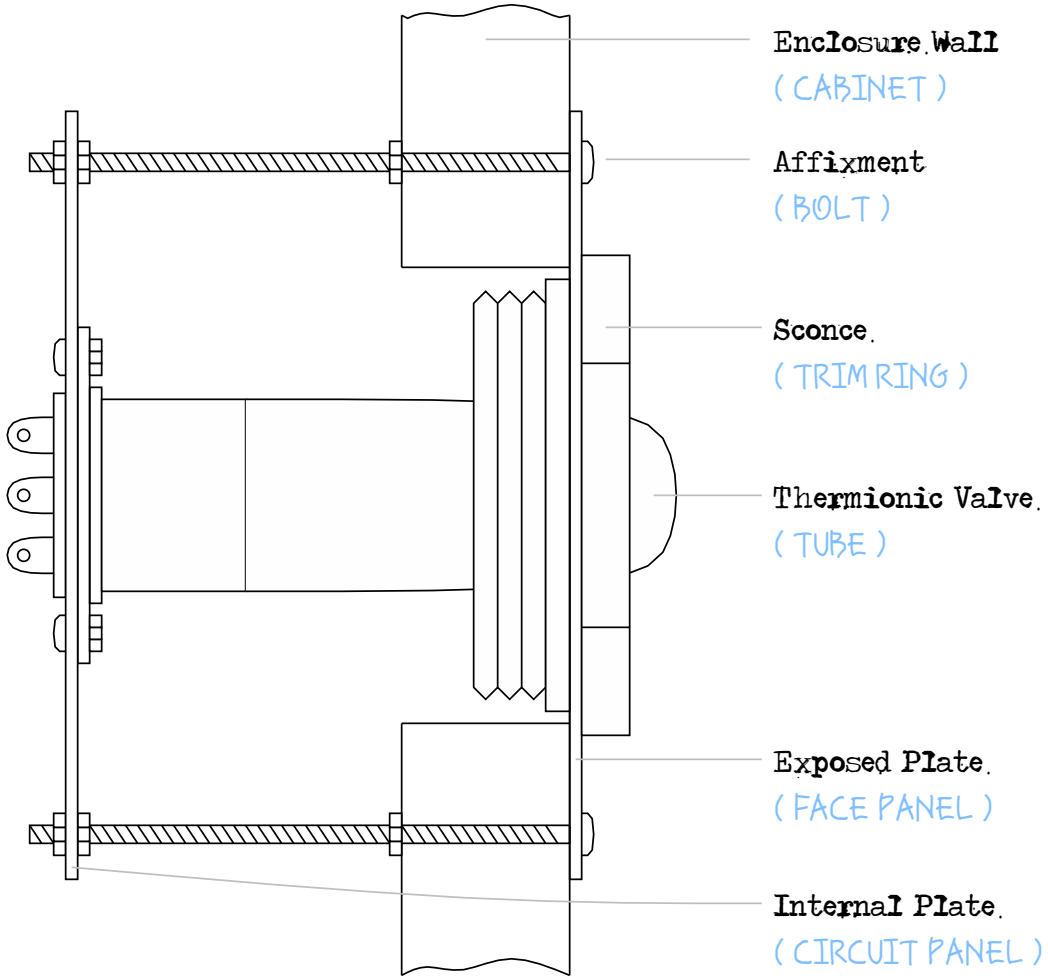
Posterior Flank

(SIDE VIEW FROM BOTTOM)

The Valve Sconces

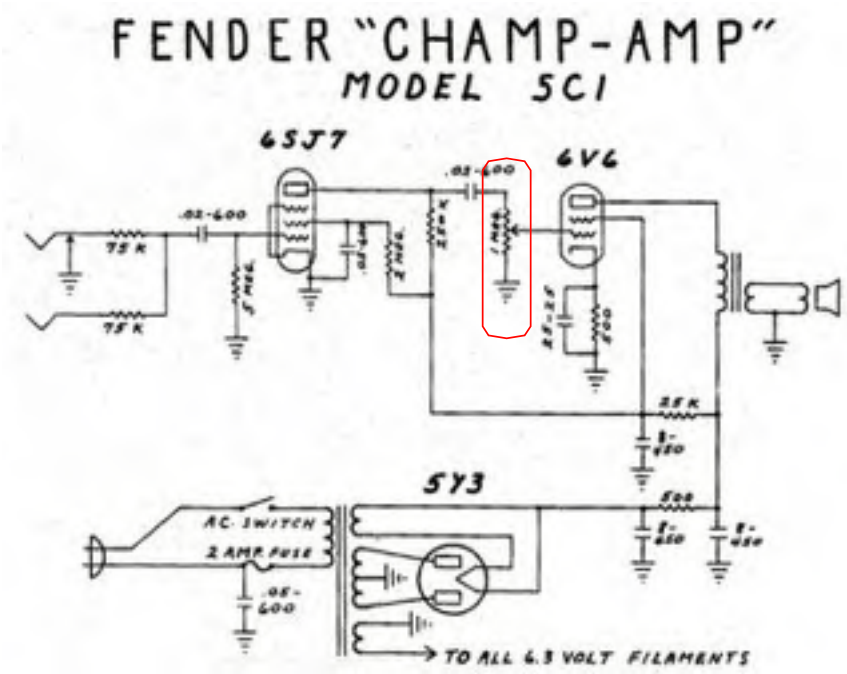
The thermionic valves must be protected yet accessible, convection-cooled yet aesthetically presented. As below.

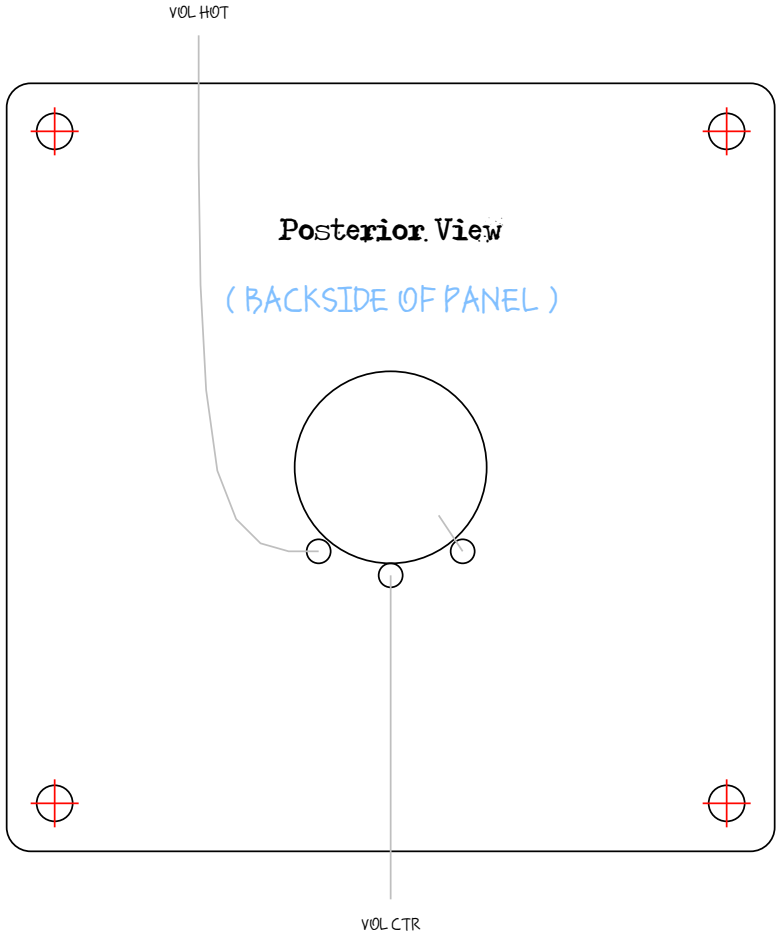
Encore Alchemy
(GLUE BLUE ON CONDUIT FITTINGS)



The Rotary Loudness Control Panel

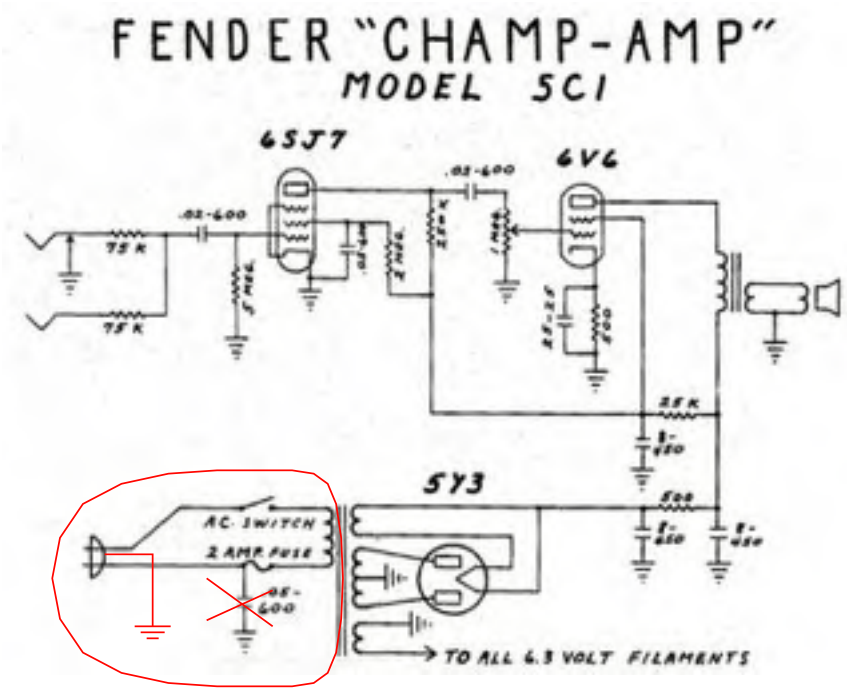
The portion of the original circuit implemented on this panel is encircled in the diagram below left. Modifications to the archetype (if any) are indicated therein using crimson ink.





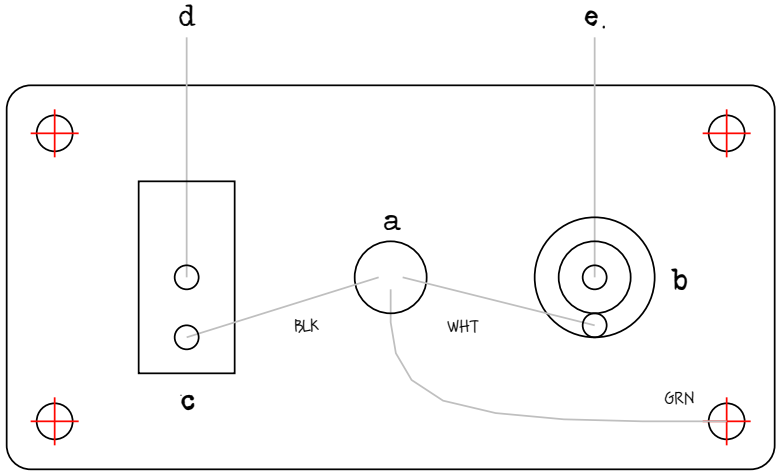
The Power Conduit Panel — POWER CORD, FUSE, AND SWITCH

The portion of the original circuit implemented on this panel is encircled in the diagram below left. Modifications to the archetype (if any) are indicated therein using crimson ink.



Posterior View

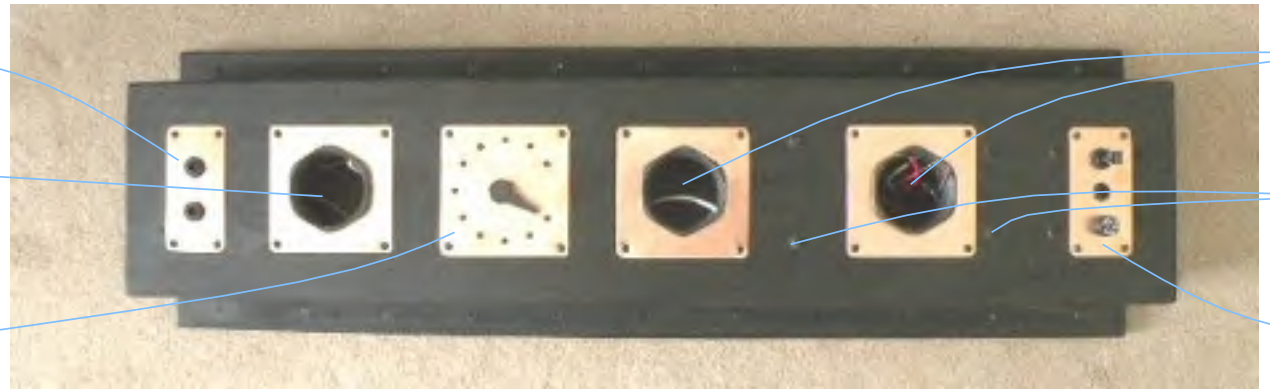
(BACKSIDE OF PANEL)

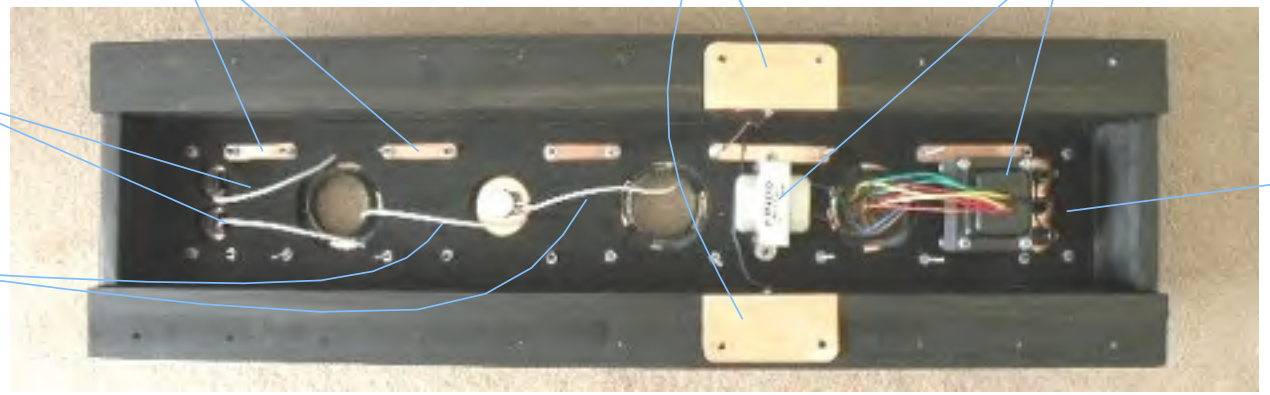


a. power conduit inlet
b. current-activated disconnect
c. hand-actuated toggle
d. to power transformer primary
e. to power transformer primary

Installing the Exposed Component Panels

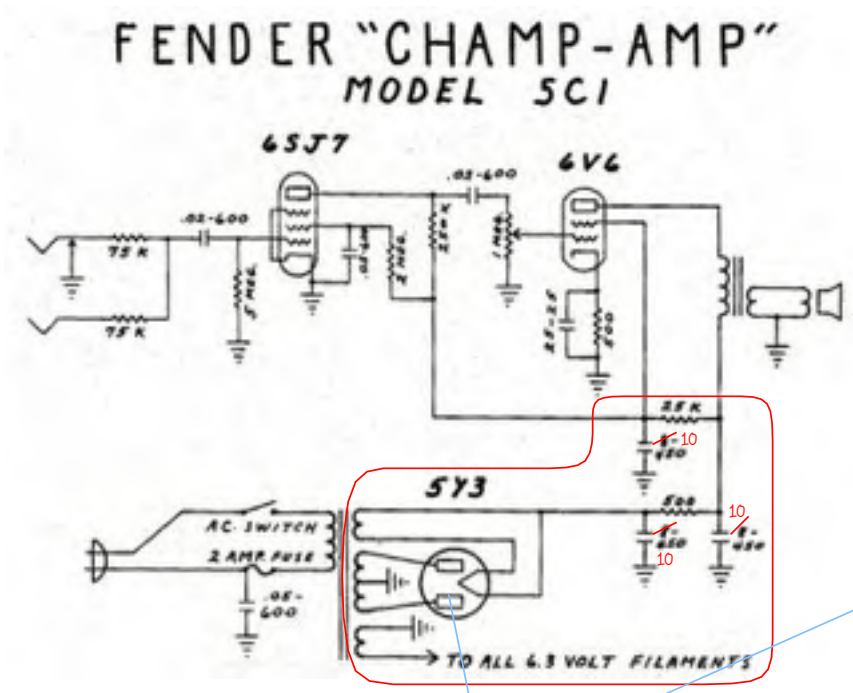
The several user-approachable instrument and control boards previously described are now permanently mounted on the posterior face of the amplifier chassis sub-assembly. Transformer units are bolted in place. Connexions most conveniently formed at this time are securely affixed. Revealing diametric views appear below.



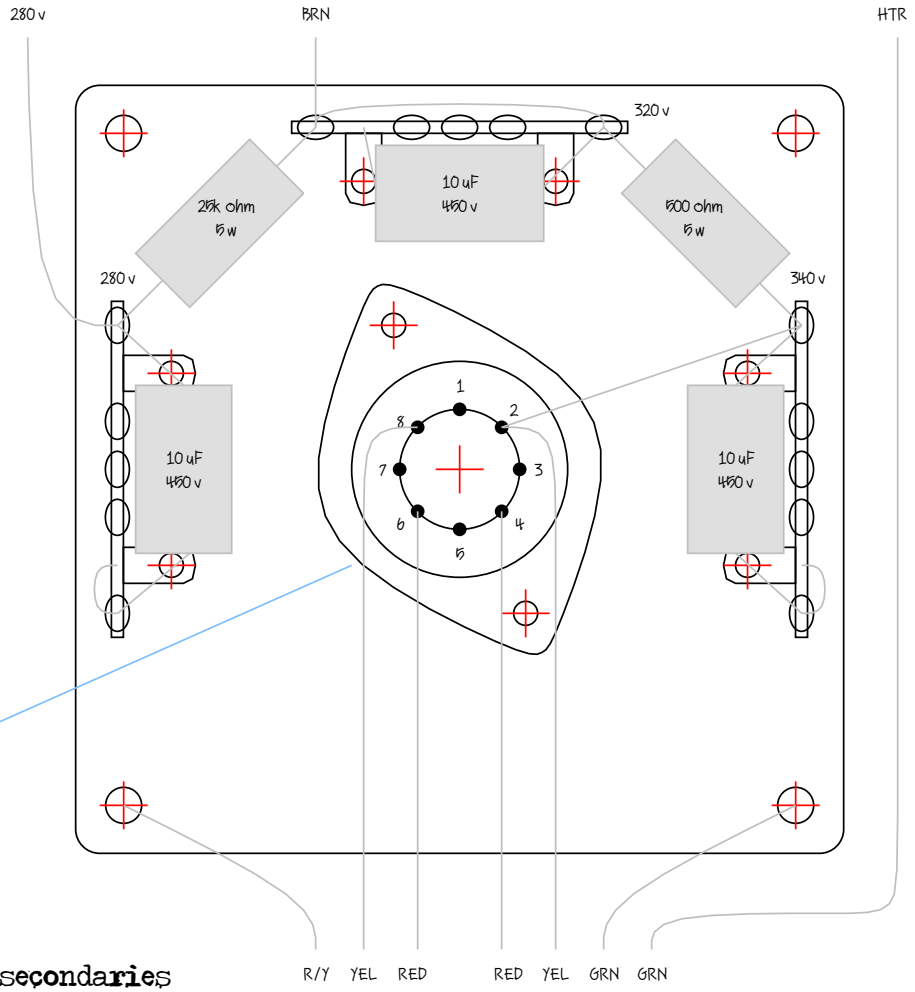


The Rectification and Filter Panel

The portion of the original circuit implemented on this panel is encircled in the diagram below left. Modifications to the archetype (if any) are indicated therein using crimson ink.



b



PINS 2 & 4 MUST BE ORIENTED VERTICALLY FOR HORIZONTAL TUBE ORIENTATION

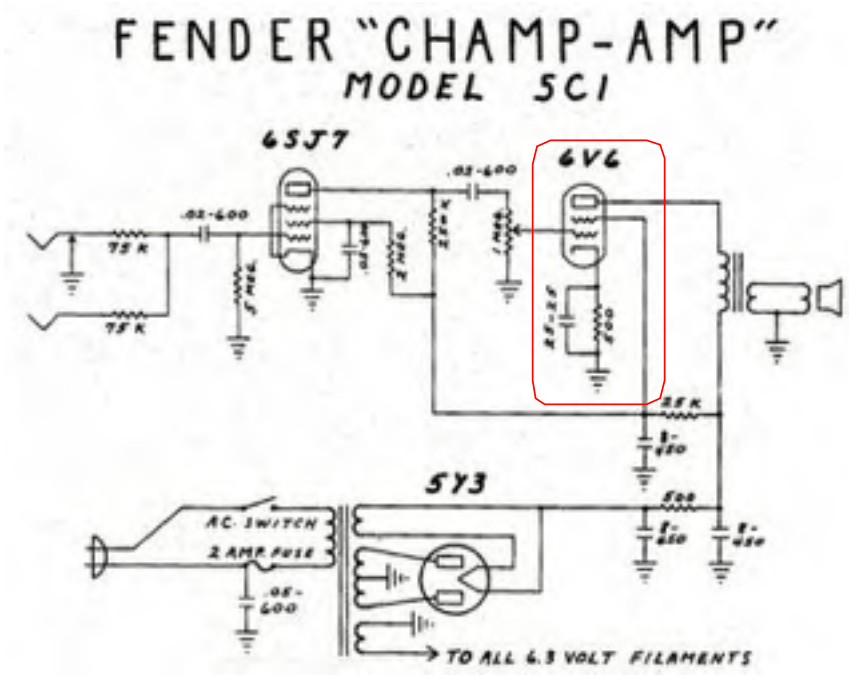
a. power transformer secondaries

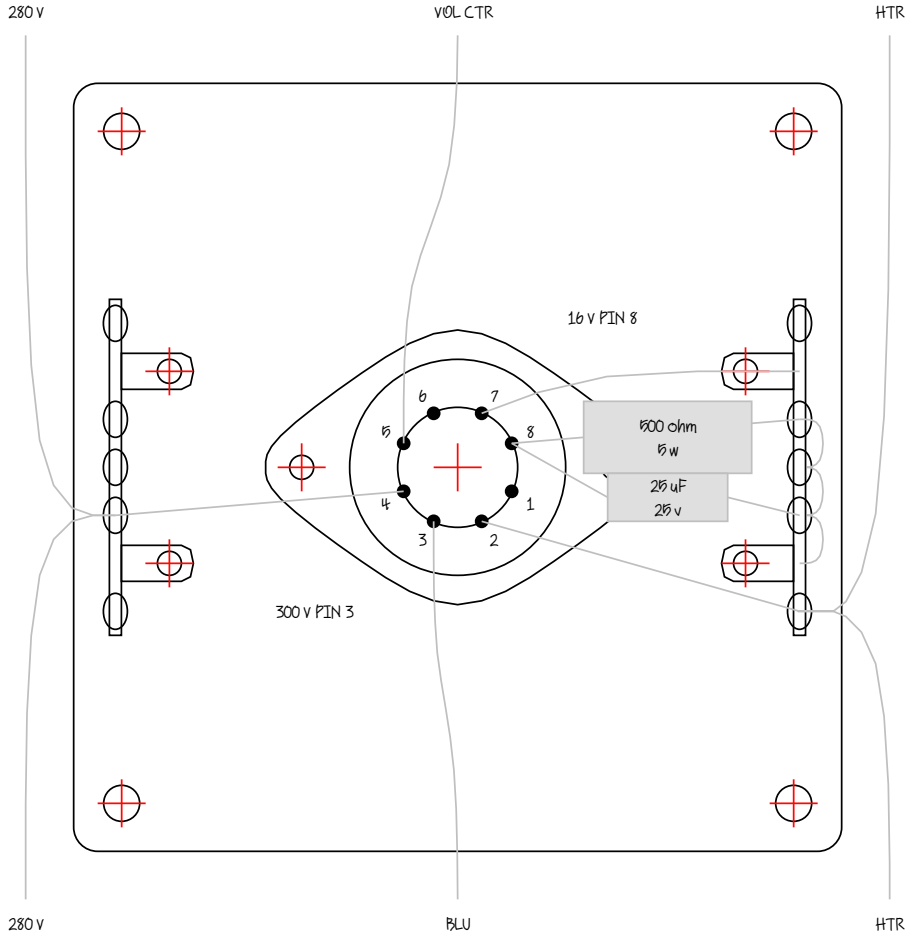
b. output transformer primary

a

The Power Amplifier Panel

The portion of the original circuit implemented on this panel is encircled in the diagram below left. Modifications to the archetype (if any) are indicated therein using crimson ink.



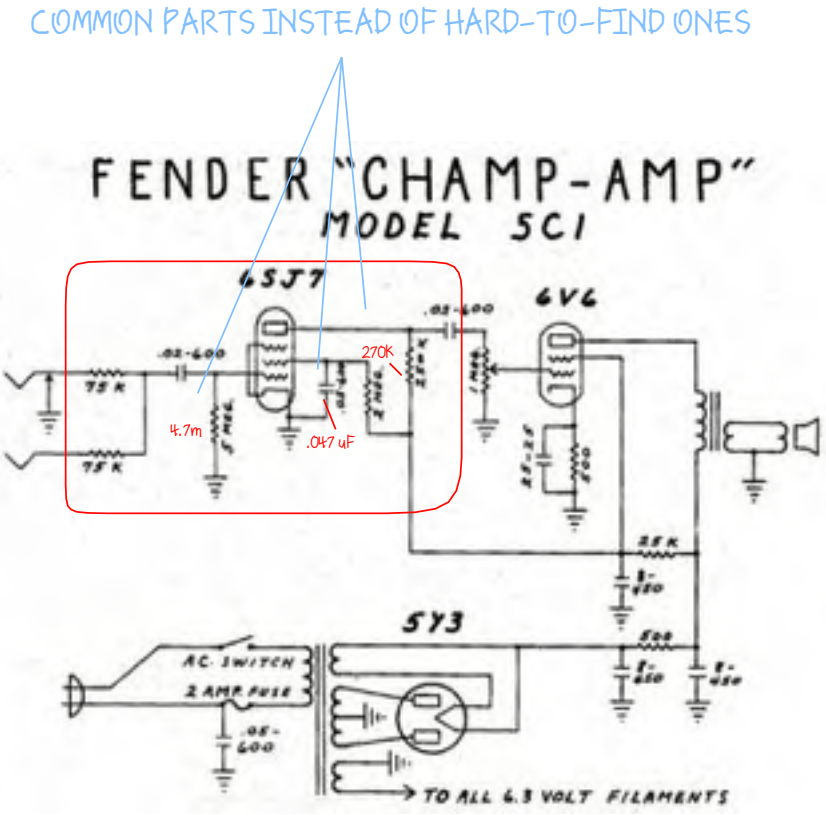


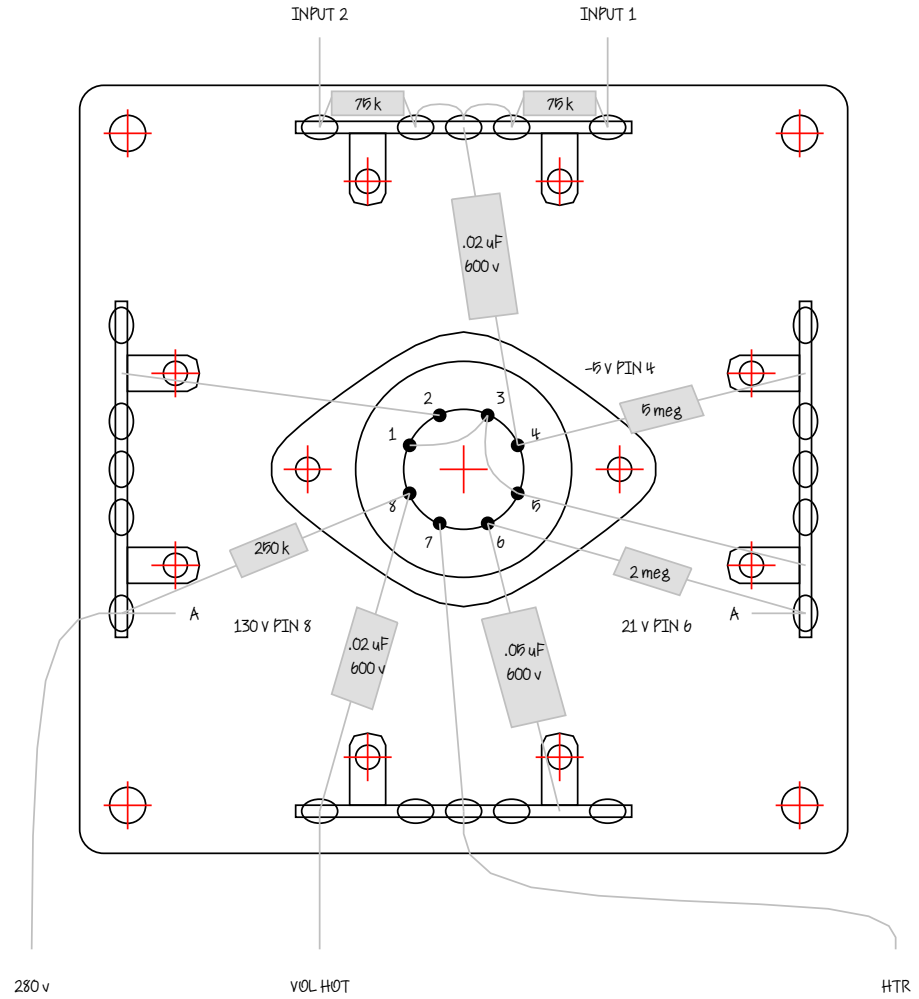
a

a. output transformer primary

The Preamplification Panel

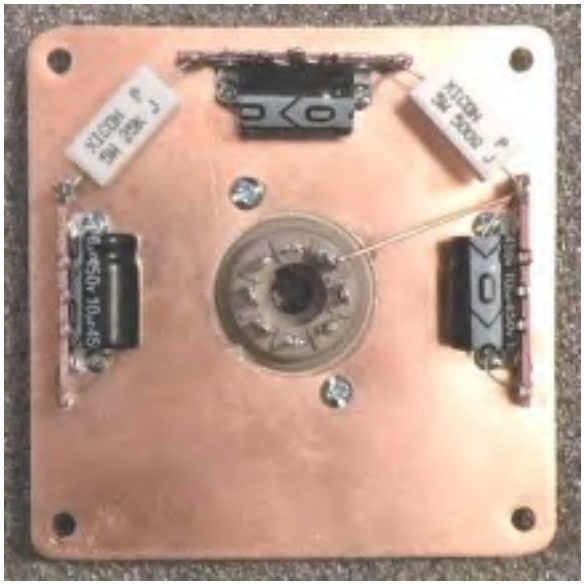
The portion of the original circuit implemented on this panel is encircled in the diagram below left. Modifications to the archetype (if any) are indicated therein using crimson ink.



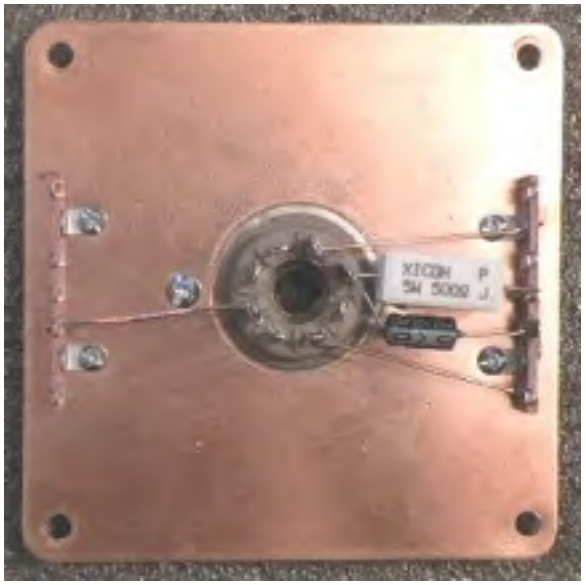


The Antecedently-Assembled Circuit Panels

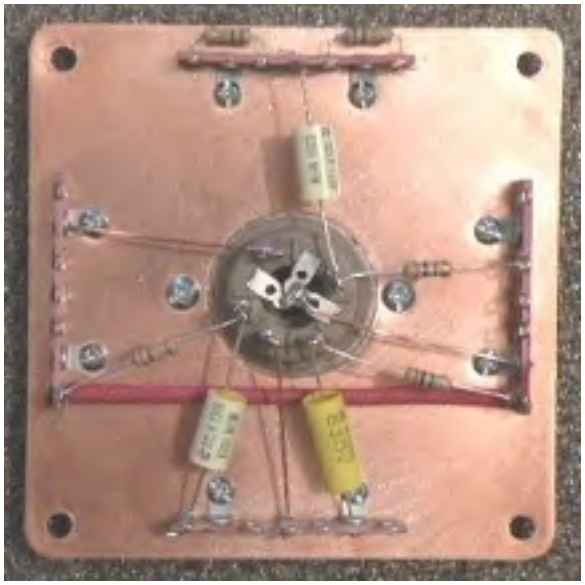
Close-proximity daguerreotypes of the pre-assembled internal circuit panels appear below. The orientation of the panels is the same in each particular case, and corresponds with the diagramatic representations on the previous pages of this document. The specific orientation of the thermionic valves, of course, varies.



5Y3 Diode Circuit
(RECTIFIER)



6V6 Triode Circuit
(POWER AMP)



6SJ7 Pentode Circuit
(PRE-AMP)

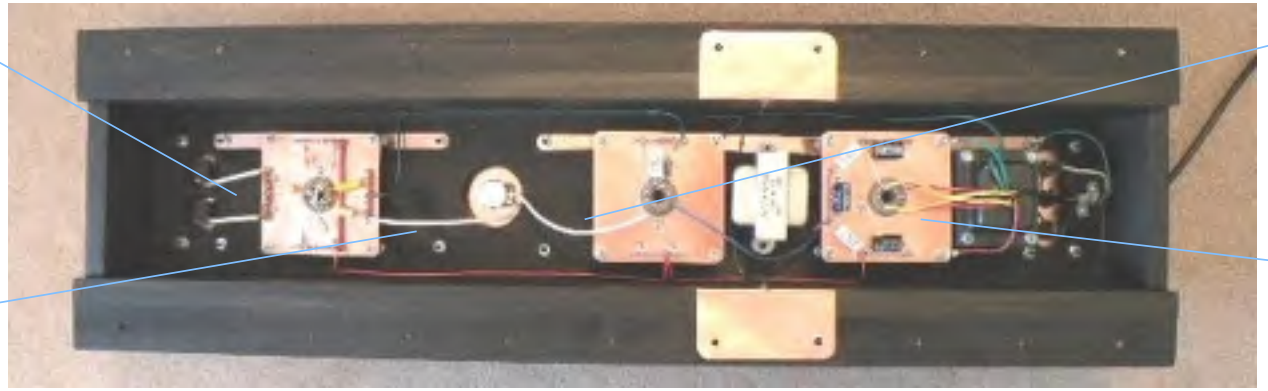
Of especial note is the remarkable simplicity of the power amplification circuit, particularly when compared with the overbearing complexity of the associated pre-amplification circuit.

(GOTTA LOVE THAT SIMPLE POWER AMP! IF ONLY THE PRE-AMP WAS THAT SIMPLE!)

Installing the Internal Circuit Panels

The internal circuit panels are wired aforetimes to relax fabrication. Said panels are then mounted on stand-offs suitably positioned on the fasteners employed to affix the thermionic valve sconce plates. The remaining connexions specified in the schematic are completed.

* OH...



* To the tune of "Dem Bones" by James Weldon Johnson. Original lyrics inspired by Ezekiel 37:1-14, a remarkable prophecy from 2,500 years ago, partially (but incontestably) fulfilled in our lifetimes.

CHECK AND TEST

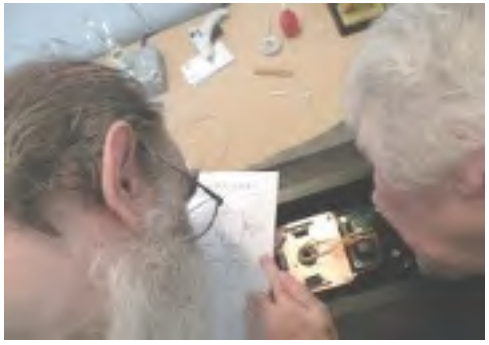
Examination and Verification

CAN'T DO THAT WITH THOSE NEW-FANGLED BULBS!

The proof of the pudding is in the eating.

Visual Circuit Verification

TWO ARE BETTER THAN ONE



A Warning to the Uninitiated

KEEPING THE KIDS SAFE

Current-Limiting Device.

BULB IN SERIES WITH SOCKET

Preliminary Voltage Check

NO TUBES INSTALLED

Substitute Transducer Exam.

TEST WITH CHEAP SPEAKER

Receptacle Confirmation

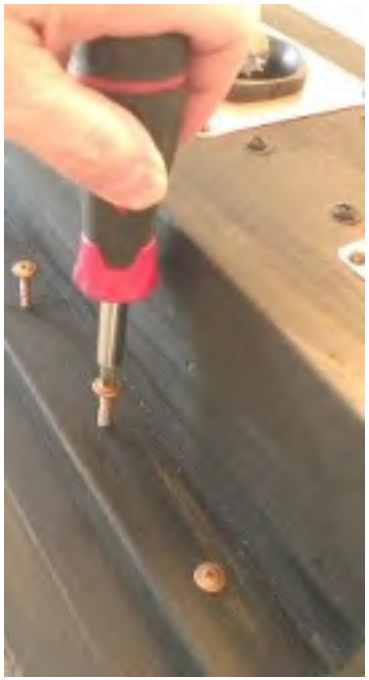
TEST HI AND LO INPUTS

Final Assembly & Certification

We are now rapidly approaching the ratiocination of our efforts. Only two steps and a concluding test remain.

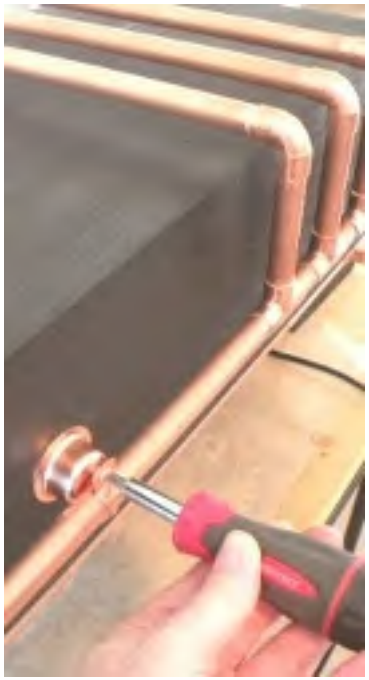
LOGICAL CONCLUSION

Conjoining Amplifier and Transducer Units



SCREWING THE AMP CHASSIS TO THE SPEAKER CABINET

Affixing Supporting Scaffolding



ATTACHING THE FRAME, GLUING THE AS-YET UN-GLUED JOINTS

Final Examination (Posterior Perspective)

FINAL TEST
HOW DOES IT SOUND?
SWEET

Certified Device (Anterior Perspective)

AND THERE YOU HAVE IT
LET'S WRAP
THIS STORY UP

Unaccounted Expenditures

Minor components and various apportioned shop supplies not previously detailed appear below.

PART		SUPPLIER	PRICE	QTY	EXT
Colloidal Adhesive Agent	(WOOD GLUE)	Lowes	3.49	1	3.49
Pure Cotton Tatters	(RAGS)	Lowes	0.35	1	0.35
Ring-Shank Pressure Activated Fasteners	(NAILS)	Lowes	1.98	1	1.98
Truss-Head Rotary Fasteners, #8 x 1-1/2"	(SCREWS)	Lowes	0.05	22	1.10
Makeweight Dough	(PUTTY)	Lowes	1.20	1	1.20
Adhesive Filler	(CAULK)	Lowes	3.69	1	3.69
Coated Abrasive, 46.2 uM avg particle size	(SANDPAPER, 320 GRIT)	Lowes	1.10	1	1.10
Coated Abrasive, 125 uM avg particle size	(SANDPAPER, 120 GRIT)	Lowes	1.10	1	1.10
Turpentine-Based Pigmented Coating	(STAIN)	Lowes	2.15	1	2.15
Dilating Anthropoid Ape Adhesive	(GORILLA GLUE)	Lowes	3.49	1	3.49
Various Zinc-Plated Steel Fasteners	(BOLTS, NUTS, ETC)	Lowes	0.05	152	7.60
Hexagonal Tube Flanges	(RINGS AROUND TUBES)	Home Depot	5.35	3	16.05
Pigmented Adhesive Aerosol Coating	(SPRAY PAINT)	Lowes	2.25	1	2.25
Alchemy Fluid	(GUN BLUE)	Amazon	9.95	1	9.95
Diamagnetic Roll Stock 12" x 6" x 0.005"	(THIN COPPER SHEET)	Hobby Lobby	3.48	1	3.48
Acoustical Damping Fabric	(QUILT STUFFING)	Walmart	4.35	1	4.35
Potentiometer Hand Grip	(VOLUME KNOB)	eBay	4.79	1	4.79
Tin / Lead Conjoining Alloy	(SOLDER)	Future Elec.	0.45	1	0.45

THIS PAGE:
$68.57

GRAND TOTAL:
$443.22

The Coppertone Family

Finally, we see the newly-minted Model 5c1 on exhibit with the five elder siblings of the Coppertone Amplification Society's line of audio amplification devices to date. Each unique, but each bearing a distinct familial resemblance.

AND WHICH, YOU MAY ASK, IS MY FAVORITE?
THE NEXT ONE, OF COURSE!

Model 5c1

Model 101

Model 201

Model 301

Model 201-B

Model 802

Index