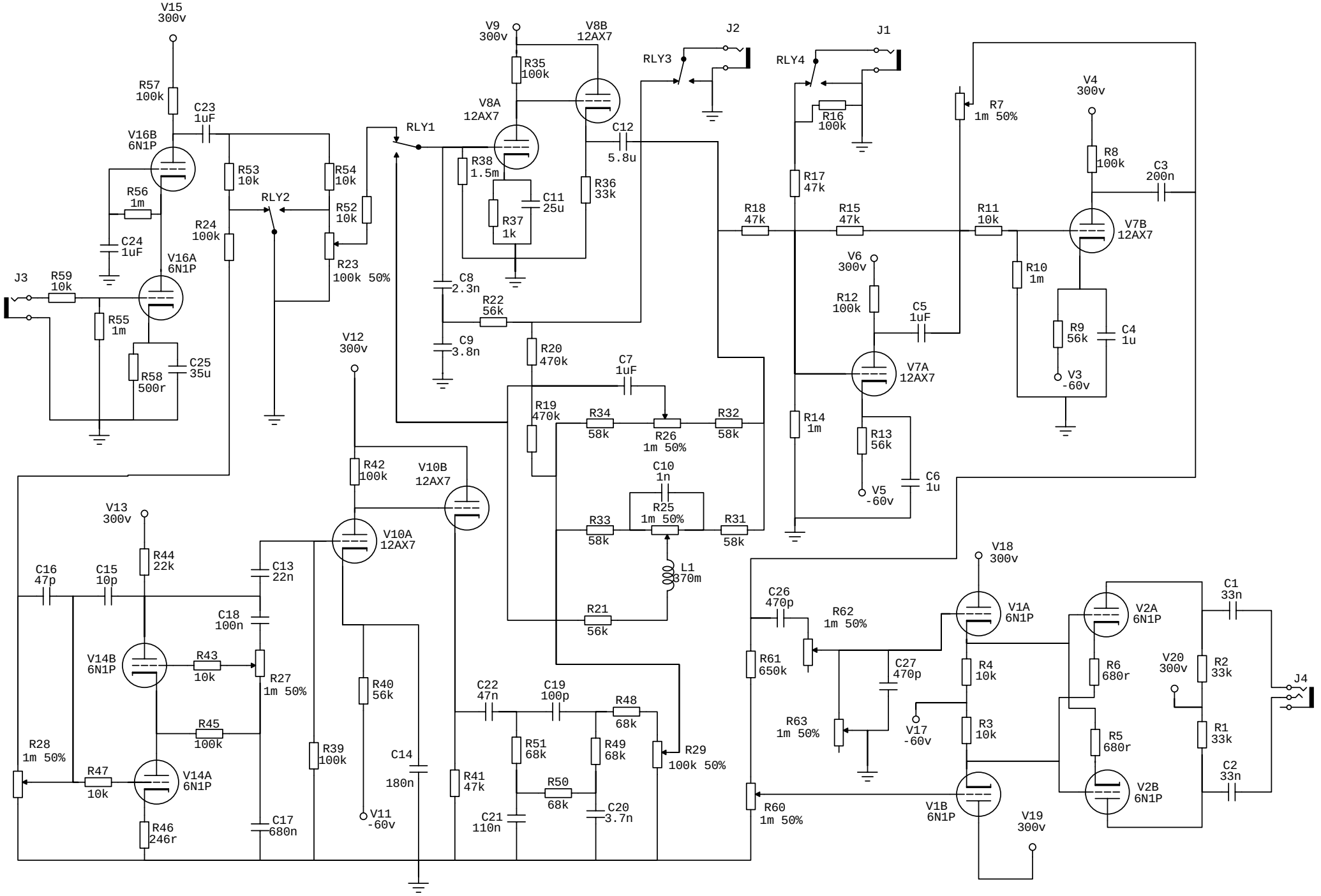
TUBE ELECTRIC GUITAR PREAMP

Ken Gilbert

1. POWER SUPPLY
    a. The complete power supply circuit will be drawn and described in a separate file.
2. SWITCHING CIRCUIT
    a. **RLY2** and **RLY1** are switched together on one footswitch circuit ***("Channel").***
    b. **RLY3** and **RLY4** are switched together on another footswitch circuit ***("Effects").***
3. SIGNAL I/O
    a. **J3** is the input jack. Input impedance >1M.
    b. **J2** is the low Z ***Effects Send***.
    c. **J1** is the parallel ***Effects Return***.
    d. **J4** is the ***Balanced Output*** <5K.
4. USER CONTROLS
    a. ATTENUATION CONTROLS
        i. **R23** adjusts the ***Clean Gain.***
        ii. **R28** adjusts the ***Distorted Gain,*** and is dual-ganged with **R27**. Note that **R27** and **R28** must be wired "out of phase" with one another—turning the pot "up" will make **R28's** wiper move up, and **R28's** move down. ***(All other vertically oriented pots on the schematic will follow an up/right trend.)***
        iii. **R29** is the ***Distorted Volume.*** It is used primarily to match levels with ***Clean Gain.***
        iv. **R7** is the ***Master Volume.***
    b. EQ CONTROLS
        i. **R62** and **R63** are dual ganged as well and comprise the ***Frequency*** control. See part 5p.
        ii. **R60** is the ***Shape*** control, which adjusts the amplitude of the frequency set by **R62** and **R63**.
        iii. **R26** is a HF shelving type active EQ control. This control is only effective when using the distorted channel.
        iv. **R25** is a corresponding LF shelving control, again effective only when using the distorted channel.
5. THEORY OF OPERATION
    a. **V16A** and **V16B** are operated as a cascode circuit. As shown, the circuit generates approximately 200x amplification factor, or 46 dBvg, as measured. It is an excellent input stage, but **R59**, the "grid stopper," must not be eliminated—the RF performance of the cascode is quite excellent, and **R59** creates a pole at around 2.5 MHz. This value can be increased in noisy environments to lower the break frequency (F = 1/[2 pi R 0.000000000005])
    b. **RLY2** is a shunt switch to ground that eliminates input from the channel not in use. Being a hard electromechanical relay it has excellent performance and switching noise is not an issue. Be sure to include diode flyback snubbers across the coils.
    c. **R53** and **R54**, along with the shunt switch of **RLY2,** present a heavy AC load to the cascode at all times. This maximizes the even harmonic distortion generated in the plate circuit. The output of the cascode is high impedance, something in the 50k range. The output is greatly diminished by the heavy shunt impedance to ground, but this is not an issue with the 100+ VAC signals easily achieved with the stage gain of ~200—there is still more than enough signal to sufficiently drive subsequent stages.
    d. **RLY1** is a series switch that eliminates output from the channel not in use.
    e. **V14A** and **V14B** are operated as another cascode circuit. **R27** and **R28** are dual-ganged, and together they simultaneously adjust both the input signal to **V14A** and the plate-derived NFB to the grid of **V14B**. **C10** and **C17** are there to couple signal and ground respectively, while maintaining DC bias via **R45**. **R27** adjusts the proportion of the out of phase plate signal fed back, degeneratively, to **V14B's** grid. This is akin to a pentode/UL/triode control, and simultaneously adjusts both voltage gain and output impedance.

f. Positive signal excursion of **V14's** plate is limited by the action of the relatively low value of Rp, creating clipping as the plate attempts to soar above the supply rail. This limit of positive excursion also lessens the effects of grid blocking in the following stage, **V10A**.
g. **R40** is tied to a negative supply rail, and serves to increase the maximum effective negative excursion of **V10A's** grid, delaying pinch off of the plate current. Gain, especially in the HF region, is maintained by the bypass action of **C14**.
h. **C19**-**C22**, and **R46**-**R51** form a frequency-shaping network that "scoops" mids from the distorted channel. **C19's** dielectric (ceramic, mica, plastic) should be determined empirically since it has a great effect on the HF response, so try different types here.
i. **V8A** and **V8B** form a high gain, low output impedance, inverting amplifier. **C8**, **C9,** and **R22** are always "in circuit" and create an additional mid scoop effective on both channels.
j. **R20** and **R19** set the gain of **V8** to be –1 at midband.
k. **C7**, **L1**, and **R21** set the effective frequency range of the LF and HF shelving filters. **C7** determines the HF break frequency, and the value of **R21** affects the Q—or bandwidth—of the LF control. Sweeping potentiometers **R25** and **R26** provides for approximately 20 dB boost or cut of LF and HF respectively. **L1** is a scavenged toroidal SMPS inductor, all windings connected in series.
l. The cathode output of **V8B** also provides low Z drive for an effects loop, accessible through **J2**.
m. **V7A** is set up as an inverting, unity gain virtual-earth summing buffer. Overall gain of dry signal is determined by the ratio of **R18** and **R15**. Likewise, gain of effects signal, injected through **J1**, is determined by ratio of **R17** and **R15**. This allows for a virtual-earth at the grid of **V7A**, and ensures effective mixing of both signals.
n. **V7B** is set up similarly, except the "feedback resistance," **R15** in the previous stage, is now variable resistor **R7**. This feedback loop allows for an output signal attenuator that exhibits little tonal change across its range of effectiveness.
o. **V1** and **V2** are set up as a cross-coupled, or Van Scoyc phase splitter. Bias for the plate loaded, cathode driven **V2** is adjusted via the cathode resistors **R5** and **R6**. Bias for BOTH **V1** and **V2** is adjusted via **R3** and **R4**. If a different tube is chosen, these values will need to be redetermined. **V1** is merely a buffer that prevents heavily loading the signal, which would occur if **V2's** cathodes were directly driven.
p. **R62**, **R63** and **R60** adjust the frequency and response of the midrange control. They do so by changing the RC product—the time constant—of **V1A's** grid circuit, and thus provide a sweepable midrange frequency. Degenerative mixing with the full-range signal present at **R60** creates a boost or cut as desired. Together they create a semi-parametric midrange control.
q. **J4** presents a medium/low impedance (4k) balanced line output. The shield of **J4** should be earthed at either end, but not both, for best ground loop rejection. Better PSRR and larger output voltage swings could be achieved with a center tapped inductive load on **V2**.
r. Output voltage at **J4** is sufficient to drive final grids of approximately 50W push-push pull tube power amplifier.
s. NOTE: all wires should be assumed as CONNECTED except the following crossovers: the junction to the left of **R21** is <u>not</u> a connection, nor is the one near **R5** and **R6**.

Questions/Comments:
Ken Gilbert


V15
300v
R57
100k
C23
1uF
V16B
6N1P
R53
10k
R54
10k
RLY1
R56
1m
RLY2
R52
10k
R24
100k
C24
1uF
V16A
6N1P
R23
100k 50%
J3
R59
10k
R55
1m
R58
500r
C25
35u
V9
300v
V8B
12AX7
R35
100k
V8A
12AX7
C12
5.8u
R38
1.5m
R36
33k
C11
25u
R37
1k
C8
2.3n
R22
56k
C9
3.8n
RLY3
J2
RLY4
J1
R16
100k
R17
47k
R18
47k
R15
47k
R7
1m 50%
V4
300v
R8
100k
C3
200n
R11
10k
V7B
12AX7
R10
1m
R9
56k
C4
1u
V3
-60v
V6
300v
R12
100k
C5
1uF
V7A
12AX7
R14
1m
R13
56k
V5
-60v
C6
1u
V12
300v
R20
470k
C7
1uF
R19
470k
R34
58k
R26
1m 50%
R32
58k
C10
1n
R25
1m 50%
R33
58k
R31
58k
L1
370m
R21
56k
R42
100k
V10B
12AX7
V10A
12AX7
V13
300v
R44
22k
C16
47p
C15
10p
C13
22n
C18
100n
V14B
6N1P
R43
10k
R27
1m 50%
R45
100k
R28
1m 50%
R47
10k
V14A
6N1P
R46
246r
C17
680n
R40
56k
R39
100k
C14
180n
V11
-60v
C22
47n
C19
100p
R48
68k
R51
68k
R49
68k
R29
100k 50%
R41
47k
R50
68k
C21
110n
C20
3.7n
V18
300v
C26
470p
R62
1m 50%
V1A
6N1P
R61
650k
C27
470p
R4
10k
R63
1m 50%
V17
-60v
R3
10k
R60
1m 50%
V1B
6N1P
V19
300v
V2A
6N1P
R6
680r
R5
680r
V2B
6N1P
C1
33n
V20
300v
R2
33k
R1
33k
C2
33n
J4