Modification and Assembly of a Fender Deluxe Reverb with Patchable Ring Modulator

John Horstman and Drew Tarico
Physics 398EMI
Prof. Steve Errede

Introduction

Since Leo Fender began selling amplifiers in the 1940's, Fender amps have produced a sound sought after by many guitarists. Many of Fender's original designs generated such a desirable tone that today's high-tech amp companies are all researching ways to make solid state designs sound as good as the equipment produced half a century ago. Rather than following these companies in trying to create an imitation of a classic, we decided to take on the original, with a few modifications made to improve its performance.

Motivation

This class offers a lot of freedom when choosing a semester project; student projects range from vintage guitar and amp assembly to more contemporary studies like MIDI controller functionality. Our common goal was to create a working device for personal use. Effect boxes and pedals were considered as potential projects, as were various amplifiers. Not being able to abandon any good ideas, we finally decided on a little bit of both: a Fender Deluxe Reverb with an external effects box containing a ring modulator, oscillator, and internal mixer.

The Deluxe is famous for its gorgeous clean tone (as are many Fender amps from the 50's and 60's). The circuit is more complex than that of the Champ or the Princeton, but at the same time it is not so daunting that a novice could be overwhelmed by its construction. We chose to build a ring modulator for its versatility and its charisma. The ring mod is probably most well known for the non-musical output it generates, which is produced by modulating two input signals. We jumped at the chance to play with something so well suited to experimentation.

Amplifier

Circuit Design and Modification

The original design of the Deluxe Reverb ("Deluxe Reverb - AMPAB763" schematic, see Appendix A) included some features beyond the standard volume and tone controls. There was a separate circuit for a vibrato effect with its own dedicated preamp stage. An effects loop was also included that sent the guitar signal to a reverb tank and some additional signal conditioning. We eliminated these features from our design, due mainly to budget constraints and chassis space concerns.

As a substitute for the effects loop which incorporates the reverb in the original schematic, we implemented an effects send and return designed by Prof. Errede. The loop is incorporated into the preamp stage, sending a line level signal to the effect and expecting roughly a line level signal in return. This method uses tip shunt jacks to bypass the effects send when no effect is plugged in. When we connect an effect, a feedback loop sends the wet signal to both the EQ/volume circuitry and back to the input of the effect itself.

Our power amp stage is nearly identical to the Fender schematic except for two modifications. First, we are using two 100k resistors attached to the plates of our 12AT7 instead of an 82k and a 100k. This results in a slightly more distorted output from our amp since we aren't running one plate quite as hot. Second, we are using 6L6 power tubes instead of 6V6's like the Fender schematic. These tubes are more powerful than

6V6's, which means that we must be careful not to crank the gain up to high and ruin our output transformer.

The switch to the 6L6's corresponds to the larger power transformer we are employing. Our circuit uses a Thordarson T-22R06, which is about 10 W more powerful than the transformer Fender calls for (for transformer data, see Appendix C). The Thordarson forced us to change a few of the resistances surrounding the power tubes to make sure that the tubes received the proper voltage. A 2k resistor was added before the screen resistors to drop the screen voltage below the plate voltage. Some additional circuitry was added to bring -Vbias into the desirable range for a 6L6, which is roughly between -48 V and -65 V (for a listing of all measured tube voltages, see Appendix D).

Layout

Fender engineers performed a good deal of noise testing on their circuit to determine an optimum layout. Factors which can contribute to noise include transformer orientation, tube placement, and component proximity. We took advantage of Fender's research by following the original layout diagram as closely as possible (Appendix B). Generally, the power handling circuitry sits closer to the power transformer than the preamp circuitry, which is pushed toward the far end of the chassis. All tubes are arranged in a straight line along the back of the chassis; this arrangement minimizes interference from other tubes. Our transformer coils are aligned in 3 different directions to avoid coupling, which can be nasty if not taken into consideration before mounting the transformers.

Parts

Acquisition of proper components was a major obstacle that plagued us through the semester and all the way into finals week. The circuit calls for specific parts, values, and component types which sometimes cannot be substituted with anything else. For example, the orange drop capacitors used for many of the .1 μF capacitances in our amp were not on hand in the lab. The same goes for the 16 μF power caps, for which we needed five large electrolytics. Luckily, Prof. Errede was able to provide us with these parts, as well as a few others: our volume, treble, and bass pots; our output transformer and choke; and the ceramic tube sockets used for our rectifier and power tubes. We purchased our power transformer and all of our tubes through a friend of the professor who deals in vintage amp parts. The chassis is a gutted out rack-mount device of some sort. Store-bought items include jacks, pegboard, miscellaneous components, and various screws and nuts. Many remaining parts (switches, pilot light, most resistors) were on hand in the lab.

Assembly

We approached the building process by generally separating the mechanical assembly and the electrical assembly for as long as possible. While one of us drilled holes for the transformers, jacks, and tube sockets, the other soldered the electrical components onto the pegboard. When these two projects finally had to be combined, the inside of our chassis quickly turned into a complicated mess of wires. Luckily we had optimized our layout so that many of the runs were as short as possible, but there were still so many connections running off of the board to the pots, jacks, tubes, and transformers that manipulating the soldering iron became a delicate surgery. We were able to work on the circuit by attaching the top plate of our chassis with a duct tape hinge so that the tube wiring could stay attached while we poked around inside. Electrical tape played a big part in many of our transformer connections, since the transformer wires are stiff and they like to stick in the air in the middle of the amp.

Debugging

We didn't do much debugging until our amp was almost entirely assembled, at which point we discovered that we were running all of our tubes way too hot. It was at this point that we made many of the modifications discussed in the circuit design section earlier, such as decreasing the plate voltages, screen voltages, and some cathode voltages. These problems did not cause the circuit to fail; we could still produce an output that sounded reasonably good. However, there was a noticeable amount of distortion and the gain was enormous (we were shaking the room with our volume dial set to about 2 out of 10). Running the tubes at their ideal voltages is not only much safer but also increases the lifetime of the tubes, and it creates a much cleaner output in the amp.

Conclusion

We are pleased with the output tone of our amplifier, and we would call the project a complete success. Not only did we learn more about the theoretical function of an amplifier, we practiced assembly techniques and discovered design considerations that could not be gained without hands-on experience. Most importantly, we learned the

value of having an experienced lab monitor around to oversee the production of your amp. Thanks to Professor Steve Errede for all of his help.

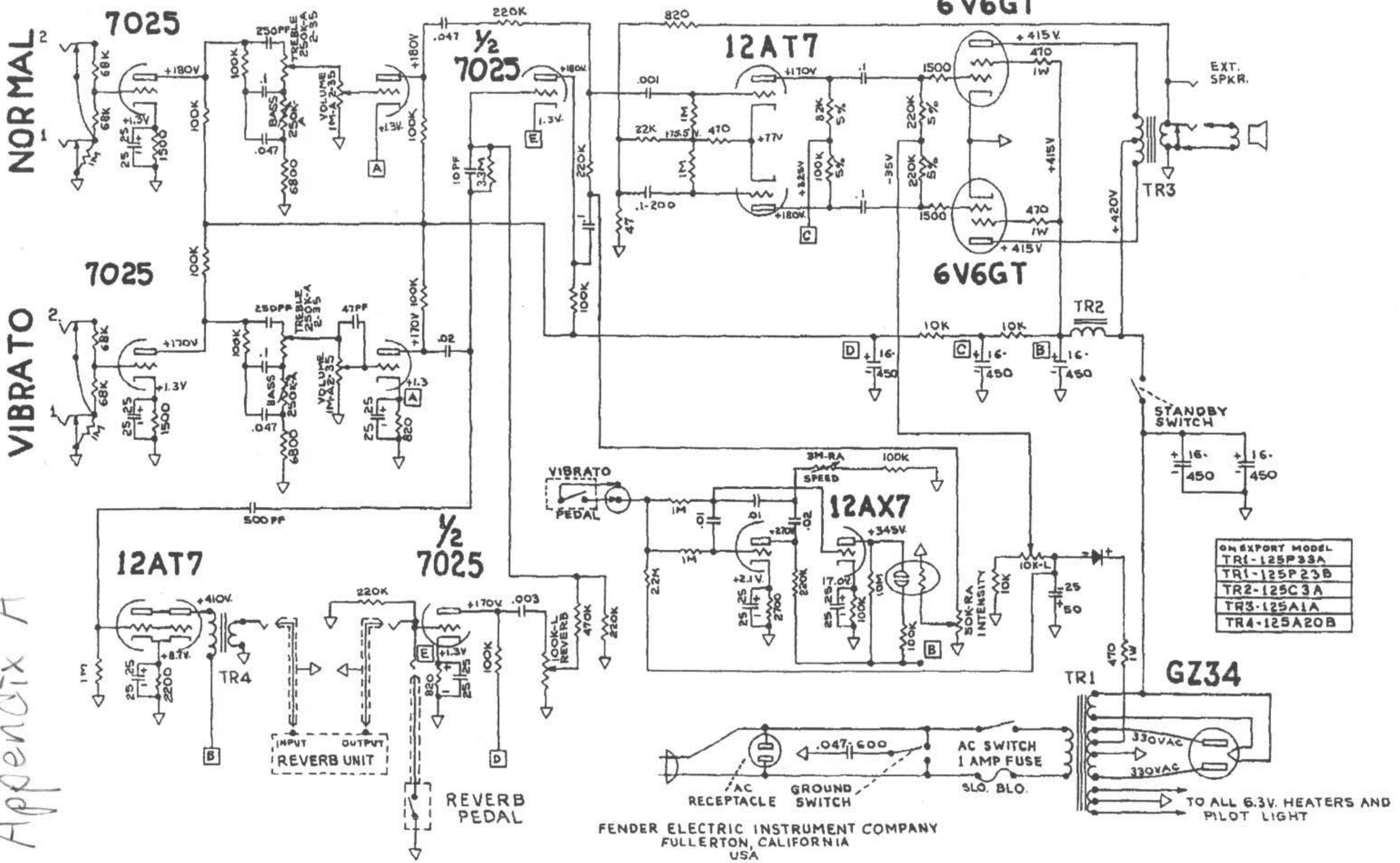
FENDER MODEL "DELUXE REVERB-AMP AB763" SCHEMATIC

THIS PRODUCT MANUFACTURED UNDER ONE OR MORE OF THE FOLLOWING U.S. PATENTS
CIRCUIT PATENT #2817708, #2973681
DESIGN PATENT #192859

C-FD

NOTICE

1 - VOLTAGES READ TO GROUND WITH ELECTRONIC VOLTMETER VALUES SHOWN + OR - 20%
2 - ALL RESISTORS ½ WATT 10% TOLERANCE IF NOT SPECIFIED
3 - ALL CAPACITORS AT LEAST 400 VOLT RATING IF NOT SPECIFIED

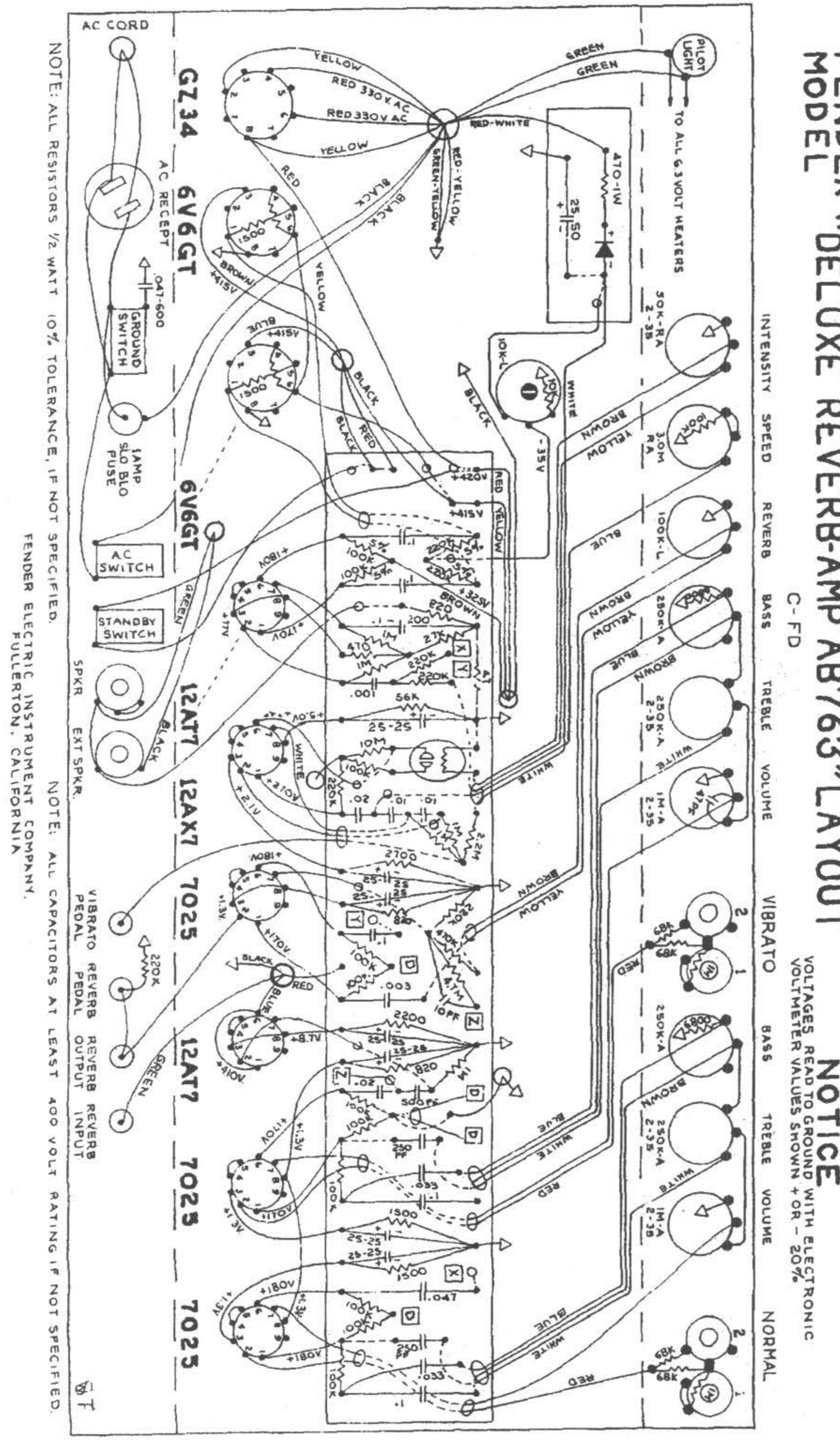


ON EXPORT MODEL
TR1-125P33A
TR1-125P23B
TR2-125C3A
TR3-125A1A
TR4-125A20B

FENDER ELECTRIC INSTRUMENT COMPANY
FULLERTON, CALIFORNIA
USA

Appendix A

Appendix B


FENDER "DELUXE REVERB-AMP AB763" LAYOUT
MODEL
C-FD
NOTICE
VOLTAGES READ TO GROUND WITH ELECTRONIC VOLTMETER VALUES SHOWN + OR - 20%
INTENSITY
SPEED
REVERB
BASS
TREBLE
VOLUME
VIBRATO
NORMAL
TO ALL 6.3 VOLT HEATERS
PILOT LIGHT
AC CORD
AC RECEPT
GROUND SWITCH
1 AMP SLO BLO FUSE
AC SWITCH
STANDBY SWITCH
SPKR
EXT SPKR
VIBRATO PEDAL
REVERB PEDAL
REVERB OUTPUT
REVERB INPUT
GZ34
6V6GT
6V6GT
12AT7
12AX7
7025
12AT7
7025
7025
NOTE: ALL RESISTORS 1/2 WATT 10% TOLERANCE, IF NOT SPECIFIED.
NOTE: ALL CAPACITORS AT LEAST 400 VOLT RATING IF NOT SPECIFIED.
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FULLERTON, CALIFORNIA

Appendix C: Transformer Measurements

Thordarson T-22R06

All measurements are made in volts, except resistance which is in ohms

	no input signal	input signal at 1 kHz	input signal at 60 Hz	resistance	Vtrue (rms)
Yellow (circuit power)	0.0036	0.0452	0.0419	0.3	0.0417
Red (main seconary)	0.0036	2.872	2.625	84.9	2.625
	0.0036	2.865	2.632	80.4	2.632
Green (pilot light and heaters)	0.0036	0.0294	0.0272	0.3	26.96
	0.0036	0.0298	0.0273	0.3	27.06

Appendix D: Tube Voltages

Power Tubes

All measurements were performed with the amp operational, units are all in volts

	plate	screen	grid	cathode
1st 6L6	454	453	-50.1	0.02
2nd 6L6	454	453	-50.1	0.02

Preamp Tubes

All measurements are recorded in Volts

	A			B		
	plate	grid	cathode	plate	grid	cathode
1st 12AX7	332	N/A	103	233	0	1.55
2nd 12AX7	221	0	1.61	332	N/A	122
12AT7	212	N/A	81.8	188	N/A	81.8

Appendix E: Parts List

Amp (based on Fender Deluxe Reverb AB763 schematic)

*All resistors are 1/2 W, 10% tolerance (silver) if not specified

**All capacitors are 400 V rating if not specified

Resistors			
value (ohms)	count	color scheme	notes
47	1	yellow-violet-black	
470	1	yellow-violet-brown	
820	2	gray-red-brown	
1k	1	brown-black-red	
1.5k	5	brown-green-red	
4.7k	1	yellow-violet-red	
6.8k	1	blue-gray-red	
22k	1	red-red-orange	
68k	2	blue-gray-orange	
100k	6	brown-black-yellow	
220k	2	red-red-yellow	
1M	6	brown-black-green	
82k	1	gray-red-orange-gold	5% tolerance
100k	1	brown-black-yellow-gold	5% tolerance
220k	2	red-red-yellow-gold	5% tolerance
470	2	yellow-violet-brown-gold	1 W
	35		

Capacitors (uF if not specified)		
value (uF)	count	notes
250p	1	
0.001	1	
0.047	2	
0.1	7	
0.047	1	600 V rating
0.1	1	200 V rating
16	5	450 V rating
25	2	25 V rating
	20	

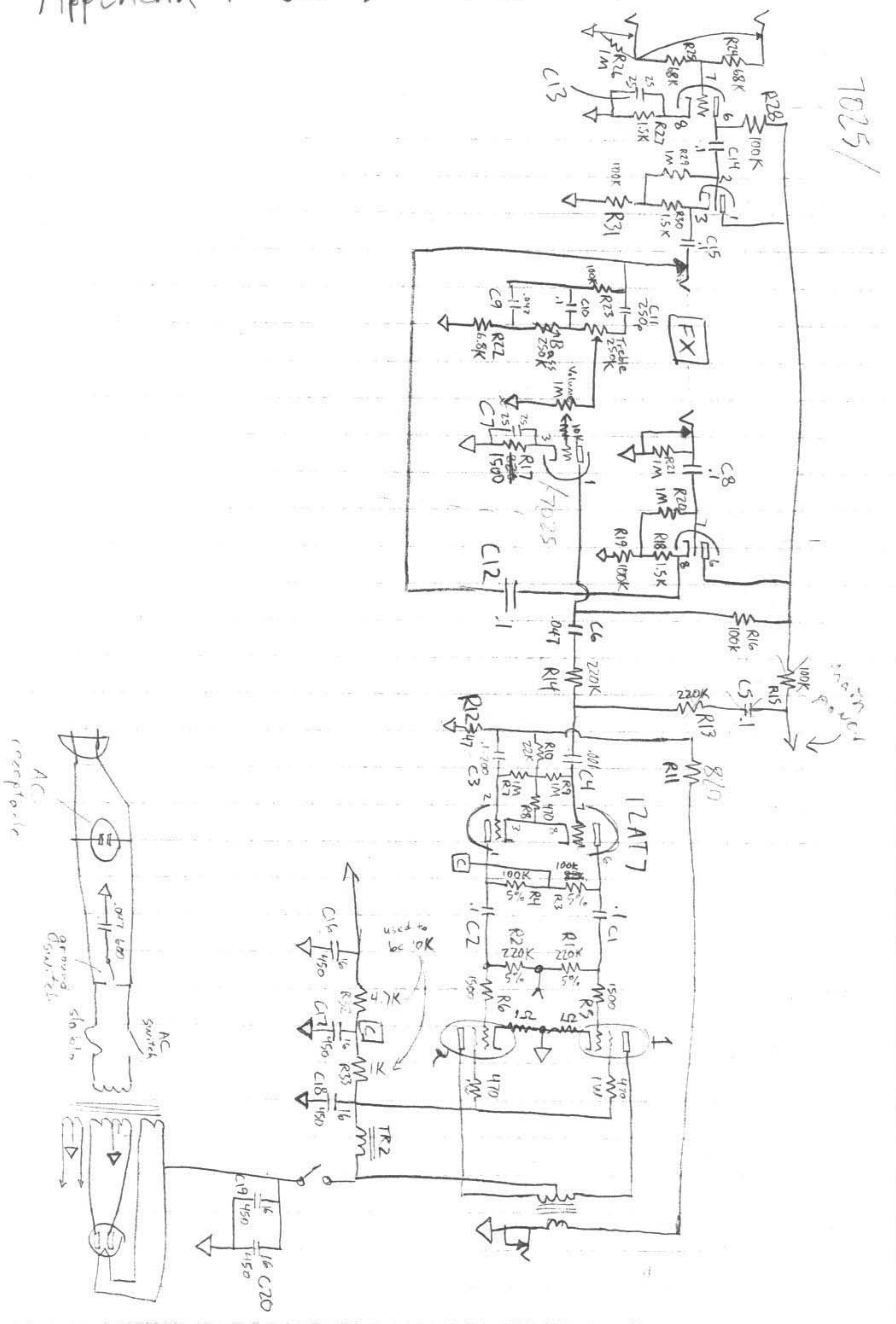
Tubes		
model	socket	count
5AR4	8-pin	1
6L6	8-pin	2
12AX7	9-pin	2
12AT7	9-pin	1

Transformers	
type	model
power	Thordarson T-22R06
output	original Fender Deluxe Reverb transformer
choke	original Fender Deluxe choke

Potentiometers	
value (ohms)	count
250k	2
1M	1

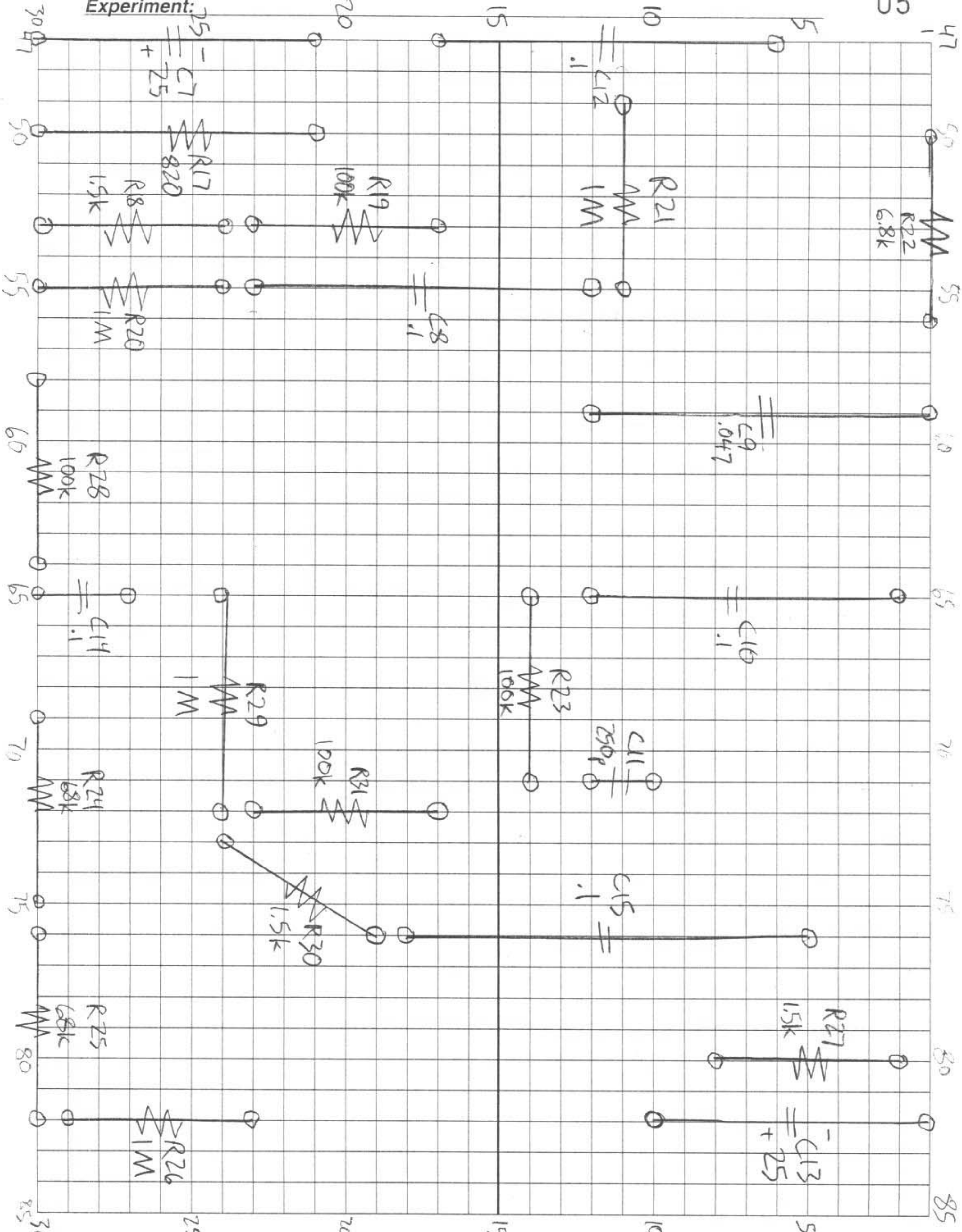
Misc.	
count	part
5	tip shunt jacks
1	power switch
1	pilot lite
1	slo blo 1 A fuse
1	fuse holder

Appendix F: Our Schematic



Name: Appendix G: Circuit Layout **Date:** Preamp stage

Experiment:



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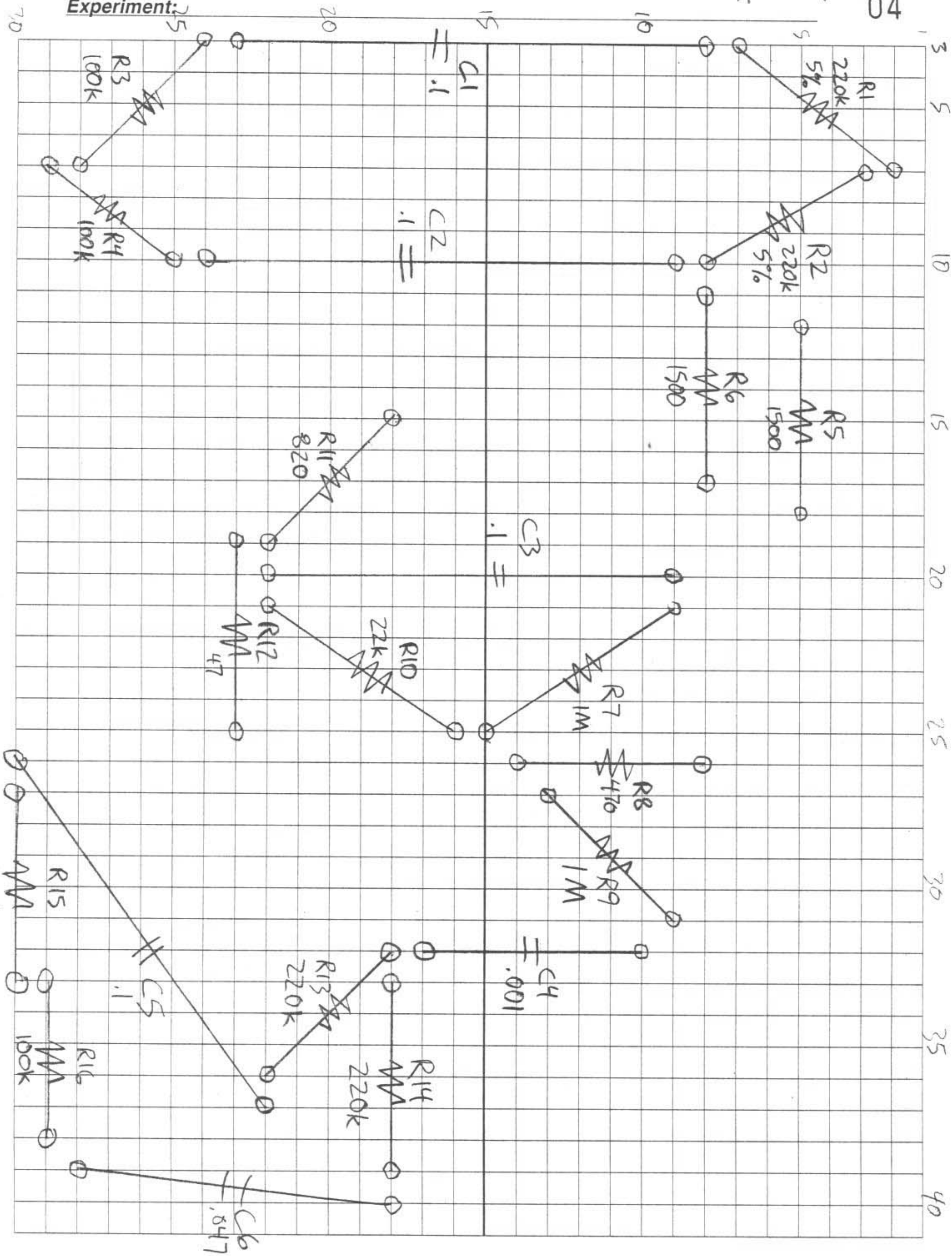
Name:

Date: Power Amp stage

04

Experiment:



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