FRESE AUDIO PILOT

Instruction Manual

Model AP-4

DESCRIPTION OF THE AUDIO PILOT
for BROADCAST AUTOMATIC LEVEL CONTROL

Purposes.

The Audio Pilot has three purposes in a radio broadcast system which are described below:

Maximum Modulation: The primary purpose of the Audio Pilot is to provide an audio modulating voltage to the radio transmitter which is, at all times, the very maximum the system limits can accept without violation of the limits, and consistant with the ultimate for maximum intelligence and the highest degree of desirability for all material transmitted.

Prevention of Overmodulation: The second purpose of the Audio Pilot is to prevent overmodulation at any time, regardless of the nature or intensity of the wave form transmitted.

Automatic Control: A secondary or third purpose of the Audio Pilot provides exact automatic level control regardless of errors on the part of the control board operator or the level characteristics of the original material.

Installation.

The Audio Pilot takes the place of the limiter, compressor, and any other leveling device used in the system. It may be installed at the studio or in the transmitter location, but it is slightly preferable to install it at the transmitter.

Brief Description of How it Works.

The audio input, after passing through the input matching transformer, is split into three channels for processing: the through pilot modulator channel, the internal limiter channel, and the activator channel.

The Through Pilot Modulator Channel: The through pilot modulator channel consists of a balanced modulator and a final balancing output stage. The input audio is modulated in the pilot modulator at the pilot voltage control rate. The pilot modulating control voltage is completely balanced out of the output, leaving only the original audio, but with new amplitude characteristics in accordance with the pilot modulating voltage.

The Internal Limiter Channel: The internal limiter channel has internal characteristics somewhat typical of a standard limiter. Its audio output is rectified, split and fed into the integral control amplifier, and differential control amplifier. The integral control amplifier has two outputs of slightly different amplitude. Number one output is used to produce internal limiting. Number two output (slightly different from the number one output) contains the integral part of the pilot modulating voltage. It differs from the number one output voltage just enough to produce a perfectly flat output characteristic, rather than the rising characteristic of the internal limiter. The differential amplifier passes rate of change voltages to make up the differential part of the pilot modulation voltage. This circuit is instantaneous so as to catch any loud surprise or spike pulse audio voltage, and will decay instep with the intergrating circuit rise. A second desirable characteristic derived from this integral-differential combination control circuit is that gun shots, record pops, or any sudden clap noise will not punch holes in the program.

The Activator Channel: The activator channel produces two modes of operation of the intergral control circuit: active or rest. With no audio input (audio level below a preset value of approximately -35 dbm) the circuit goes to rest. In the rest position the gain change is very slow and seeks a low resting value. With audio input levels above the present level, the circuit goes to active. In the active position,

gain time release is more rapid and the gain can reach high values with a low level signal input. The input audio to the activator channel passes through a 60 cycle bridge notch filter so that 60cycles by its self cannot pass through to operate the activator circuit. The purpose of the activator circuit is to prevent noise pumping during silent periods such as between words in a speech program, or during silent pauses in music, and to set the gain to a closer ready to go position for future audio.

Special Features.

Proof off-on and Proof Gain Controls: With the proof switch thrown to on, all automatic control is disabled and the channel gain is controlled by a manual control, and the gain is read on the gain meter. This serves two purposes: one, it simplifys the running of an audio proof; two, it gives a method to make a direct comparison between sound produced by the automatic control against the original sound.

Recovery time: Recovery time is continuously variable from slow to fast. This allows for a setting which best satisfies individual broadcaster needs.

Balancing: The unit contains circuits to test and balance tubes over its complete dynamic range of operation.

Leveling Characteristics: A flat level characteristic is believed to be by far the most desirable. This unit is capable of any level characteristic; thus if the level characteristic of any older type limiter, compressor or a new dreamed of characteristic was wanted, the Audio Pilot could be adjusted to such a characteristic.

Float Clippers: With the instantaneous flat characteristic of the Audio Pilot, floating clippers become workable and desirable. The clippers float just above the 100% modulation point. Then the negative float is weighted to cause a slight sink. The process is used to further increase modulation power, without over modulation, and with absolutely no noticable distortion when switched in or out, but with a noticeable increase of audio level.

Specifications.

Frequency response: ± 1.0 db 30 to 20,000 cycles
Harmonic Distortion: below .3% at all levels
Insertion system gain: + 10 db
Input level: 0 dbm
Output level: +10 dbm (maximum +20 dbm)
Useable gain change: 40 db
Input and Output Impedance: 600 ohms

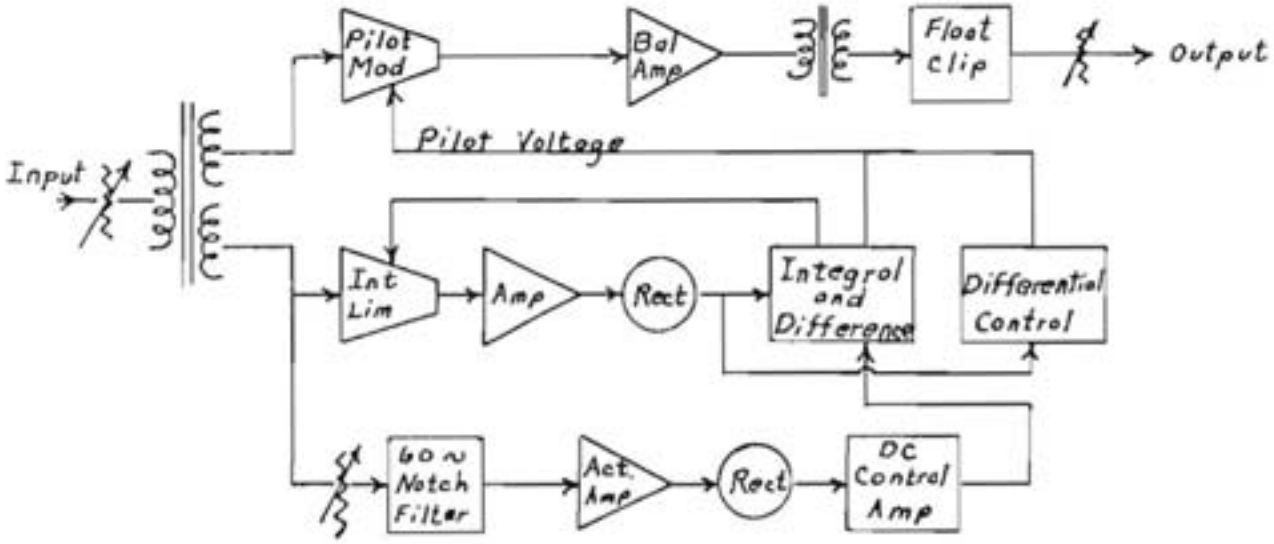
Final Results.

Coverage: For AM stations coverage is considerably increased and the outer limits are more definitely fixed. Close in service is improved where there is exceptionally high noise level from neon signs and etc.

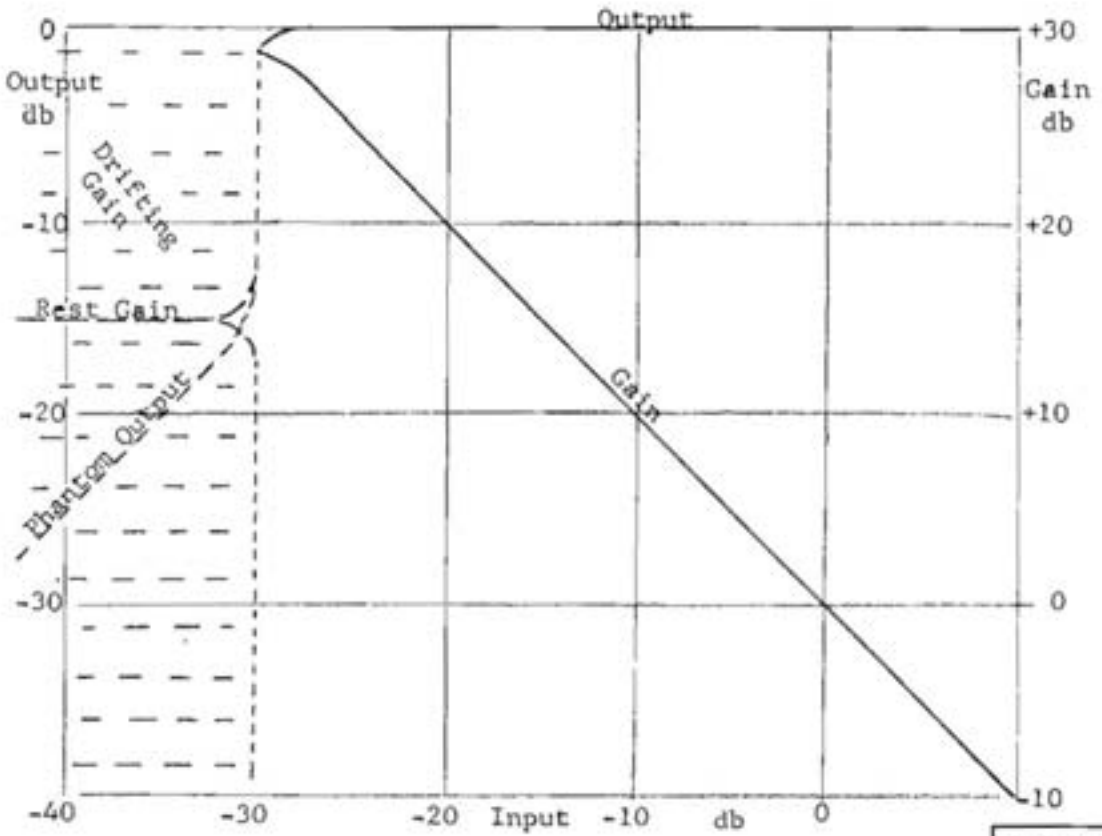
Volume: News casts and other speech material contains more intelligent information and are therefore easier to listen to.

Desirability: Here we have a new concept for audio broadcasting, that all audio regardless of its original dynamic level, shall be passed through the system at the maximum level the system is capable of handling. Without direct experience with this concept, the question (what affect does this technique have on the dynamic effects of music, particularly classical music) should come to mind. From many hours of experimentation with many people, I believe the maximum level concept for broadcasting is more desirable to listen to than the normal or modified concepts now in use for several reasons, but the logical way for you to decide upon these findings is to hear your favorite music played through an Audio Pilot system.

FRESE AUDIO PILOT



Block Diagram



Performance Characteristics

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ENGINEERING REPORT

by George M. Frese, P. E.

AM MODULATION PROCESSING - PRODUCTS AND SERVICE

Explanation of the Purpose and Scope of this Project.

The Products and services explained in this paper are for the purpose of enhancing the AM modulation process so as to deliver to the receiver the highest quality of desirable audio possible. The objectives are to extend the outer limits of usable service, to overcome man made interference, to provide a more pleasing sound, to produce a more dynamic appearance compared to the present process or competition, and to increase the general intelligence transmitted in order to make listening easier. The objectives set forth are accomplished in six items of products and services as described in the remainder of this paper.

The Audio Pilot.

The Audio Pilot is a product designed to provide automatic control of the audio level fed to the transmitter. It uses a new concept for broadcasting: the audio level fed to the transmitter is always the maximum the system peak limitation will allow. The level is controlled so exact, over modulation will never occure. The control board operator can not make gain control errors, nor is the level transmitted dependant upon the level characteristics in the original material.

The Linearity Correction Amplifier.

This is a product designed to correct for nonlinearities that occure in the transmitter audio and modulation process. It will extend the linearity range of the system and reduce audio distortion of the overall system. The unit also provides for negative clipping and clip rounding so that maximum advantage can be taken of the extended positive range. A secondary purpose of the LCA is to allow the using of old transmitter power tubes for many thousands of hours longer than otherwise.

The Response Network.

A flat response is not the most ideal to achieve the objectives set forth. Frequencies below 100 cycles are seldom heard in AM service. To transmit frequencies below 100 cycles results in the using valuable amplitude modulation space with a very small return. The network maintains flat response down to 100 cycles, then filters out all voltages below 100 cycles, and provides for a slight boost between 2500 to 4000 cycles.

Antenna Load Correction.

The antenna impedance is usually not a constant resistance load for plus and minus ten kilocycles each side of the carrier, and consequently some r-f side band power is lost and can not be made up or compensated for by any other process. This service consists of measuring the band response of the antenna system network, designing and installing compensating elements to the tuning network to provide a constant resistive load for the pertinent bandpass.

Carrier Shift Correction.

Negative carrier shift in an AM transmitter results in a decrease in demodulated audio power in the receiver, which is proportional to the square of the carrier shift. As the P.A. tubes age, negative carrier shift increases. Carrier shift correction is accomplished by adding to the transmitter a small modulation device capable of positive pulse modulation with a shift of the DC reference, with modulation capacity up to about ten percent.

Facility Service.

Usually some or considerable improvement to an existing broadcast station can be made by bringing all system equipment up to its highest standard of performance in the following areas: overall frequency response, distortion, carrier shift, modulation capacity and settings, P.A. effeciency and antenna tuning, and miscellaneous items.

BLOCK DIAGRAM OF THE AP-4

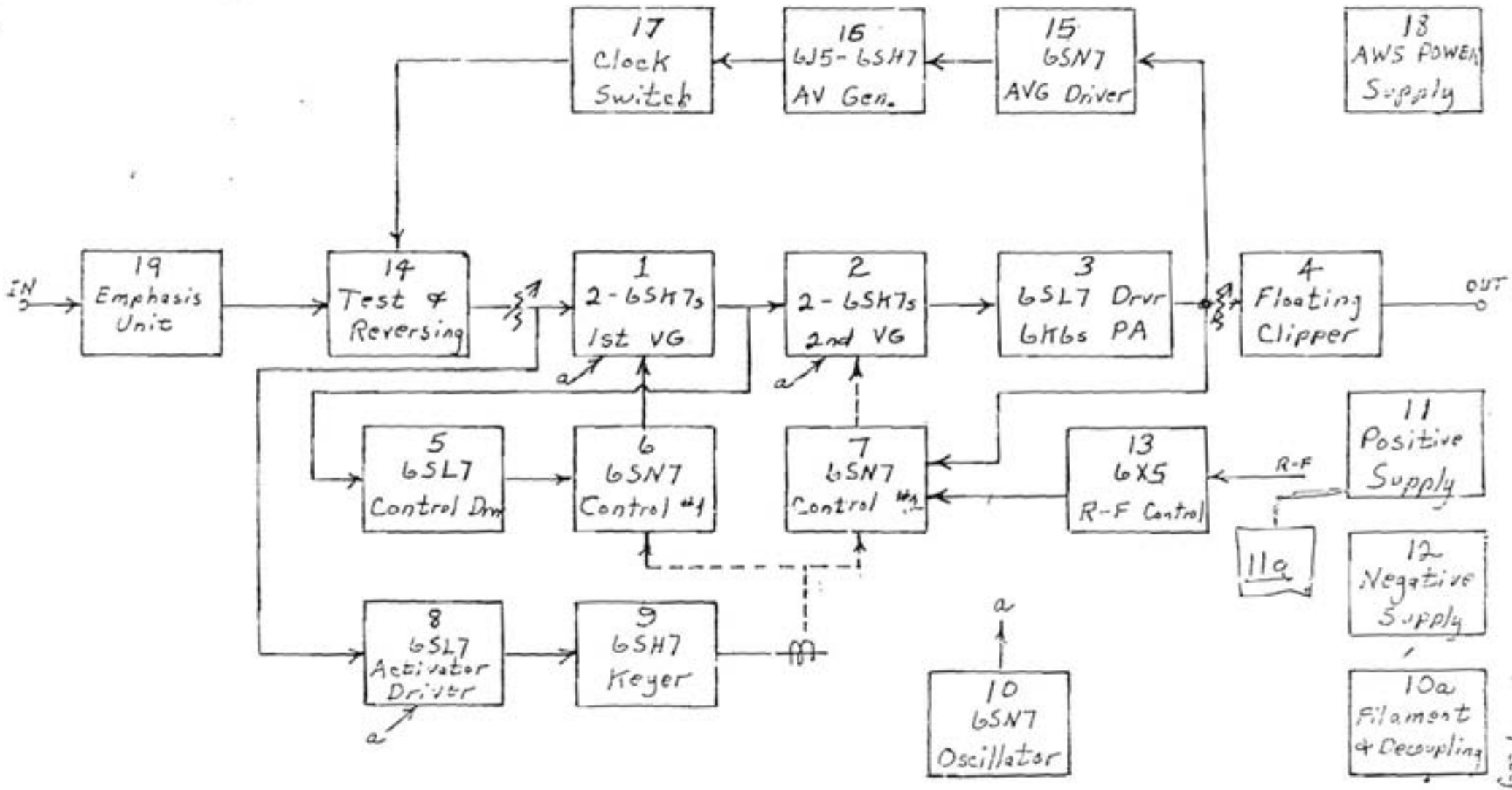
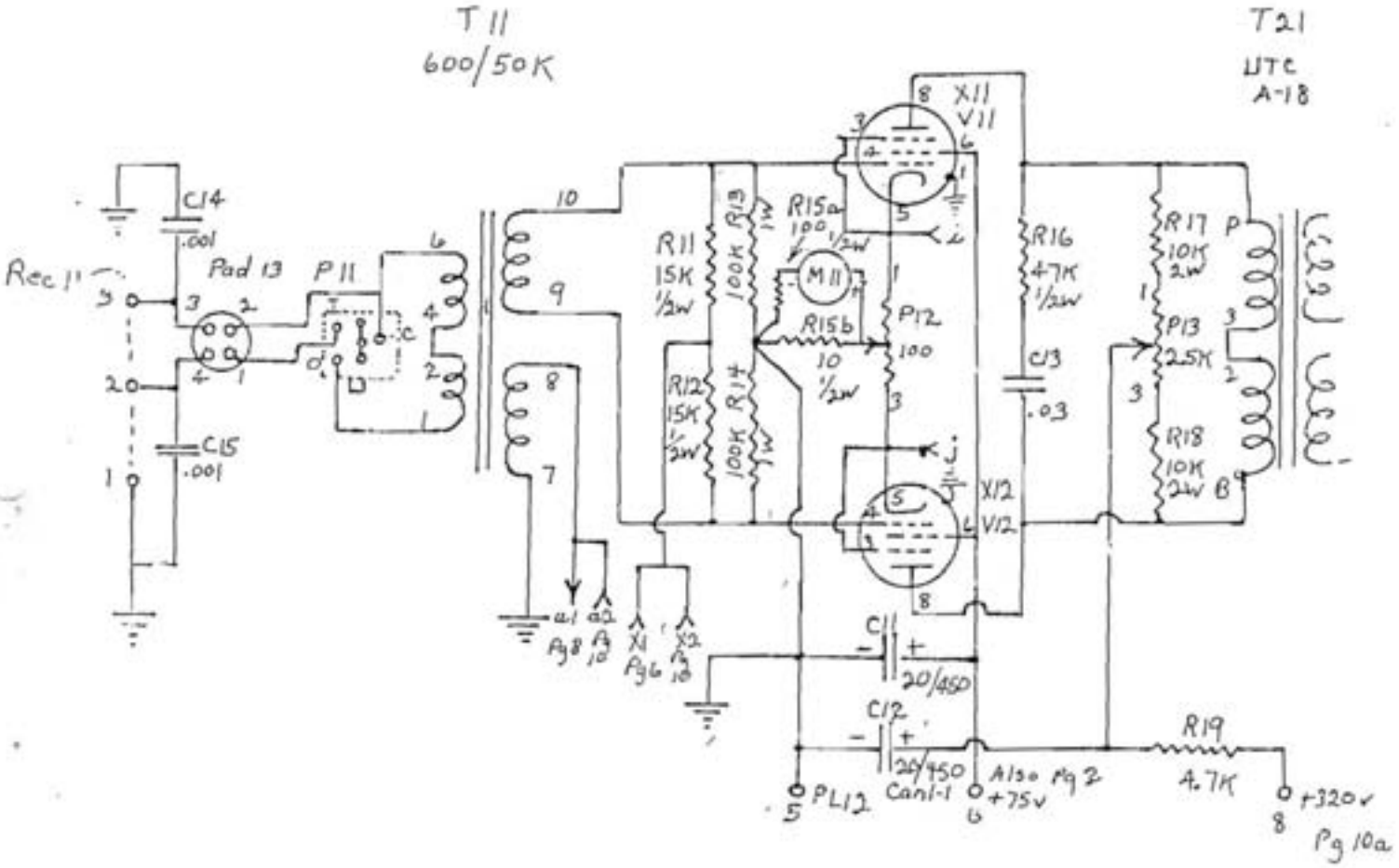
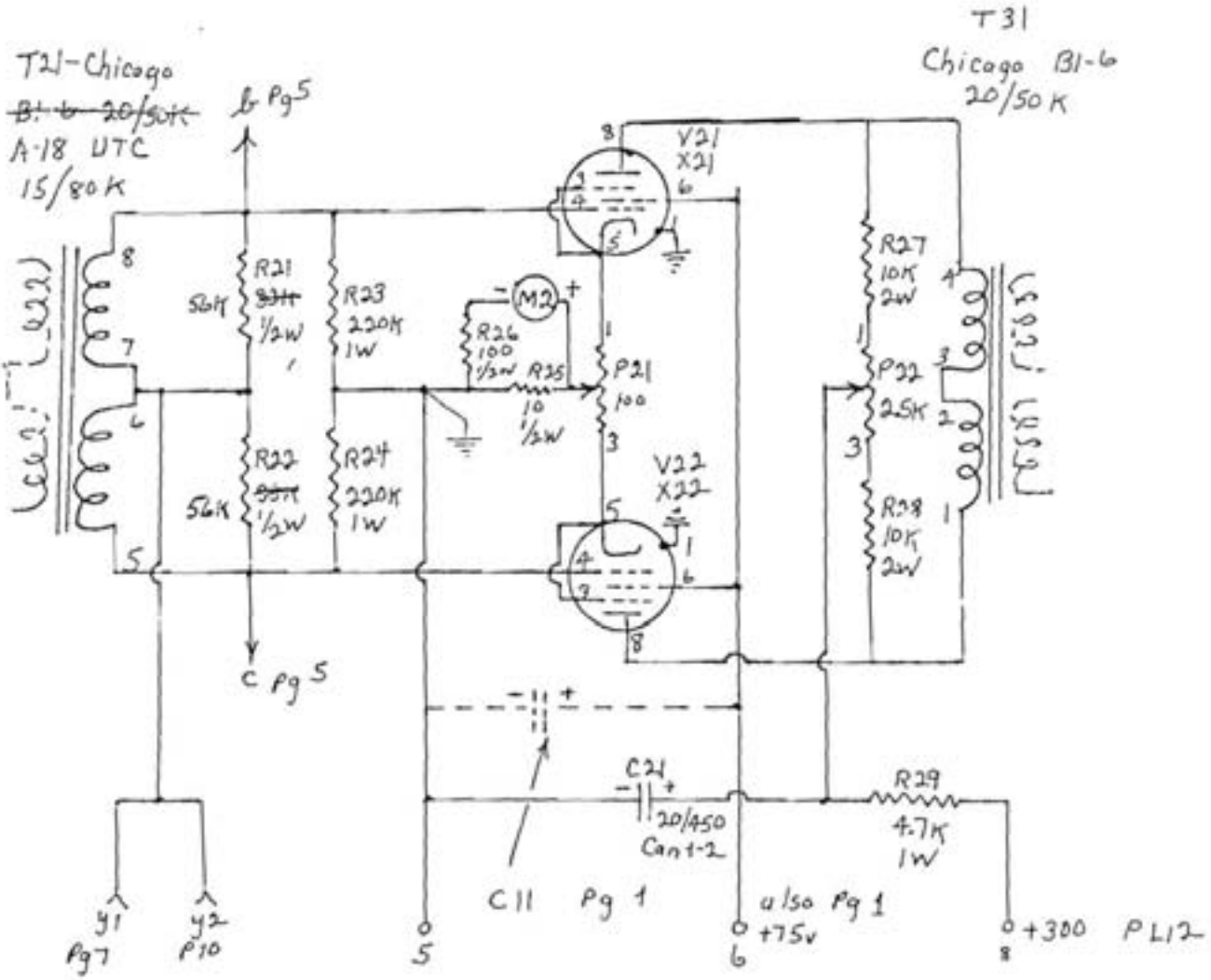


DIAGRAM No. 1
FIRST 6SK7s V. G. STAGE
PP 6SK7s



P11 - INPUT
P12 - 1K BAL
P13 - 1P BAL
P14 - HUM 1
P15 - HUM 2

DIAGRAM No. 2
SECOND 6SK7s V.G. STAGE
PP 6SK7s



P21 - 2K BAL
P22 - 2P BAL

DIAGRAM No. 3
POWER OUTPUT STAGE
6SL7 - 2-6K6s

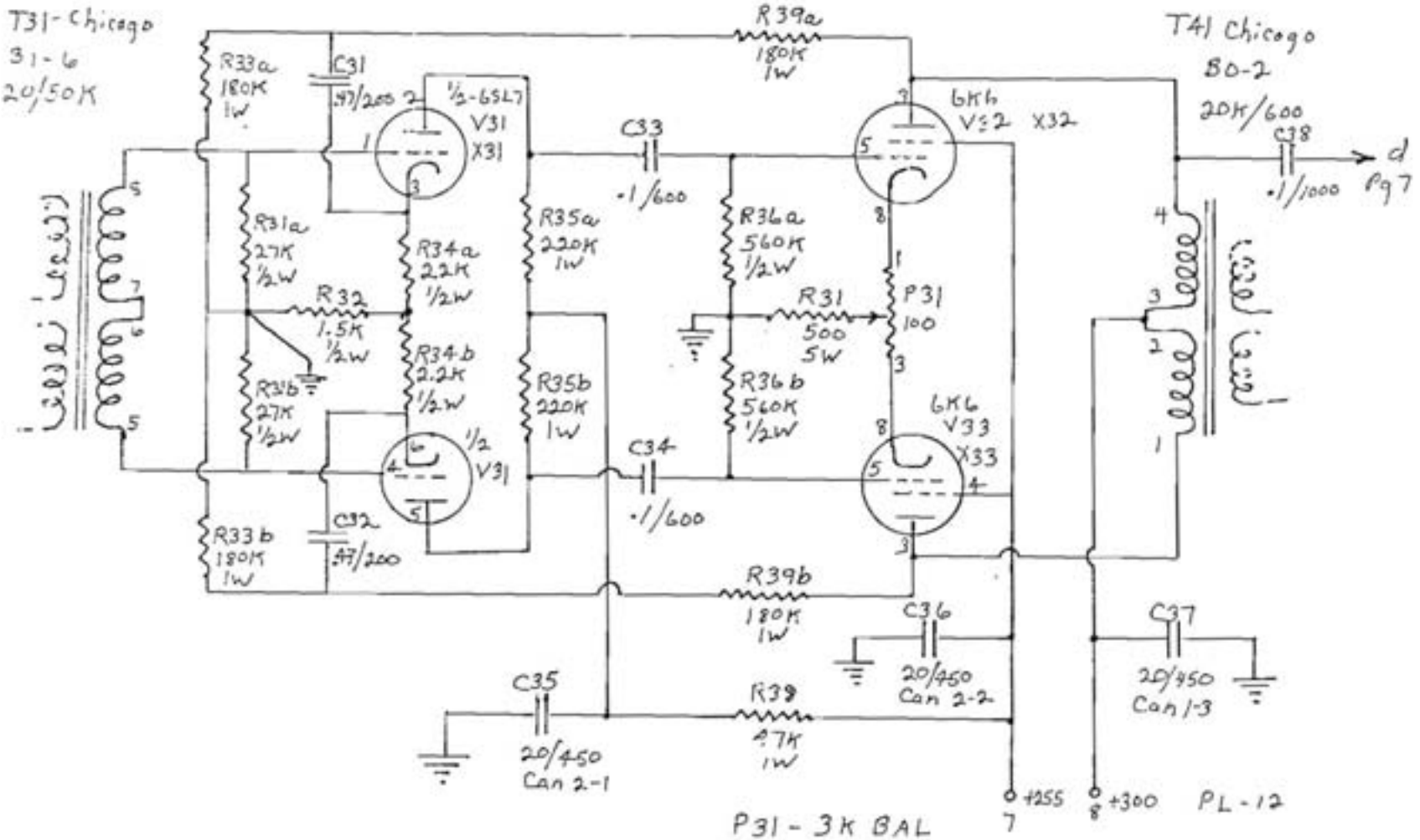


DIAGRAM No. 3

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A.C.-4
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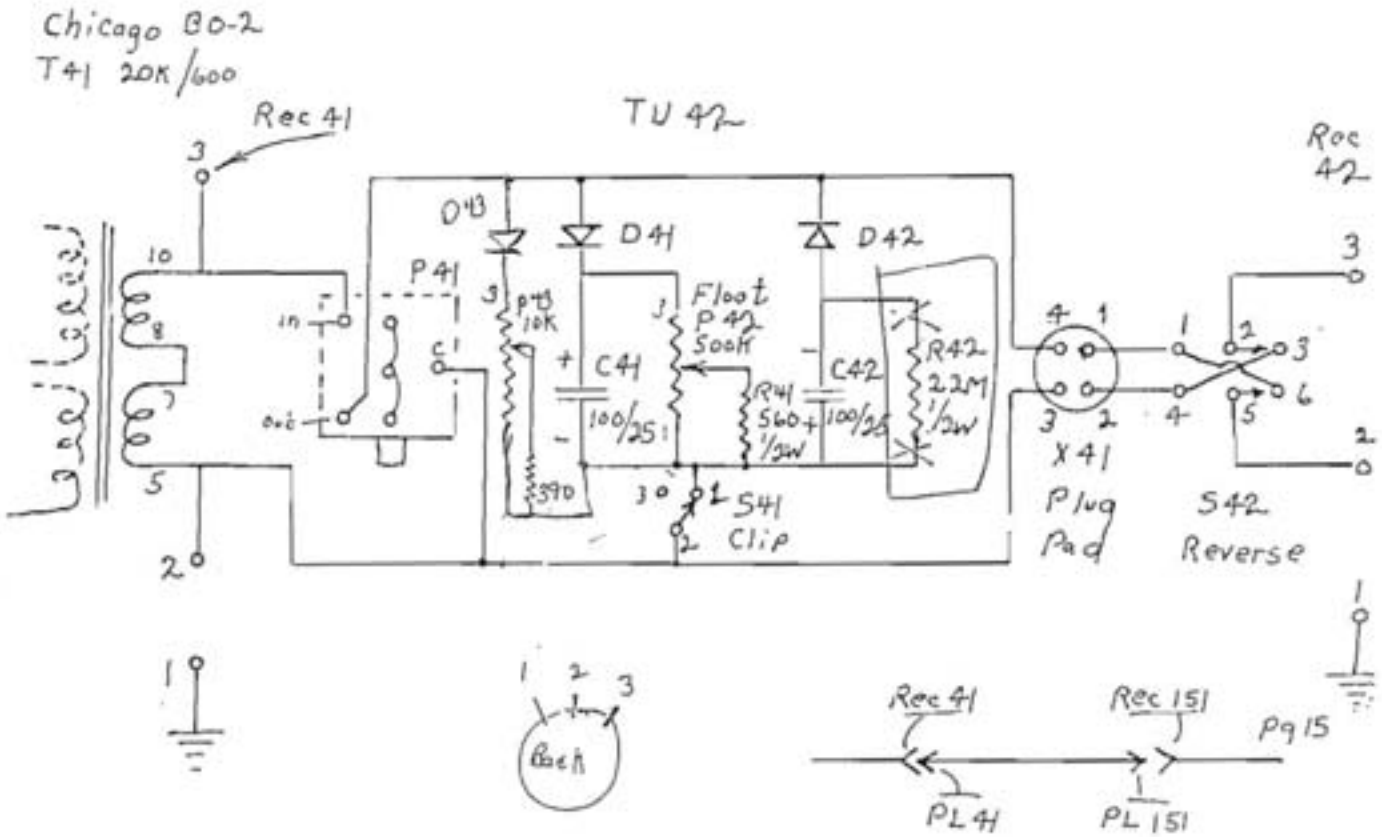
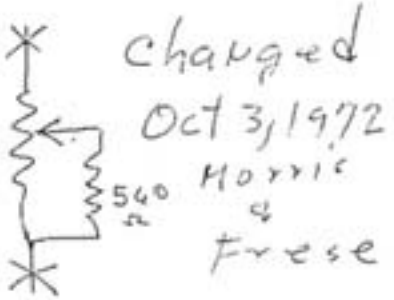
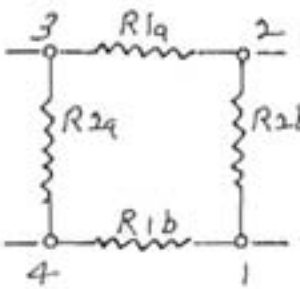
DIAGRAM No. 4
OUTPUT FLOAT CLIP CIRCUIT



P44



changed
Oct 3, 1972
Morris
&
Freese



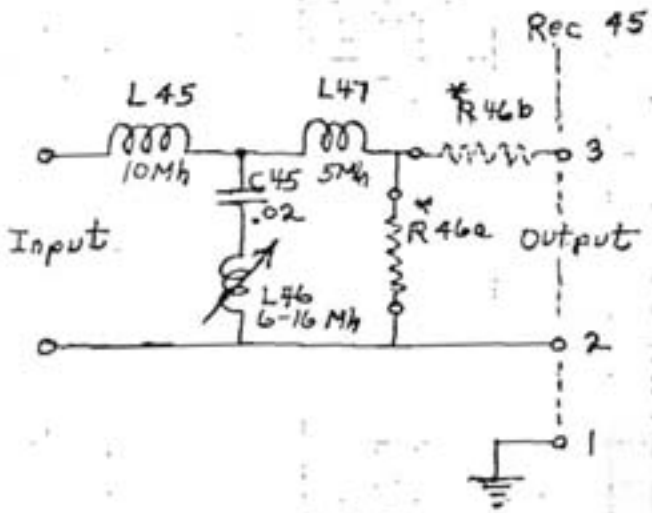
Plug Pad

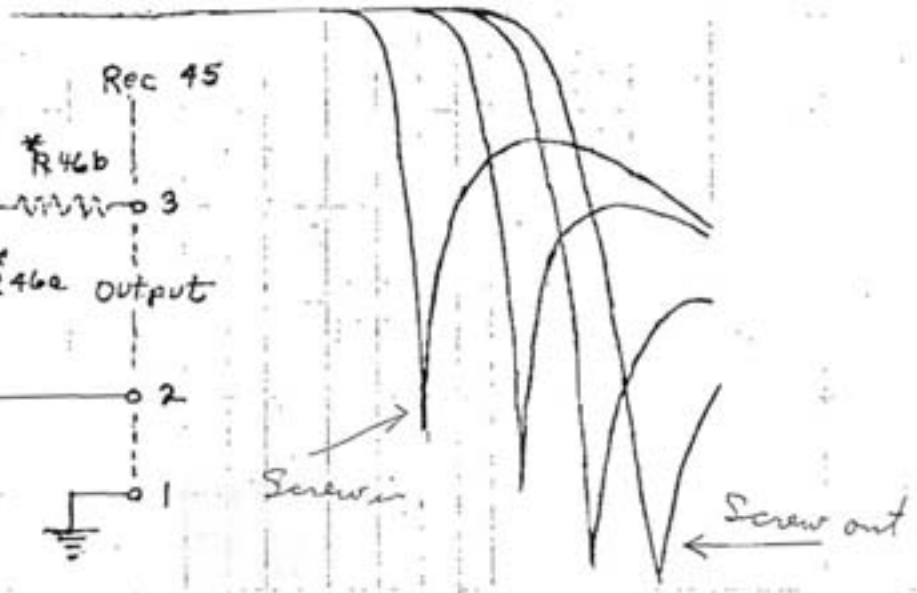
9½ db R1 = 390
R2 = 1200

22 db R1 = 1500
R2 = 680

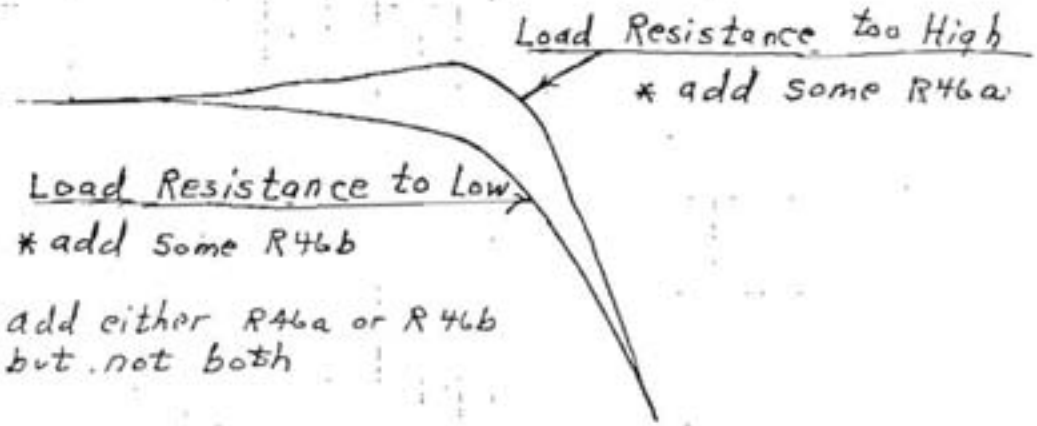
Diagram No. 4A
FILTER ON AUDIO PILOT OUTPUT
TO TRANSMITTER INPUT

Output Low Pass 5K 10K 15K 20K
600 Ohm Balanced Floating Ground Filter



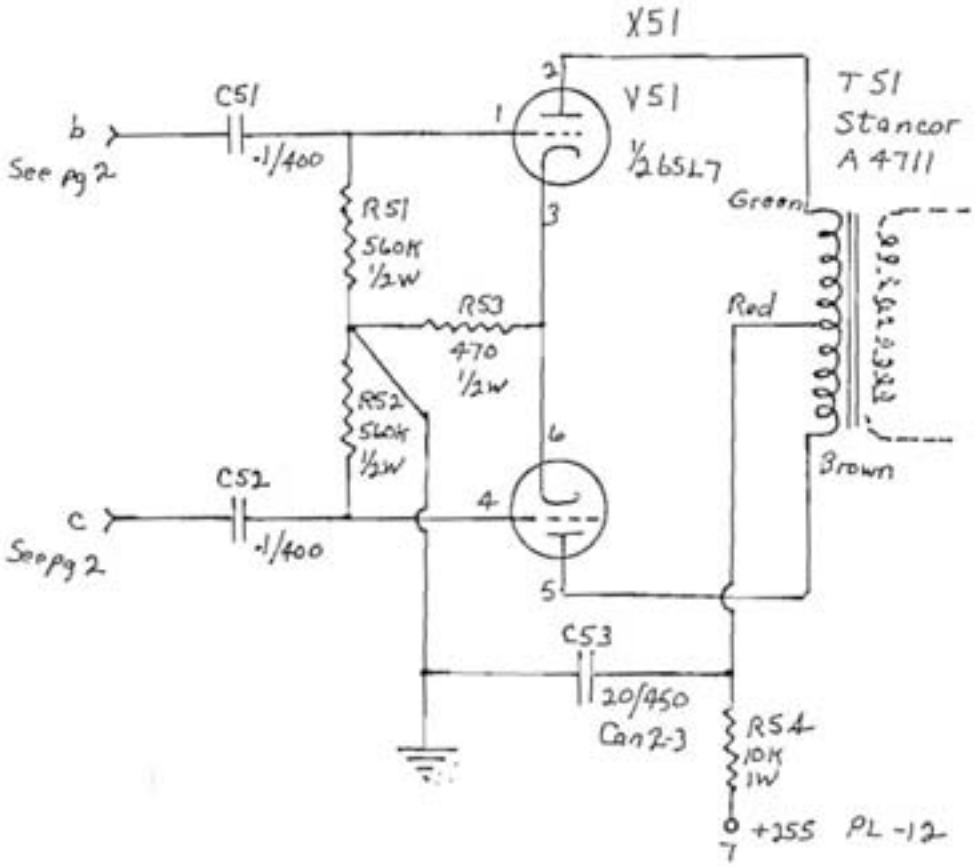


L45- Miller 6306
L46- Miller 9005
L47 Miller 6304



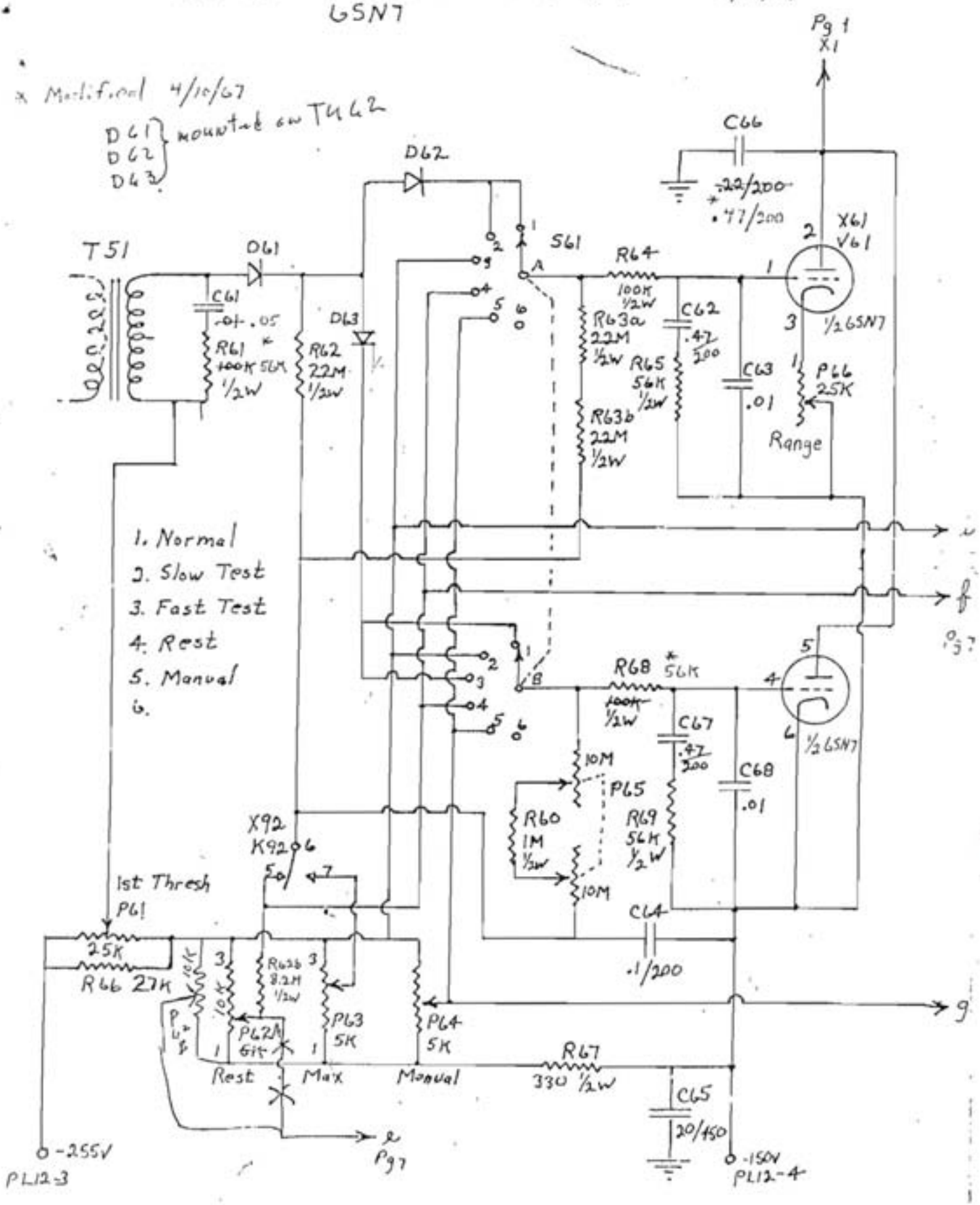
add either R46a or R46b
but not both

DIAGRAM No. 5
CONTROL DRIVER
6SL7



Last Modification
5/15/67

DIAGRAM No. 6
FIRST CONTROL SYSTEM
6SN7



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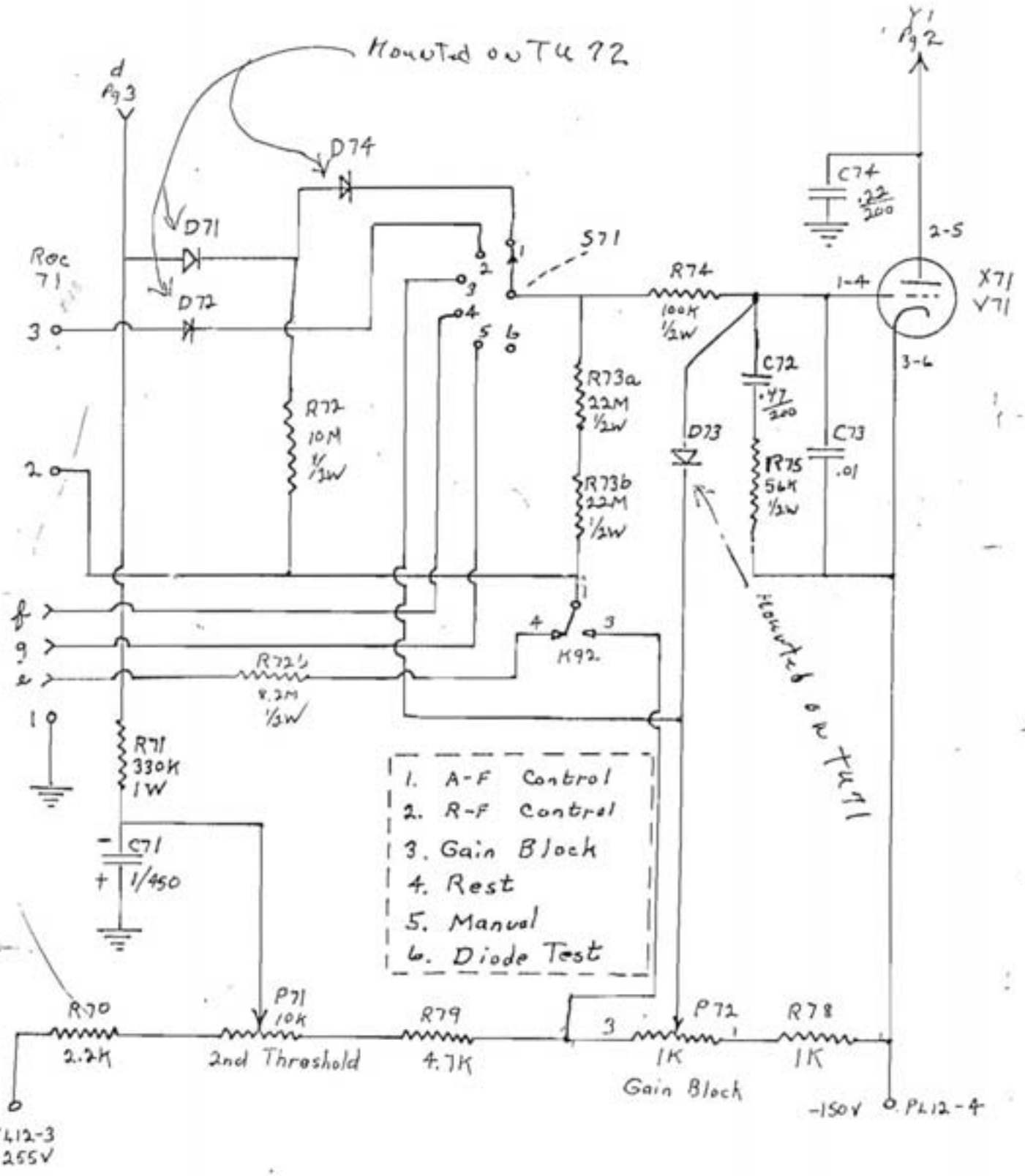
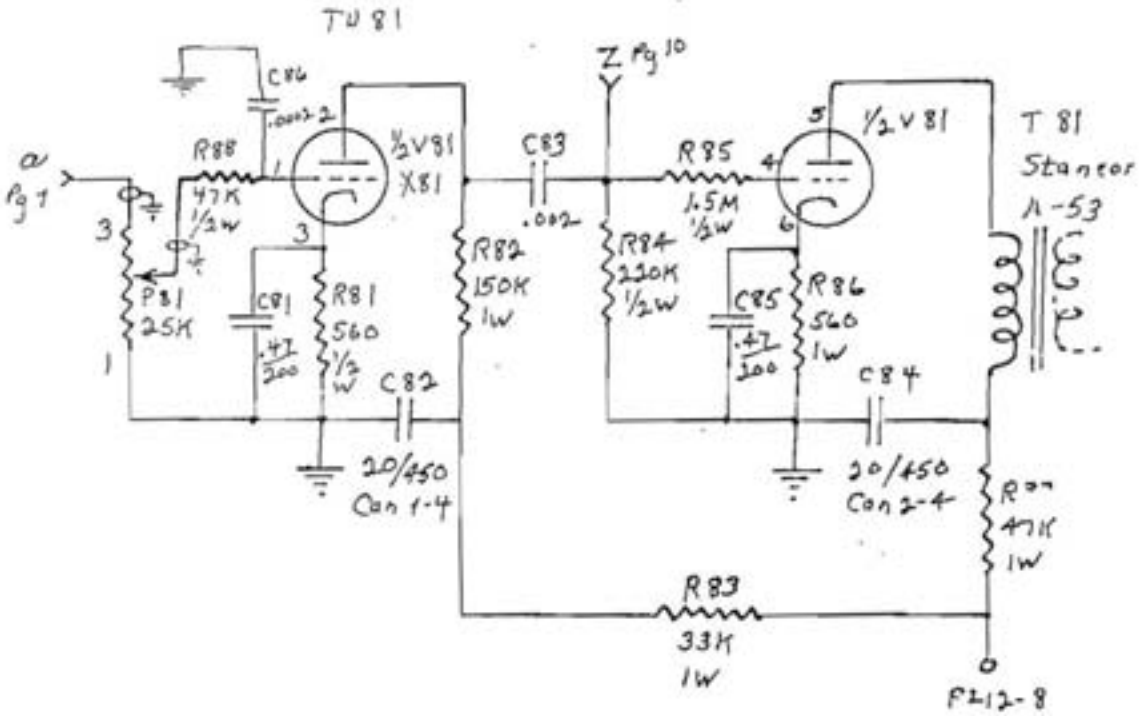
Last Modification
5/15/67

DIAGRAM No. 7
SECOND CONTROL SYSTEM
6SN7



Last Modification
5/15/67

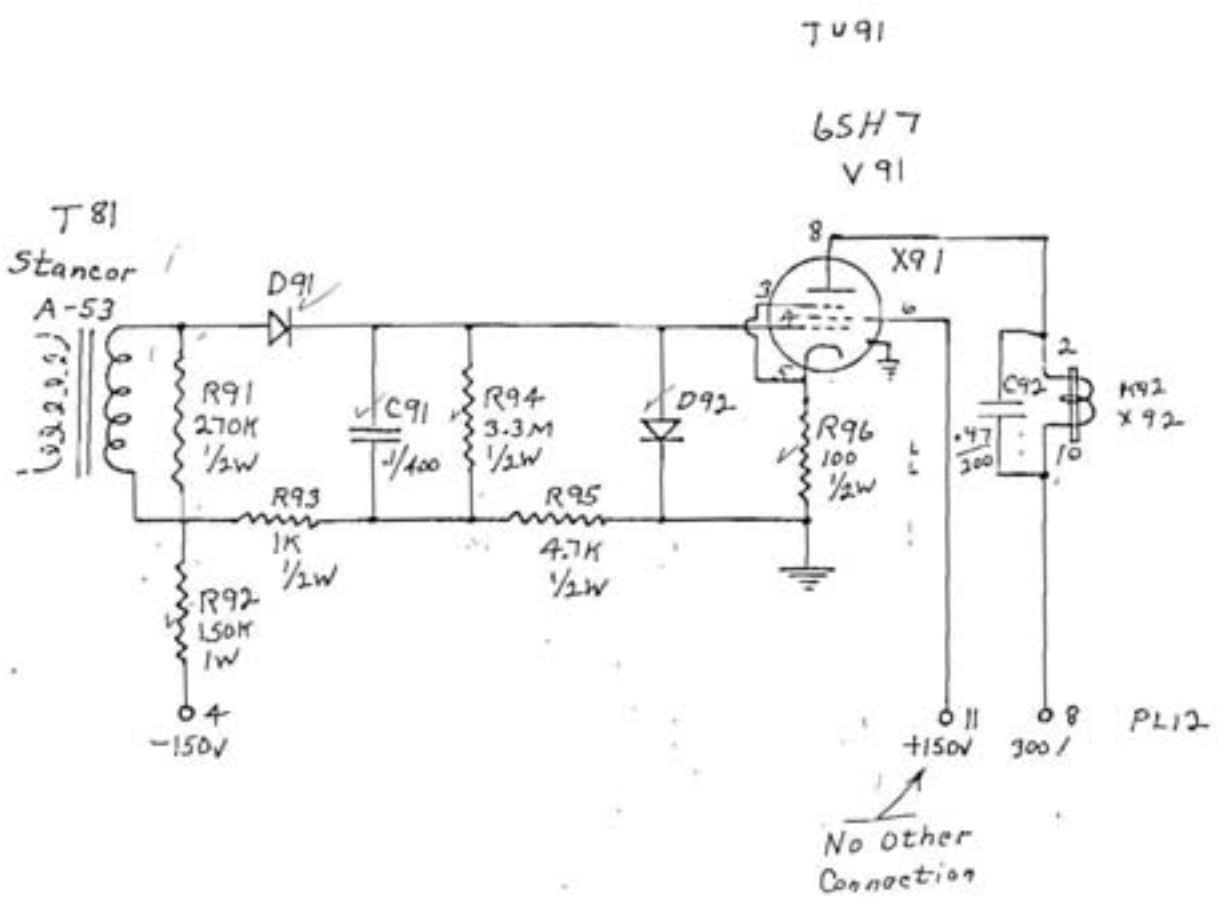
DIAGRAM NO. 8
ACTIVATOR DRIVER
6SL7



P 81 - ACTIVATOR

Last Modification
5/15/67

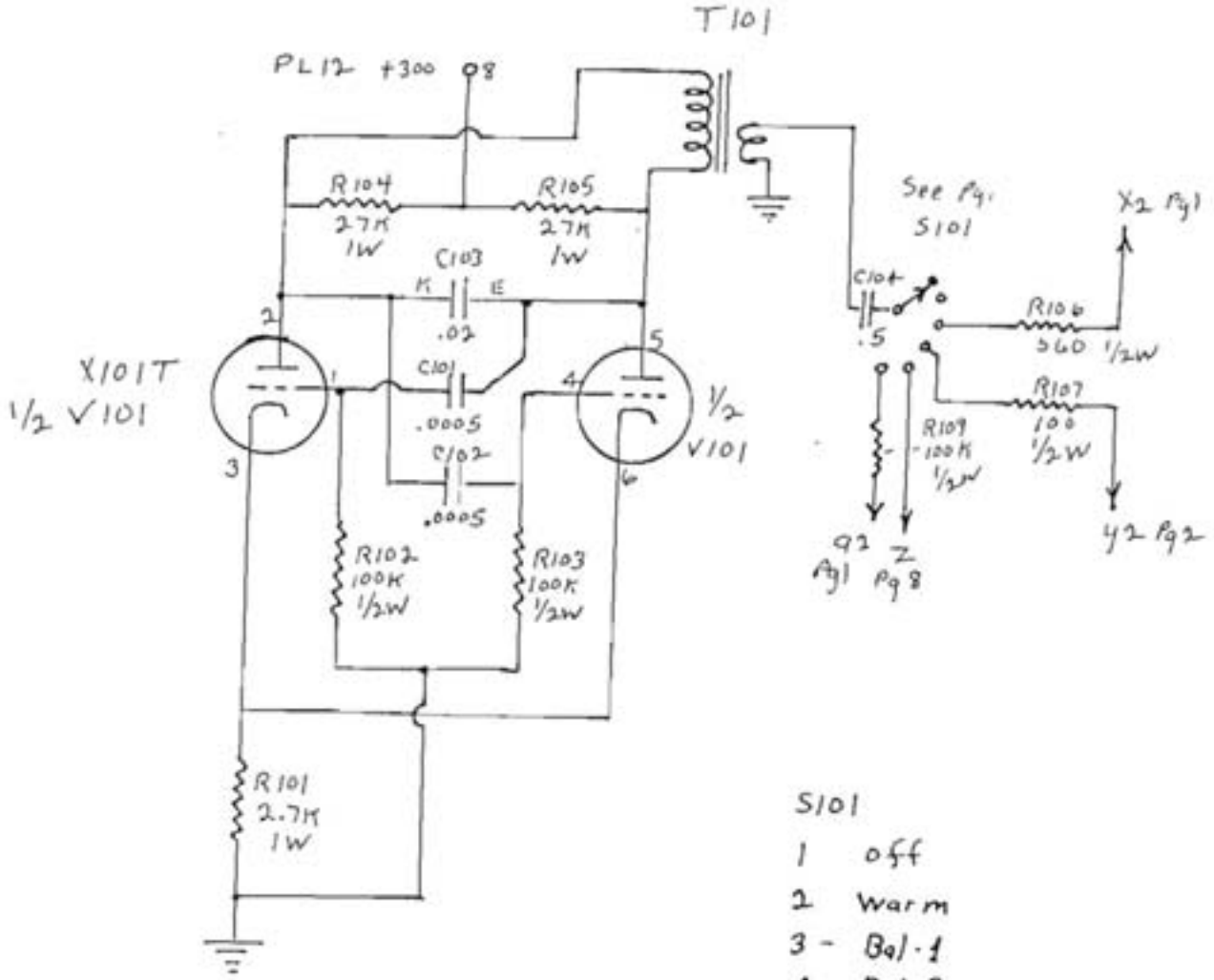
DIAGRAM No. 9
ACTIVATOR KEYER



Use PB KCP 14

SCHEMATIC DIAGRAM NO. 10
BALANCING OSCILLATOR

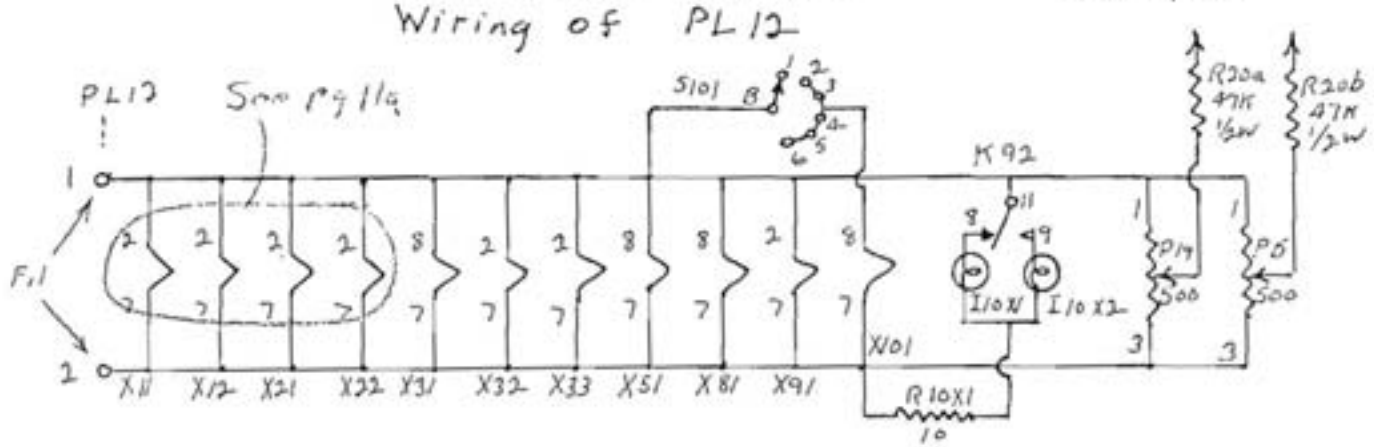
6SN7

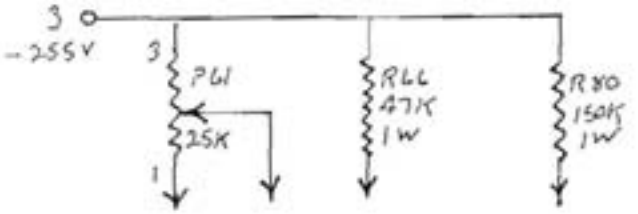


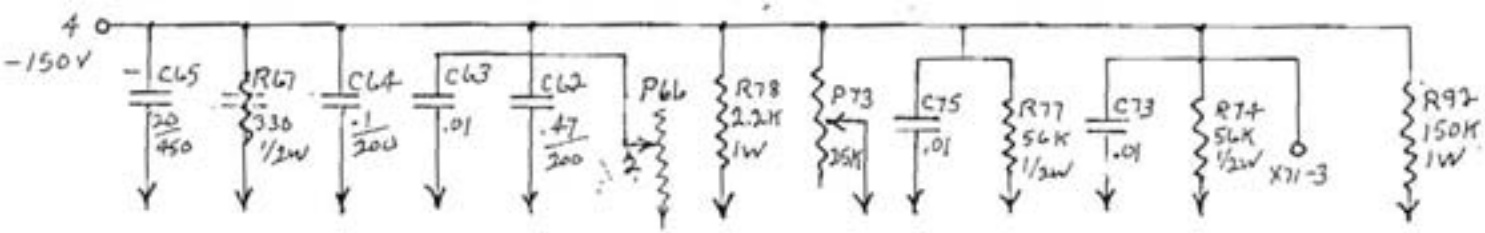
S101

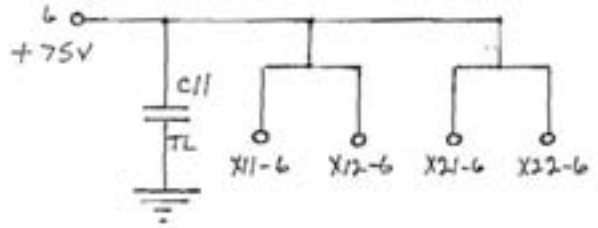
1 off
2 Warm
3 - Bal-1
4 Bal 2
5 Activate
6. Tone Test

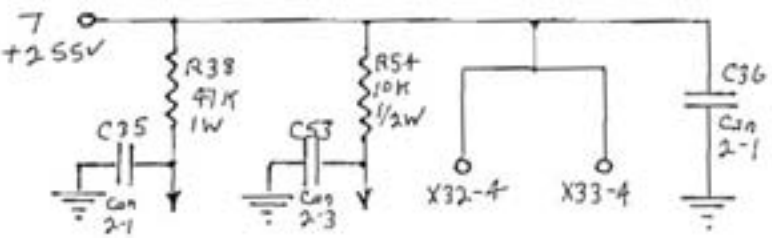
DIAGRAM No. 10x
Wiring of PL12

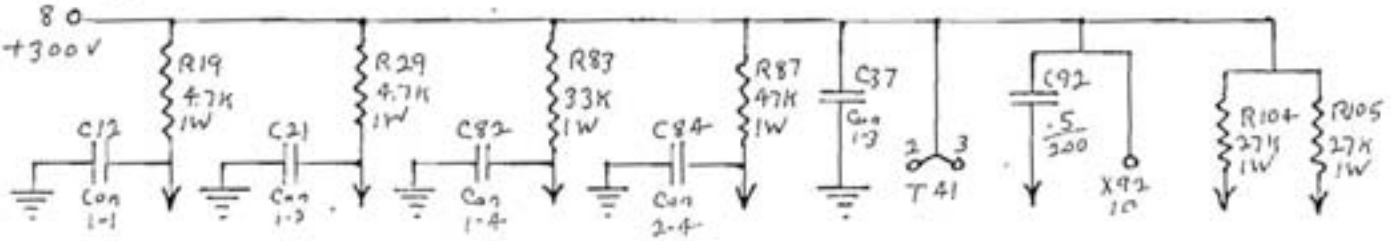


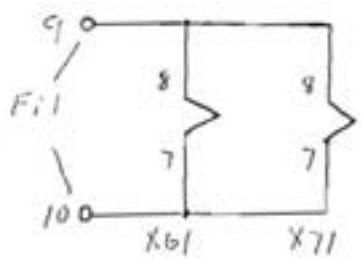


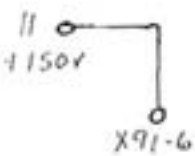






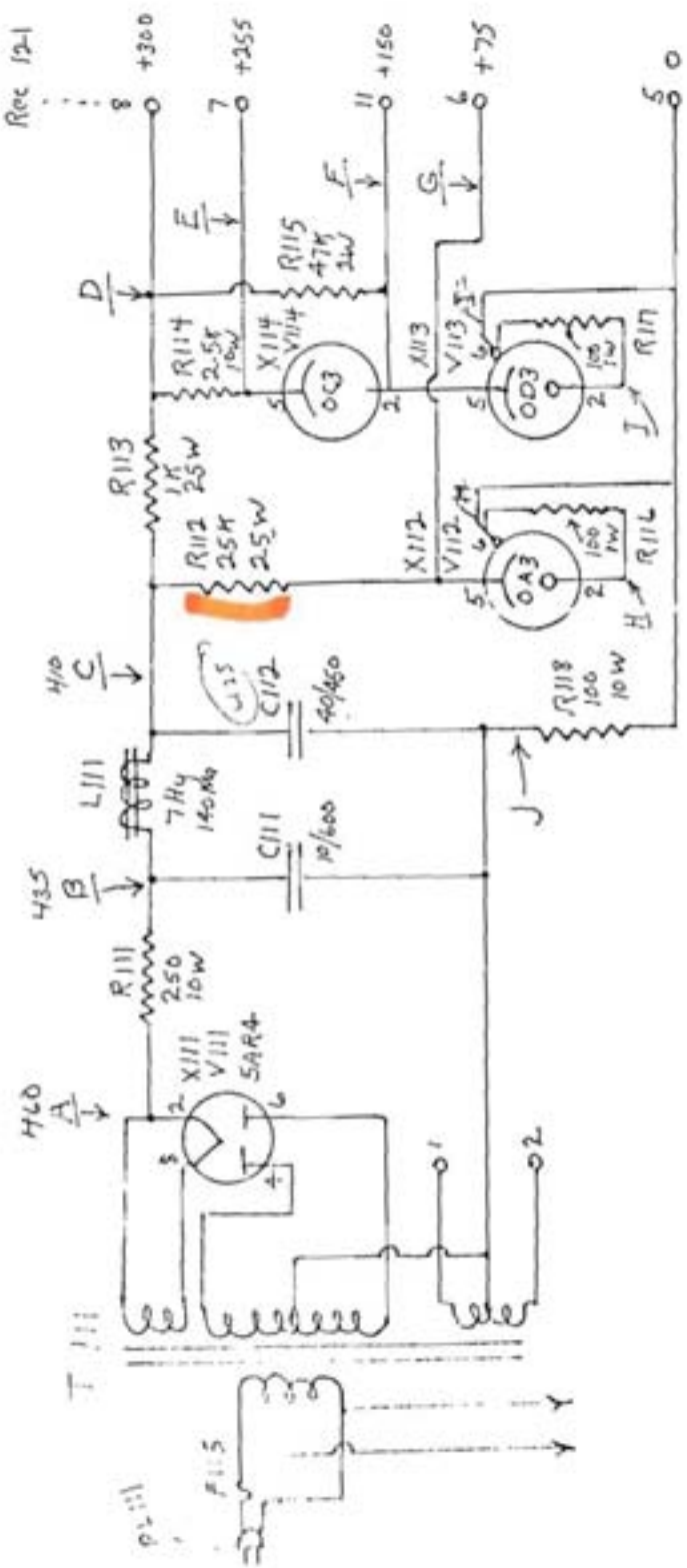






See pg 11a for PL12-12

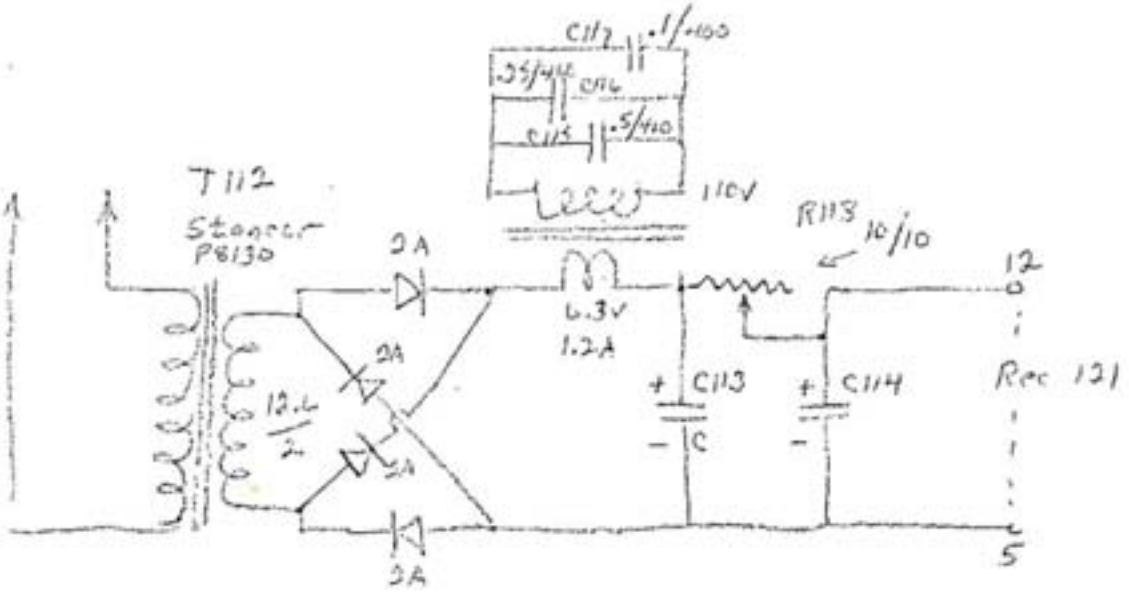
DIAGRAM No. 11
POSITIVE POWER SUPPLY



Page 11a
AP-4 1'5
4/4/5?

DIAGRAM No. 11a

6 Volt DC Filament Supply for the 6SN7s



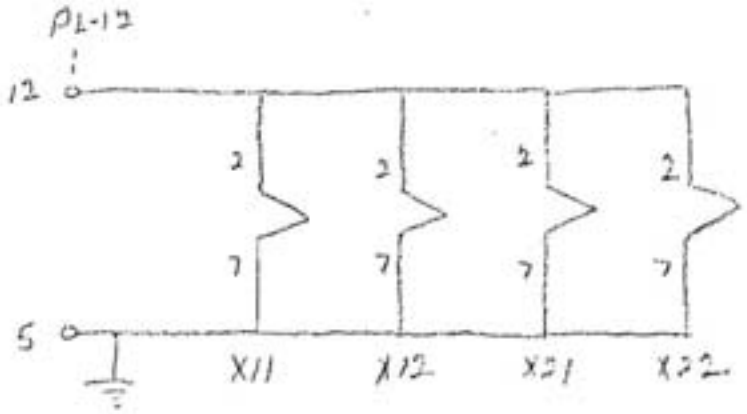


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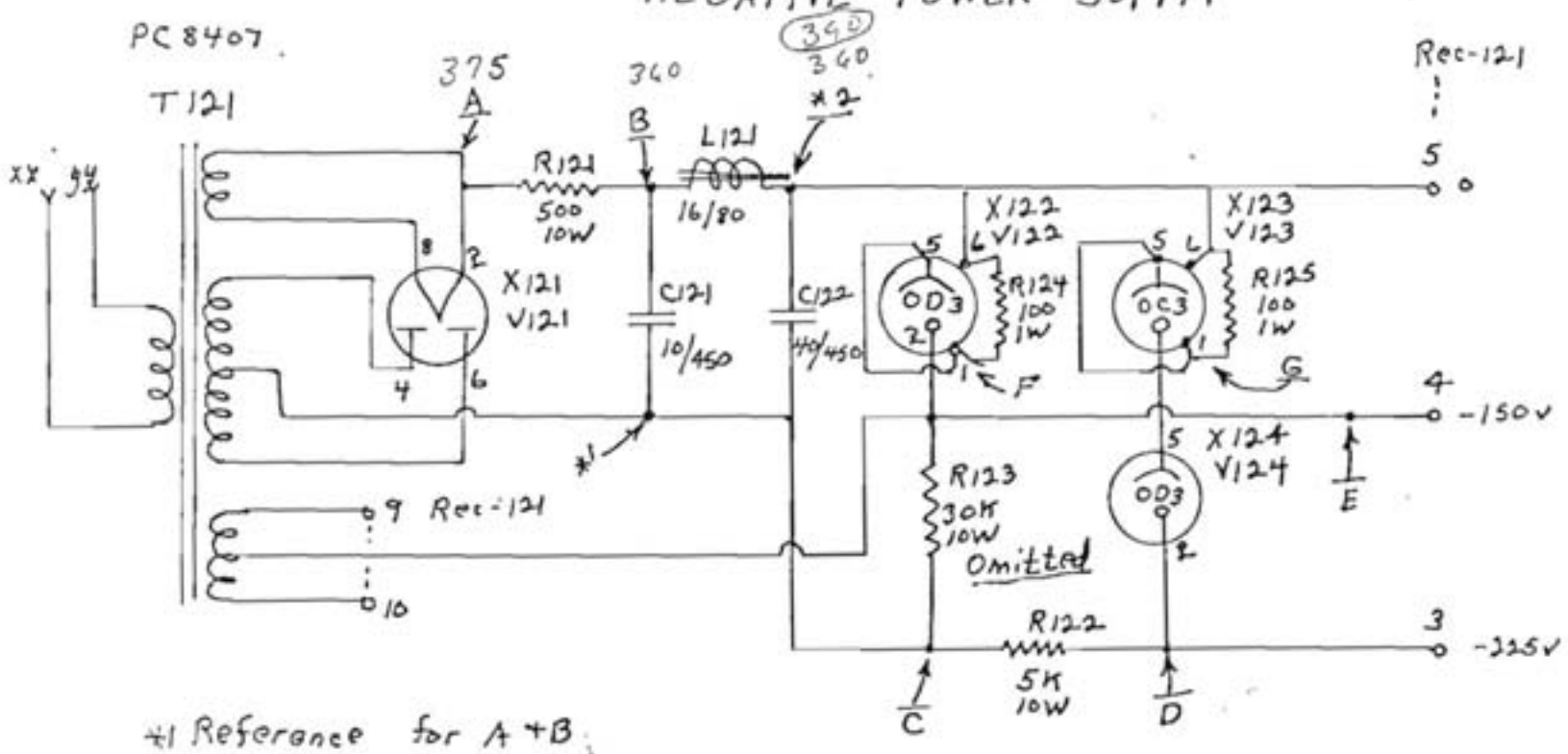
DIAGRAM No. 12
NEGATIVE POWER SUPPLY



*1 Reference for A + B

*2 Reference

DIAGRAM No. 13
R-F CONTROL UNIT
6X5

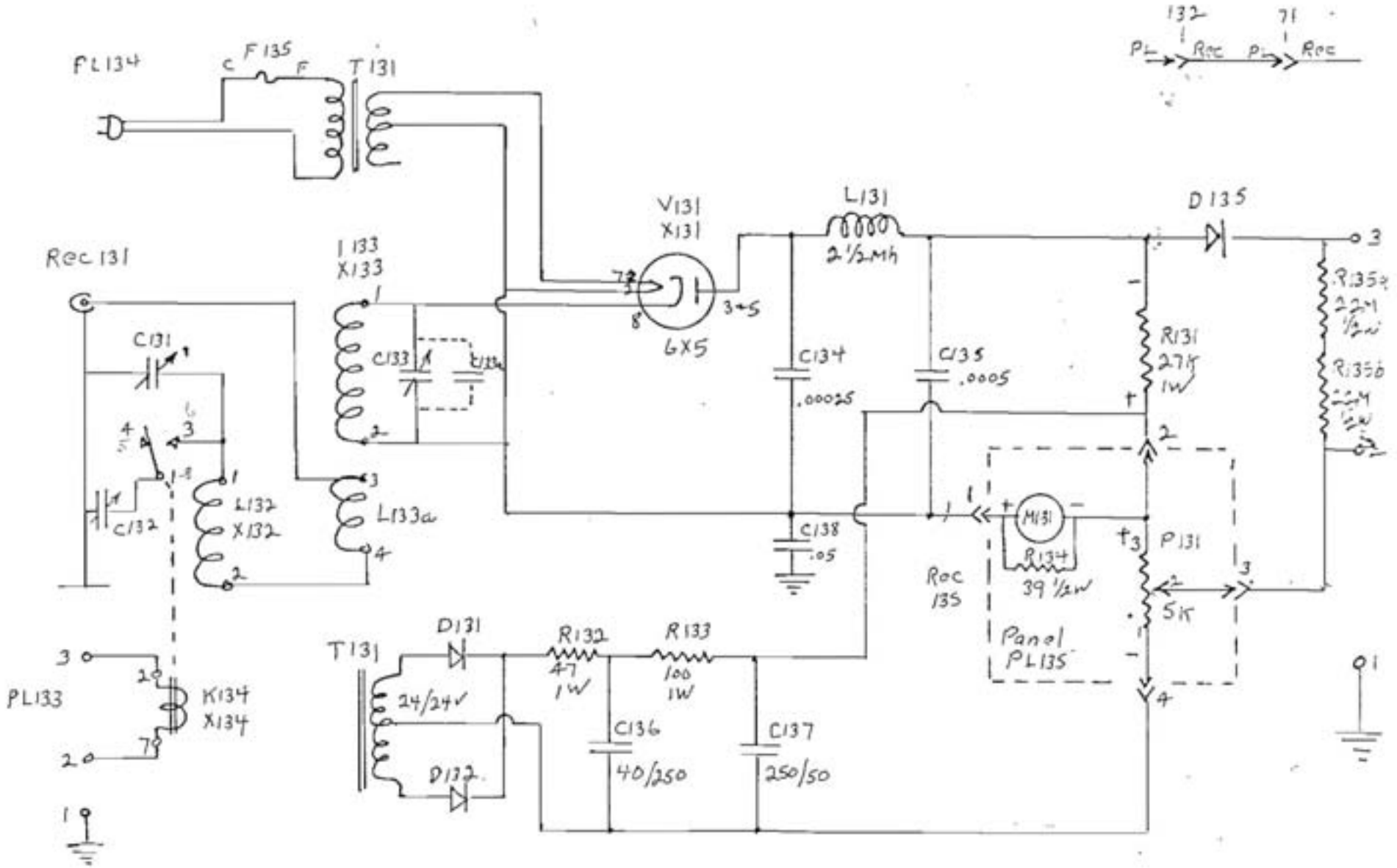
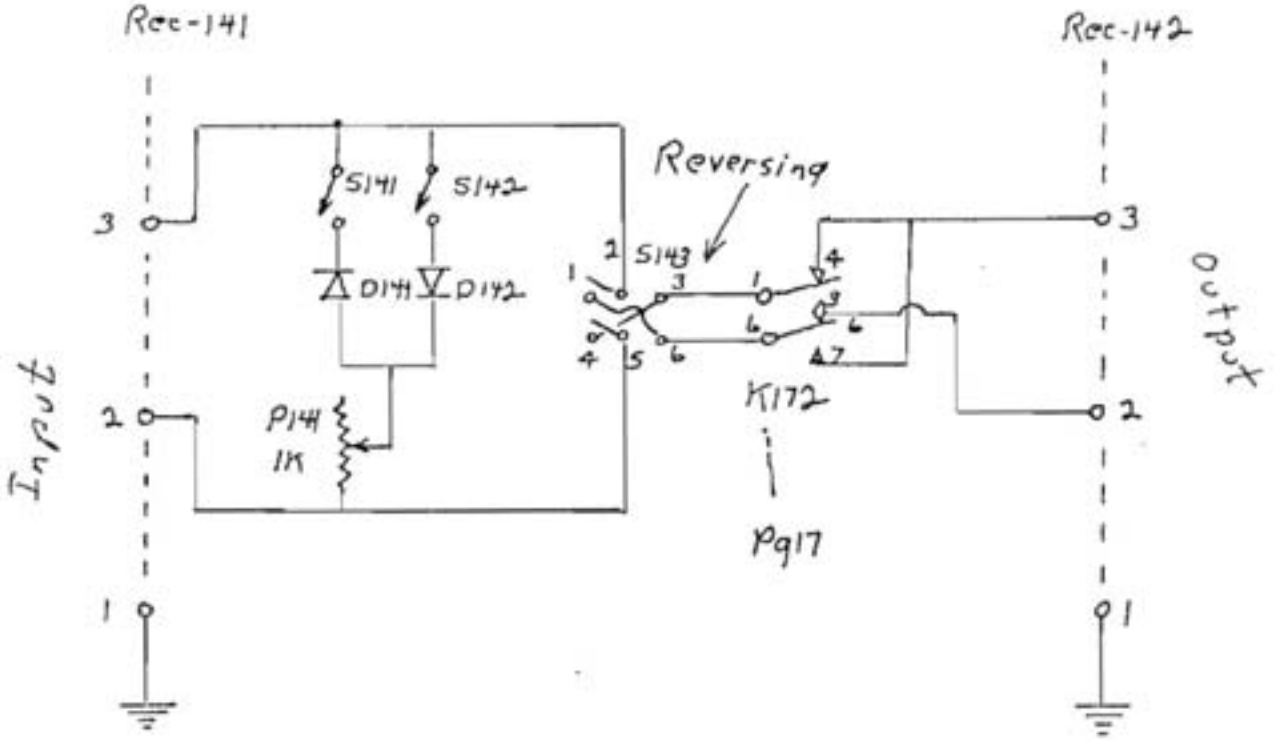


DIAGRAM No. 14

TEST AND REVERSING SWITCH



P1 - DISTORTION

S141	NORMAL	Push
S142	REVERSE	Push
S143 -	REVERSING	Toggle

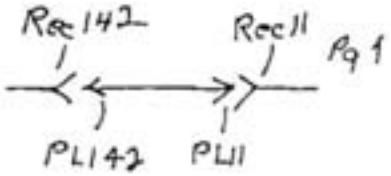
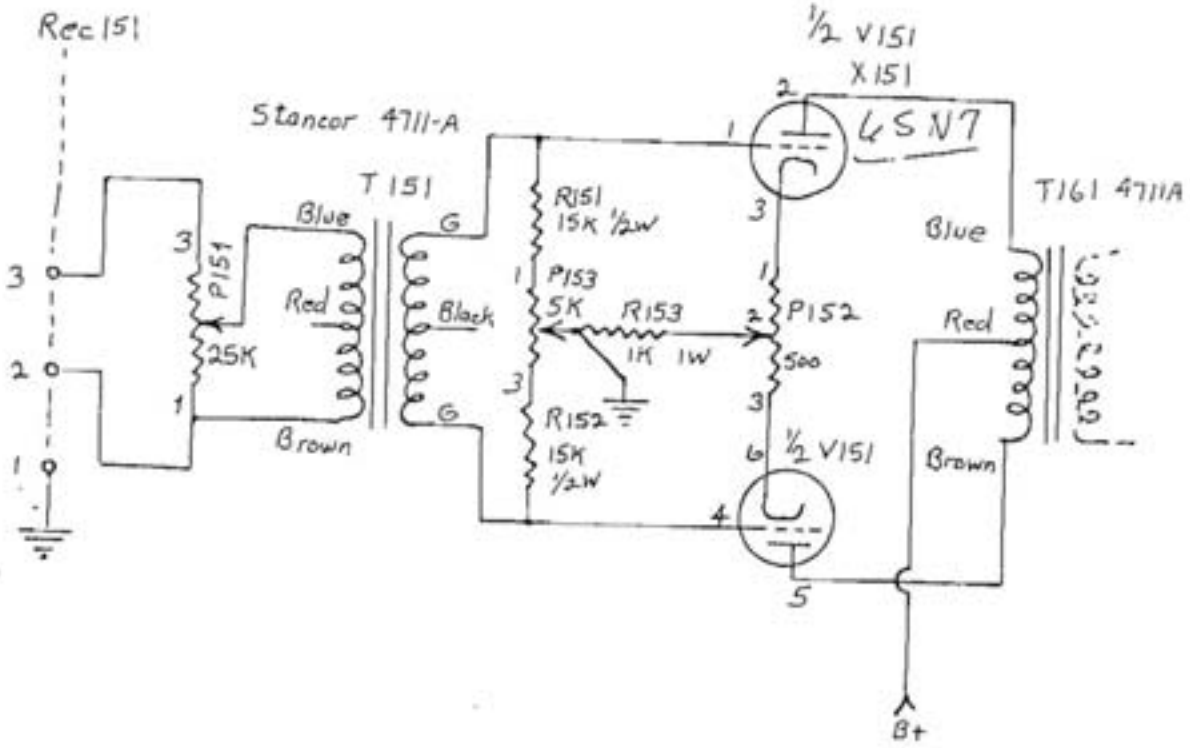


DIAGRAM No. 15

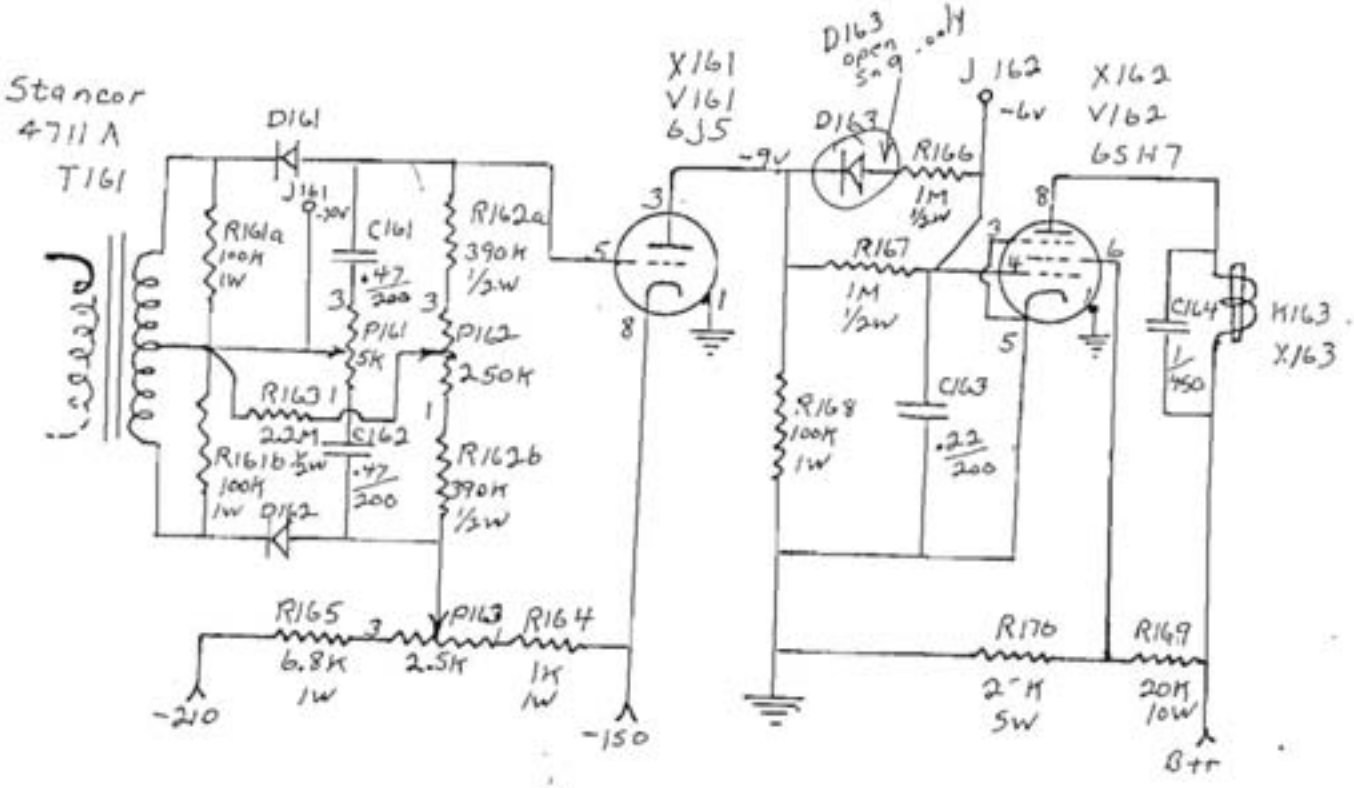
AVG DRIVER

6SN7



P151 - INPUT
P152 - BALANCE - 50 Hz Bal 2
P153 - BALANCE - 1 KHz Bal 1

DIAGRAM No. 16
ASYMMETRICAL VOLTAGE GENERATOR
6J5 - 6SH7



D161 & 162 Are High back Z and balanced back Z

P161 - CHARGE BALANCE - Bal 3
P162 DISCHARGE BALANCE Bal 4
P163 - BIAS

DIAGRAM No. 17
CLOCK SWITCH

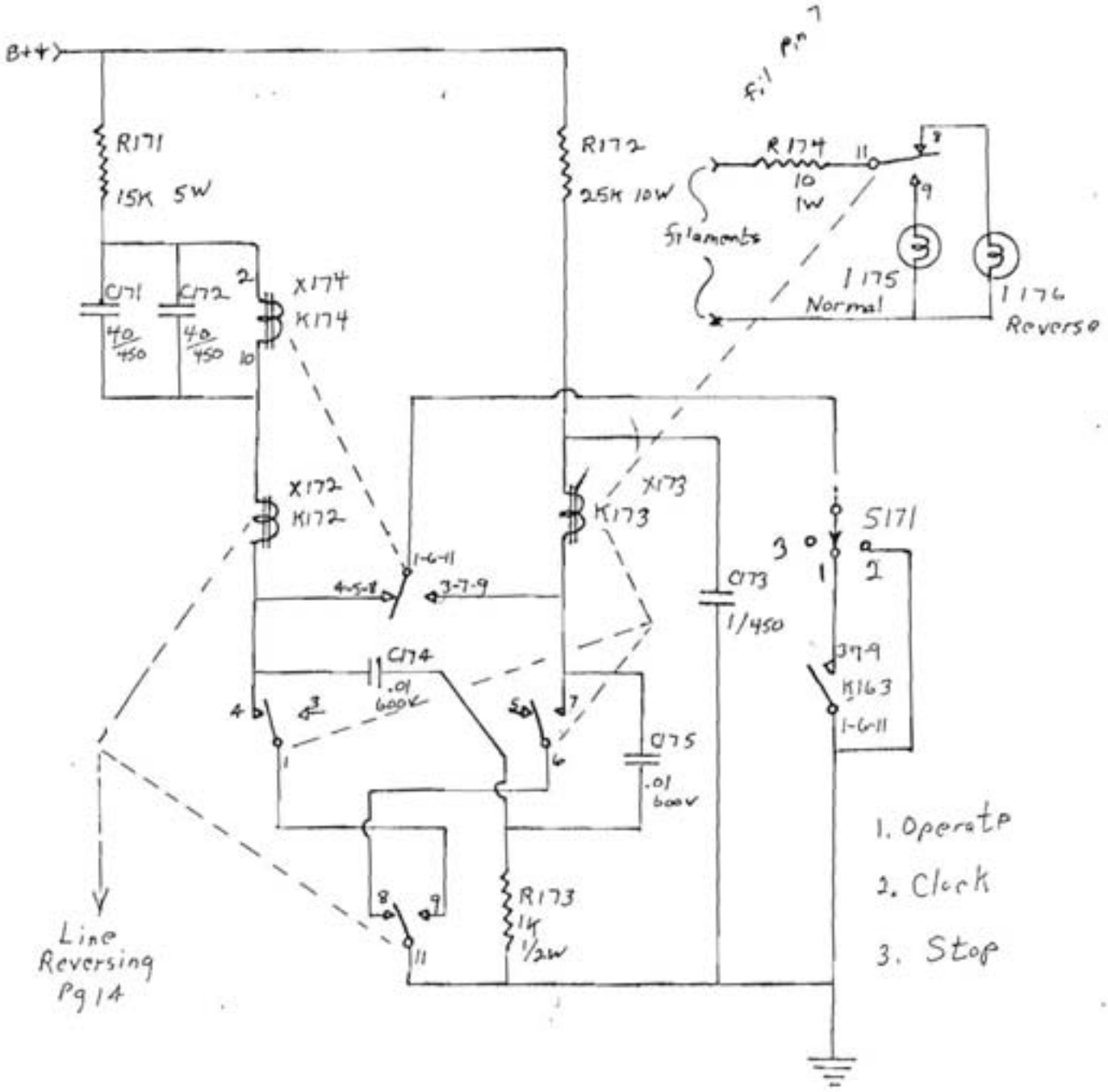
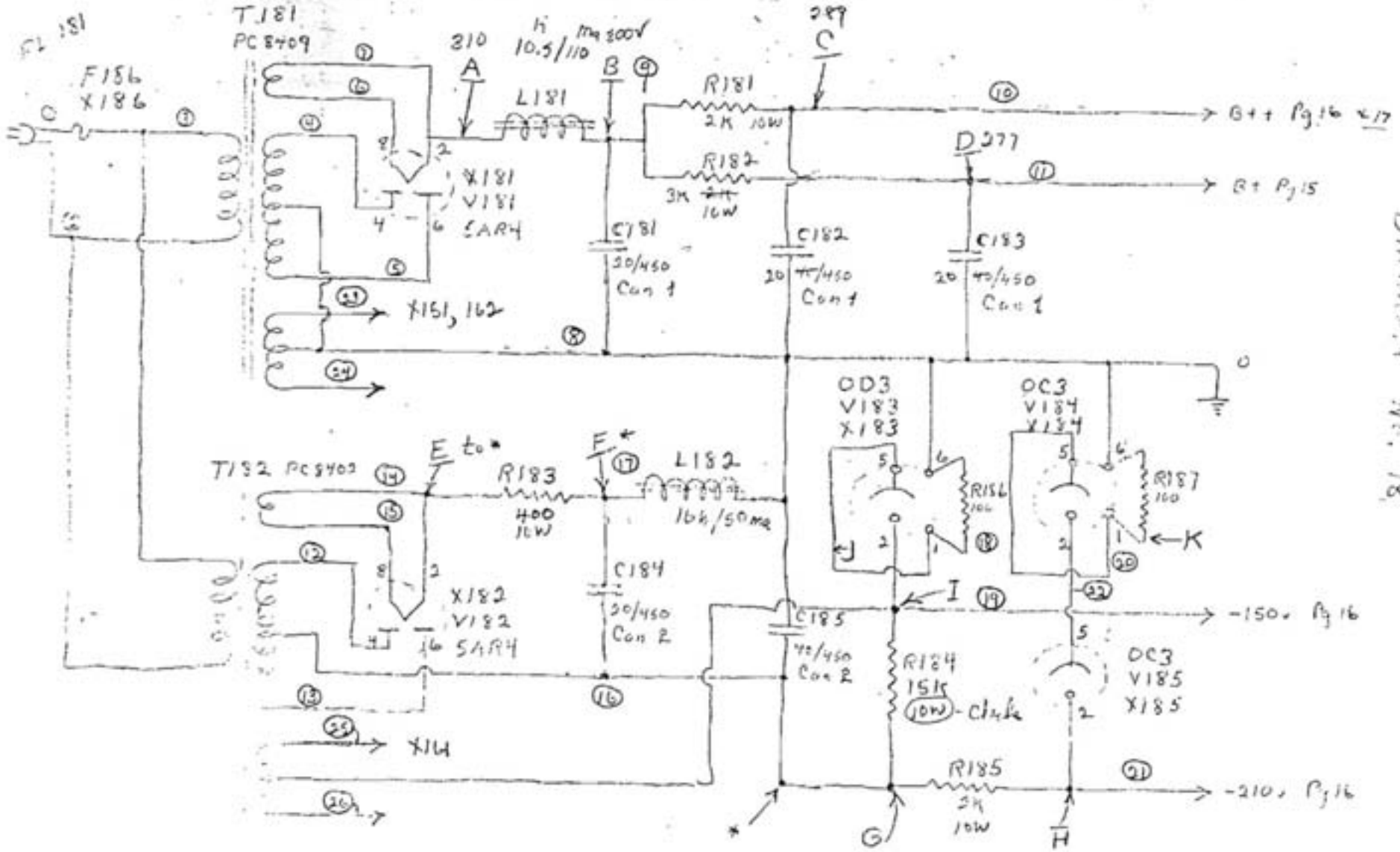
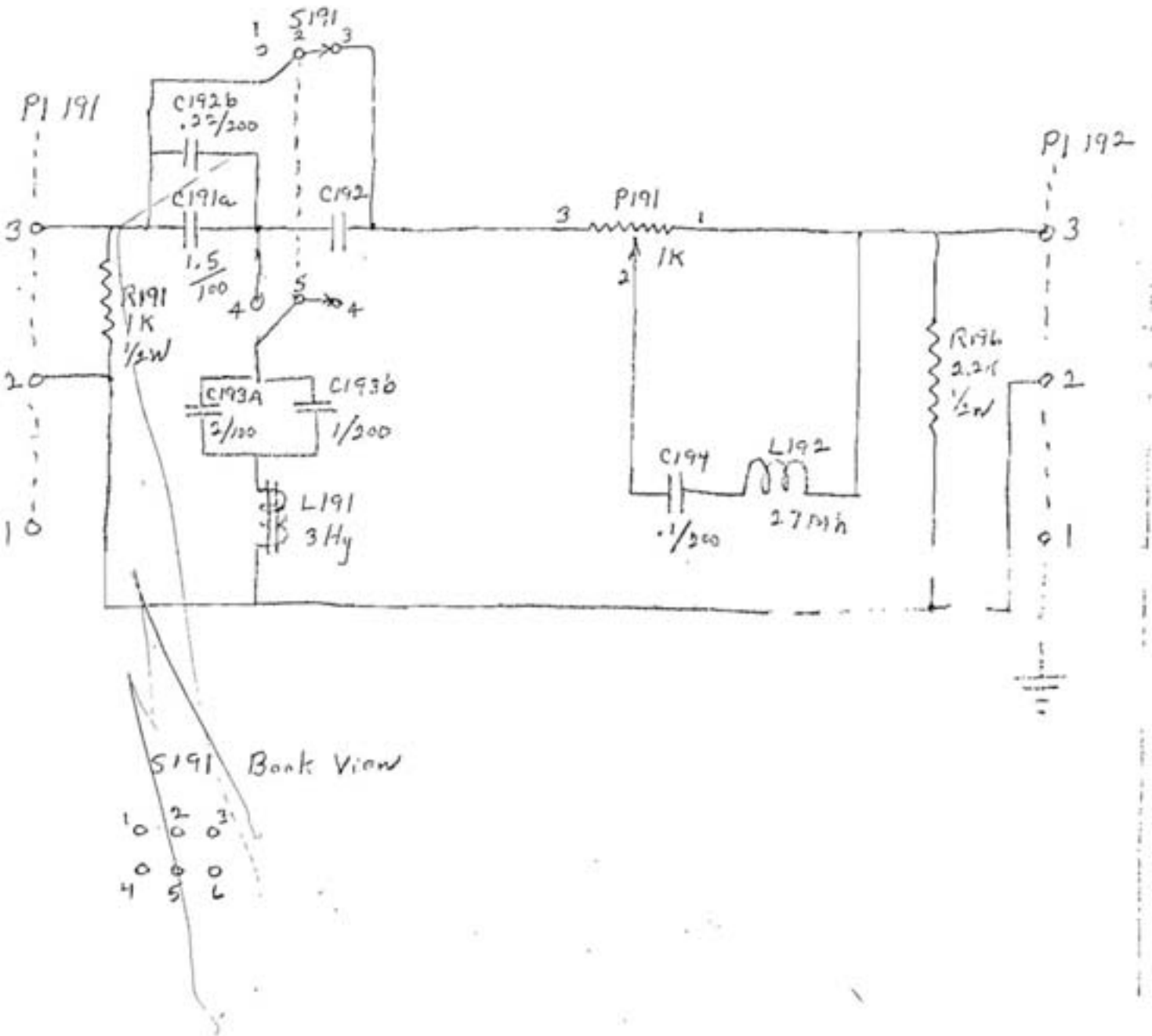


DIAGRAM No. 18
POWER SUPPLY FOR AWS



P. 15-19-
APH-EU
1/10/67

DIAGRAM No. 19
EMPHASIS UNIT



DESCRIPTION OF THE AUDIO PILOT SYSTEM

Primary Purposes.

The "Audio Pilot" performs several vital primary functions and several extra secondary functions for AM broadcasting systems. The primary purposes are now listed below:

(1) To produce the maximum modulation carrier envelope power on a standard AM broadcast transmitter for any given program material inorder to provide the greatest possible coverage.

(2) To improve the intelligibility and desirability of all program material.

(3) To provide the most desired automatic balance between various types of program material such as between music to speech, entertainment to commercials, telephone conversations, and etc.

(4) To correct for any gain riding errors that are fed into the system.

(5) To prevent overmodulation at all times and at any instant.

Secondary Characteristics.

(1) The gain deactivates during silent or redundant periods.

(2) It will recognize and enhance reverbration.

(3) It will not thump, pump, click, pop, swish, or make holes in the audio during gain attact periods.

(4) It will automatically correct for transmitter changes over a short or long period of time.

(5) Response correction gives a more live sound.

(6) Audio feed to transmitter is automatically shut down instantaneously if the r-f carrier fails, and returns after carrier reappears.

DESCRIPTION (Continued)

Description of the Process.

First the frequency response is slightly altered to better fit the AM transmission process. Mid-high frequencies are slightly emphasized and the low low frequencies are cut (all within FCC limits for AM broadcasting.

The second process involves asymmetrical wave analysis and line reversing. The audio is fed into the asymmetrical voltage generator and symmetry analyser. If the symmetry is not correct for AM modulation and gain controlling, the input audio polarity is immediately reversed. If symmetry polarity is correct, no switching takes place.

The third process is a precision A.G.C. control system. This stage has extremely fast attact characteristics. The output is constant over a 70 db range of input, but amplification does not increase on no or redundant signals, due to the activator system. Recovery time is complex depending upon the nature of the program material, being fast for snappy loud material and slow for sustained soft material.

The fourth process is a precision gain control system that operates off of the information derived from the r-f modulated envelope. This accurately sets the gain to fit the negative trough requirements of the transmitter. Recovery time of this system is slow and a function of the activator.

The fifth process is called float clipping. Due to the prior asymmetrical wave switching, the negative peak is now the flatter peak and very precisely controlled in amplitude. This will now allow for a further negative wave shapening process without adding appreciable distortion. This process should not be used if the asymmetrical wave switching process has not taken place first. This negative float clipping process in association with the asymmetrical wave switcher and precision gain controls, will produce the greatest increase in envelope power over any other known method.

DESCRIPTION (Continued)

Should the transmitter r-f carrier fail, the audio feeding the transmitter is instantly shut down, which protects the transmitter audio circuits, and allows for an easy return to the air.

Conclusion.

The audio pilot processes are response correction, asymmetrical wave analysis and switching, precision A.G.C. control, r-f envelope negative trough control, and float clipping. This gives the most complete AM broadcasting r-f envelope control known.

PERFORMANCE SPECIFICATIONS FOR THE AUDIO PILOT AP-3

Frequency Responce: Flat ± 1 db between 50 Hz and 15 kHz.

Harmonic Distortion: Below 1% for all conditions of operation.

Noise Level: Below -65 dbm at normal gain.

Input Level: -25 dbm to +10 dbm. Low passages may be as low as -50 dbm for full level output.

Output Level: Operate at +10 dbm. Can deliver up to +25 dbm without exceeding the distortion ratings.

Input and Output Impedance: 600 Ohms Balanced.

Maximum Gain: 75 db.

Attact Time: Instantaneous

Recovery Time: Less than 6 Milliseconds for shot attacts.
1 to 6 seconds for sustaining material.

Reverse Switching: Less than 1% undesirable asymmetrical wave continuous for 100 Milliseconds.

Automatic output level control: Controlled on the negative r-f trough.

Line Voltage: 117 volts ± 10 %

Line Current: 1.8 Amps

INSTALLATION

The installation of the "Audio Pilot" into a standard A.M. broadcast system is relatively simple. It comes completely assembled in a 36 inch rack. If the station has 36 inches of rack space, the unit can be removed from the provided rack and re-installed in the station's rack; otherwise, all that is needed is to place into position the provided rack. It plugs into standard 117 volt 60 cycle power.

Input: The input audio is 600 ohms balanced and usually will come from the station's control board. No other type of automatic gain control device should be left in the system. Input can be from a phone line in the case of remote control, but input peak level should not be less than -25 dbm.

Output: The output is usually connected into the transmitter. It can feed a phone line, but if the audio pilot is located at the studio, a r-f amplifier will be needed if the r-f control feature is to be used.

R-F Input: R-F input is connected back into the sampling system of the transmitter. In many cases it can be connected directly to the modulation monitor r-f terminals. If this does not give enough r-f level, or if the modulation carrier meter is pulled down too low, a separate r-f sampling will have to be installed in the transmitter.

Power Change Over: Power change over for the inserted r-f level has been provided. If the station operates with a different power nighttime than daytime, a connection should be made to the transmitter low voltage solinoid from the r-f control unit P133, and the proper voltage relay plugged into the relay socket.

THE AUDIO PILOT
To place into operation

For this instruction it is assumed that the factory fixed adjustments are made and that the reader is preparing to place the "Audio Pilot" into operation.

Start: Start by checking to see that switches and controls are in the following positions:

1. Input - off (ccw)
2. Output - off (ccw)
3. Activator - full (cw)
4. Clip - off (left)
5. Float - Minimum (ccw)
6. Range - Minimum (ccw)
7. Recovery - Minimum (ccw)
8. First Control S61 - Position 1 (ccw) (function 1)
9. Second Control S72 - Position 1 (ccw) (function 2)
10. A-F, R-F switch S71 - a-f

Input: Feed typical program material into the input. Increase the "Input" control until there is a reading of 0 db on the first gain control meter. If the input control is below the 9 oclock position, increase the value of the fixed plug pad Pad.13.

Reversing: The next operation is to determine the correct setting of the "Reversing" switch. With audio playing into the input, as per above, set the output to approximately 85% positive peak modulation as indicated on a modulation monitor or oscilloscope. Set the "Float Clip" control to about the three oclock position. Switch the "Clip" switch to on ~~(up)~~ RIGHT. Observe the modulation monitor or scope for peak amplitudes. Then reverse the "Reversing" switch. If the positives peaks of the modulated envelope increase, the switch has now been placed into the correct position; if however, the positive peaks decrease, return the reversing switch to its original position. The original position is the correct position. (WARNING Be sure this switch is not thrown in the wrong position, or the modulation level will not come up to optimum performance). Now turn off the clip switch for the following adjustments.

Output: Now to adjust the "Output" control, set the output control to give negative modulation very near to 100%. The 2nd control meter should be reading approximately 0 db.

R-F Carrier: Adjust the "Tuning" for a peak reading on the r-f meter, and adjust the load to read .8 on the same meter.

Percent Modulation: Set the "Percent Modulation" control to 98%. Switch the "A-F R-F" switch to the R-F position. There should be no noticable change, but you are now on r-f control. Set the "Percent Modulation" control to the exact desired negative peak modulation.

Float Clip: Turn the float clip control to full ccw position and switch the "Clip" switch to on. Now slowly increase the "Float Clip" control. The negative peaks will remain constant, but the positive peaks will begin to increase. On a good audio speaker monitor listen to the signal and increase the "Float Clip" control until you can just hear distortion. Now back off the control to a safe sounding point. This should occur between 110% and 120 % depending upon the condition of your transmitter. It may occur closer to 100% if the transmitter is not capable of more than 100% positive modulation.

Activator: For all of the above adjustments, the "Activator" control should have been full cw position. Now stop the input audio. Close all control board keys and open only the main announce microphone key. If you are in the control room with this microphone, you need to be quite. Turn back the activator gain until the rest light comes on. This is a good place to start. Further operation experience will tell you exactly where to set the "Activator" control.

Range and Recovery: The range control sets the amount of manual recovery range. The recovery control sets the rate of recovery for the manual portion of the recovery operation. Set these controls from experience to best fit your range and recovery needs.

LIST OF ALL CONTROLS AND SWITCHES
AND A BRIEF DESCRIPTION OF THEIR SETTINGS

Input: With incoming audio signal, adjust to give 0 db reading on the 1st gain meter when zero VU is being fed into the system.

Output: Adjusted to give a 0 db reading on the second gain meter when S71 is on the r-f position or to give 98% modulation when S71 is on a-f.

Activator: Adjust so that the system goes from rest to active or visa versa at the desired level as determined by the active-rest indicator lights.

Rest: Turn off the input to the Audio Pilot. Be sure the rest light is on. Adjust the "Rest" gain control to the desired value of gain, approximately +6 db average on the gain meters.

Max: This control sets the maximum gain you will ever want the system to produce. Usually this is full cw, but it can be cut back if you desire less than full gain on your lowest passages.

Range and Recovery: See description under "Operation" page 33.

Manual: This control is only in the circuit when S61 and or S72 are on position 5. In this case it is used for running proof of performance, or in the tuning process of balancing the V. G. Stages.

Bal 1 K & P.

1. Turn off input audio.
2. Set oscillator control to position 1.
3. Set control 1 switch to position 5.(Manual) Osc to position #3
4. Set control 2 switch to position 4 (Rest) and set to 0 db on gain 2 meter.
5. Turn manual gain to give a reading of +15 db on the fst gain control meter.
6. Observe output on a sensitive output monitor or meter.
7. Adjust K control for a minimum in the monitor.
8. Adjust " Manual" control to now give a 0 db reading on the meter.
9. Turn P control for a minimum in the monitor.
10. Go back and forth between steps 5,7,8,and 9 until the tone is a minimum over the range of gain settings of the manual control.
11. Return the "Oscillator" to the warm or off position.
12. Set the "Rest" control back to where it belongs for normal operation.

Bal 2 K & P.

1. Switch S61 to position 3 ~ Osc to position #4.
2. Switch S72 to "Manual" (Position 5)
3. Follow the same procedure as given above for Bal 1 K & P from step 5 on. on 2nd Control Gain Meter.

TECHNICAL INSTRUCTIONS FOR ADJUSTMENTS

Field Settings and Factory Settings.

All controls with shaft locks were originally set at the factory. In the field they should be adjusted only by personnel with a full understanding of its operation. The controls with knobs are adjusted to fit the individual station's operational needs.

Replacing and or Balancing the 6SK7s.

(Warning: Do not remove more than one 6SK7 at a time while the power is on due to the rising characteristics of the D.C. filament supply. If removing the 6SK7s for testing in an external tube checker, do not mix them up, but replace each tube in the socket from which it came.)

Testing the Emmission of existing tubes: Normally it will not be necessary to test the 6SK7s in any external checker unless looking for a tube internal short condition. To test for emission switch "Function 1" and "Function 2" on position 5. Turn "Manual" control full CW. If control meters go above 20 db, tubes are good. They can be used until they fall short of 20 db, possibly to 15 db.

Testing for balance: Good balance is very important for the control stages. The only equipment needed to test for balance is a method of monitoring the A-F output. This method can be either headphones, monitor amplifier ~~amplifier~~ with speaker, audio voltmeter, or an oscilloscope.

To balance or test the balance of the first control stage, proceed as follows: (1) Turn "In" (input) off (ccw); (2) Switch "OSC" to position 3; (3) Switch "FUNCTION 2" to position 4; (4) Switch "FUNCTION 1" to position 5; (5) Set "MANUAL" control to give a reading of 15 db on "1st Control Gain" meter; (6) you will now hear a slight tone, If you need more gain to hear it (better) turn up the "REST" control or even the "OUT" (output) control, If you have external gain controls on your indicator use it so as not to disturb operational settings. (7) Now, adjust "K BAL 1" for minimum tone; (8) Set "MANUAL" control to give a reading of 0 DB on "1st Control Gain" meter; (9) Now, adjust "P BAL 1" for minimum tone; (10) Go back to the 15 db setting and readjust "K BAL 1" for minimum; (11) Go back and forth several times until both settings agree; (12) If either balance control is near one end of its rotation, it is suggested that you try another pair of tubes and repairing them until you find the best balanced pair.

To balance or test the balance of the second control stage, proceed as follows from the above conditions: (1) Turn "MANUAL" control off (ccw); (2) Switch "OSC" to position 4; (3) Set "REST" control to give a meter reading of 15 db on "2nd Control Gain" meter; (4) You will now hear (see) a tone; (5) Now, adjust "K BAL 2" for minimum tone; (6) Reset "REST" control to give a 0 db meter reading; (7) Now, adjust "P BAL 2" for minimum tone; (8) Go back and forth as you did for stage one, replacing tubes only if necessary, in the same manner as for stage one.

When finished, switch "OSC" back to position 1; Switch "Function 1" to position 4; Adjust "REST" to the operating condition; Switch "FUNCTION 1" back to position 1; Switch "FUNCTION 2" back to position 1 (if you are using R-F control); Turn "IN" and "OUT" controls to their normal operating positions.

BALANCED 6SK7s

The family characteristic curves of tubes V11 and V12 need to be nearly identical inorder to obtain excellant over-all dynamic balance. The same is true for tubes V21 and V22. Some audio pilot owners have purchased as many as six tubes and not found a really good overall balanced pair. At our lab we purchase 6SK7s in larger lots and then pair them off in a balancing machine. We therefore have nearly perfectly balanced pairs of 6SK7s for use in the audio pilot. These balanced pairs are available for audio pilot owners at only slightly higher than regular prices.

SETTINGS (Continued)

Bal 3 K.

1. Connect audio oscillator on the input and a distortion meter on the output.
2. Switch S61 and S 72 to position 5.
3. Set "Manual" control to give +20 db output (Output Pads out)
4. Set oscillator for a 50 Hz signal.
5. Set Bal 3 K for minimum distortion.
6. If you wish to skip this adjustment, set the 3 K Bal control in the mid Position.

Hum 1 and 2: After the balancing has been done, set "Hum controls for minimum on a sensitive output monitor. Take the hum out with each control from the mid position.

THRESHOLD 1: Set "Threshold" 1 control so as to give the proper level as indicated by the 2nd gain control meter. Be sure A-F R-F switch is on the A-F position.

THRESHOLD 2: Set the "A-F R-F" switch to A-F. Set "Threshold 2" control to give +20 dbm output level with no pads considered in the output circuit.

A-F R-F Switch: On the A-F position the output level is controlled by the negative peaks of the audio output wave. On the R-F position the output level is controlled by the negative trough of the modulated envelope.

Control Switch S61:

1. Normal Operation.
2. Special mode of operation (All control comes from the output).
3. Shuts down the first stage for aiding in balancing the second stage.
4. Rest, for adjustment purposes.
5. Manual, for adjustment purposes.
6. With no signal input (system at rest) read meter. Switch to position 6. Read meter again. It should be the same reading. If it is not, there is a leaky control diode, tube or condenser.

Control Switch S 72:

1. Norman Operation.
2. The slow fixes operation section is switched in.
3. The fast recovery range section is switched in.
4. Rest.
5. Manual.
6. Leak test.

Oscillator Switch:

1. Off.
2. Warm.
3. Bal 1st stage.
4. Bal 2nd stage.
5. Switches oscillator into activator so as to produce activation with no external signal. Can be used to adjust the "Max" gain control under no signal conditions.
6. Switches tone into the main system for a general purpose test observation.

AP5

SETTINGS (Continued)

Bal 3 K.

1. Audio oscillator is connected to the input and a distortion meter is connected to the output.
2. Set function switches S61 and S71 to position 5, and adjust manual control to give approximately 0 db on the two gain meters.
3. Set oscillator to give 50 Hz.
4. with all output pads out (zero attenuation) set the input to give an output of +20 dbm.
5. Set Bal 3K for minimum distortion. If the minimum is at one end of the pot, try a new set of tubes.
6. If you skip this adjustment, set the Bal 3K pot in the mid Position.

THRESHOLD 1.

With either program or an oscillator feeding the system at somewhat normal levels, set "Threshold 1" control to give a reading of 0 db on the second gain control meter.

THRESHOLD 2.

Set Function switch 1 on position 1 and function switch 2 on position 2. Feed in a tone (say 1000 Hz) and adjust "Threshold 2" to give +20 dbm in the output with no pads in the output circuit (zero db attenuation).

CONTROL SWITCH S61. — Function 1

1. Normal Automatic operation
2. Diode Test (can operate in this position)
3. Max setting
4. Rest
5. Manual
6. Open diode test.

CONTROL SWITCH S71. — Function 2

1. Normal r-f control operation
2. A-f control operation
3. Gain Block setting
4. Rest
5. Manual
6. Open Diode test

WE HAVE A MODEL 4-3 : #2 IS "NORMAL RF" CONTROL 11/22/68 RWH

SEE PAGE 7

OSCILLATOR SWITCH.

1. Off (including filaments)
2. Warm up only
3. Bal 1st control stage
4. Bal 2nd Control stage
5. Switches oscillator into the activator so as to produce activation with no external signal present. Can be used to adjust the "Max" gain control under no signal conditions.
6. Switches the oscillator into the main system for a general purpose test observation on the oscillator or system.

APS

SETTINGS (Continued)

CLIP SWITCH & FLOAT AND NEG LOAD.

This switch turns on (or off) the float clippers and the negative load. Adjustments of the float clipper and negative load control should be made in observation with a very high quality off the air audio monitor. Set controls full CCW. Turn on clip switch. Now advance either control in any order CW until there is distortion just noticed. Drop the control back just alittle so that no distortion can be heard. If your monitor isn't good enough, you can set both controls in the mid position for most stations. The further to the CW position these controls are set, the higher will be the positive peaks, but distortion will be introduced to some degree in the process.

HEADPHONE JACK J41.

The primary purpose for this jack is to balance Bal 1,2,3,&4, using instructions given on page 34-A.

AP5

ASYMMETRICAL WAVE SWITCHER ADJUSTMENTS

Input Level.

Connect a VTVM from ground to J161. With no signal into the Audio Pilot the reading should be approximately -130 volts. With the audio pilot operating in a normal manner, put in a 1000 Hz tone. J161 reading should now go down to between -80 to -75 volts. There are no variable adjustments for this action. Not So sure about

Bias, Bal 1, Bal 3, &Bal 4.

For all adjustments connect a VTVM from Ground to J162. With no signal in, adjust "Bias" to read -90 volts.

Put in a 100 Hz signal (into Audio Pilot). Be sure that the activator has come on. Adjust balance 1 to give -90 volts. Now switch to 500 Hz and check to see that reading does not fall below -7 volts. If it does, change the 6SN7 V151 tube and repeat.

Balance 3 and 4 are factory set and should not need any further adjustment Should they get turned by mistake, set them in the mid position until a more exact setting can be made. Balance 3 is set for a minimum charge pulse deflection when a 1000 Hz tone is keyed on (key pushed down). Balance 4 is set for minimum discharge pulse deflection when a 1000 Hz tone is broken (key up).

Caution of steady clocking.

The switcher is not intended to clock steady under normal operation. If it does and there isn't time to perform the above adjustments, the following setting should be made. Remove all program material. Turn bias control slowly CCW until clocking stops. Now turn it just 30 minutes (angle on a 12 hour face clock) CCW further. The unit should now perform as normal.

If the switcher switches every time a low tone passes, adjust the balance control 1 until this doesn't happen. Later the balance control should be adjusted as described above.

NOTES TAKEN FROM DISCUSSION WITH GEORGE BRESE 2/3/68

CHECKING DYNAMIC BALANCE:

(1) Take runs on individual tubes on tube tester, recording meter readings against varying grid bias. Pick pairs of tubes that "track" most closely.

(2) Using regular balancing proceedure, balance at 0 and 15DB. Set manual gain control to position where output tone is greatest. Remove one tube from amplifier being balanced. Adjust output to read zero level on distortion meter connected to output. Replace tube and readjust balance for minimum output. It should be possible to balance to at least 35 DB below reading with one tube removed.

DETERMINING WHICH AMPLIFIER IS AT FAULT:

Set 1st Function Switch on Position 5 and adjust manual gain control for that stage so that meter reads zero. If trouble continues, it's in the second stage. If trouble stops, it's in the first stage. (Above results can be confirmed by returning 1st Function Switch to normal and performing same test with second Function Switch).

DIODE TEST:

When making Diode Test, set Function Switch to Position 5 and adjust Manual control for same meter reading as in Position 1. This reduces range of during switching and facilitates evaluating result in a minimum of time.

W.A. NO.	W.A. ISS.	P.T. NO.	C.P. NO.		KIT DEL	WORK START	WORK COMP	Q.C. BUYOFF ASSOC.	Q.C. BUYOFF A.F.	REMARKS	T.C.T.O.
3-B 131	2-23-2	01	9204	S							
				P							
				A				2-28-2	N/A		
				S							
				P							
				A							
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				A							
				S							
				P							
				A							

REV		DATE	

PRIOR TO ____________

UCN XO-9961

FACTORY TEST DATA
(Static Measurements)
AUDIO PILOT

Date of test 6/6/67
Station ____
Serial No. 9

Diagram No. 1 - First 6SK7s V.G. Stage						
Point	V11-4	V12-4	V11-6	V11-8	V12-8	P13-2
Name	G1-Set	G2	Sg	P1	P2	B+
Read	-5v	-5v	70	275	275	300

Diagram No. 2 - Second 6SK7s V.G. Stage						
Point	V21-4	V22-4	V21-6	V21-8	V22-8	P22-2
Name	G1-Set	G2	Sg	P1	P2	B+
Read	-5v	-5	70	275	275	298

Diagram No. 3 Power driver and Output Stage					
Point	V31-3	V31-6	V31-2	V31-5	R38
Name	K1	K2	P1	P2	B+
Read	1.82	1.89	131	134	210

6K6s Final Stage

Point	V32-8	V33-8	V32-4	V32-3	V33-3	T41-2
Name	K1	K2	Sg	P1	P2	B+
Read	21.3	21.6	243	320	320	324

Used VTVM
11 Meg input

Factory Test Data
(Static Measurements
AUDIO PILOT

Date of test ~~6/11/67~~
Station
Serial No. 9

Diagram No. 5 - Control Driver					
Point	V51-3	V51-6	V51-2	V51-5	R54
Name	K1	K2	P1	P2	B+
Reading	1.61	1.61	209	209	210

Diagram No. 6 & 7 - Control Systems						
Point	P62-1	P62-3	R78/R79	P71-1	P71-3	
Name	Min	Max	Gain Bias ~~Cut off~~	Thresh Min	Thresh Max	
Read	-2.3	-13.5	-5.7/11.0	-37	-90	to -150 volt bus

Diagram No. 8 - Activator Driver						
Point	V81-3	V81-2	R83	V81-6	V81-5	R87
Name	K1	P1	B+1	K2	P2	B+2
Read	.68	121	282	1.40	218	219

Diagram No. 9 Activator Keyer						Relay Closed with audio
Point	R93/95	R92/93	V91-5	V91-6	V91-8	
Name	6SH6 Bias	Overall Bias	K	Sg	P	
Read	-4.5	-5.5	.25 .31	142 142	300 264	

FACTORY TEST DATA
(Static Measurements)
AUDIO PILOT

Date of test 6/7/67
Station
Serial No. 9

Diagram No. 10 - Oscillator									
Point	V101-3	V101-2	V101-5	S101-A	S101-A	S101-A	R106	R107	R109
Name	K	P1	P2	Freq.	Level	Distort.	X Level	Y Level	a Level
Read	12.6	255	253	1400 Hz	-7dbm	5.5%	-16 dbm	-11 dbm	-7

Diagram No. 11 - Positive Supply								
Point	V111-4+6	V111-2+8	Rec121-1,2	AC	DC	A	B	C
Name	HV/HV	5	6.3v	Amps	6.2v	In	1st filtr	2nd filtr
Read	422/422	5.1	6.23	1.32	.08v ripple	460	435	410
Point	D	E	F	G	H	I	J	
Name	8	7	11	6	V112	V113	I total	
Read								

Diagram No. 12 - Negative Supply								
Point	V121-4+6	V122-2+8	Rec121-9,10	In E		A	B	C
Name	Hv/Hv	5.0v	6.3v	fine V		In	1st Filtr	2nd Filtr
Read	350/350	4.8	6.15	117		375	360	360
Point	D	E	F	G	H			
Name	-255	-150	V123	V123	Nothing			
Read	-243	-142	12 Ma	16.8 Ma				

10/5/66
Date of test 6/7/67
Station —
Serial No. 9

FACTORY TEST DATA

Dynamic Performance

AUDIO PILOT

No. 1 Frequency Response -25dbm in +20 dbm out

Frequency	30	100	1K	5K	7.5K	10K	15K
Manual	-.2	+.1	0	-.1	-.3	-.5	-.6
Automatic	+.2	+.1	0	0	0	-.1	-.3

No. 2 Output Level and Distortion Vs Input

Input	-60	-50	-40	-30	-20	-10	0	+10	+20
Output	-10	-.2	0	0	0	0	0	0	-4
Distortion		2%*	.45	.4	.24	.05	1.5%	6%	38%

*Outside noise

No. 3 Distortion Vs Frequency -25dbm in, +20dbm out

Frequency	50	1KHz	7.5
Distortion	.65%	.24%	.4%

No. 4 Distortion Vs Output Level

Out Level	0	+10	+15	+20	+25	+30
Distortion	.25	.22	.27	.36	.47	.75

No. 5 Overall Gain and Noise

Function	Overall Gain	Absolute Noise	DB Below Measured -20	Below -30
DB + DBM	83	-108db		

Date of Tests 6/17/61
Station
Serial No. 9

FACTORY TEST DATA
(Dynamic Performance)
Audio Pilot

No. 6 Activation Response						
Frequency	60 Hz	100	400	1K	3K	5K
Level DBM	-34	-42	-61	-69	64	-58

No 7 Balance Tests	
First Stage	Second Stage
OK	OK

No. 8 Keying Attact Test Comments
OK

Diagram No. 13 - R-F Control Unit

Point	P131-3/K13A	Across R136	1 & P131-2	R131 *	[illegible]
Name	Supply	Carrier Osc	100%	DC-RF	
Read	29.6			48	

Sol Mtr at

FACTORY TEST DATA
Asymmetrical Wave Switch

Date of Test 9
Station ____
Serial No. 6/8/67

Diagram No. 14 - Test + Reversing				
Set	Test Level in DBM			
P141	0	-10	-20	
ccw				} Distortion
cw				

Diagram No. 15 AVG Driver-					
Point	V151-3	V151-6	V151-2	V151-5	T161-C
Name	K1	K2	P1	P2	B+
Read	10.0	9.6	255	256	269

Diagram No. 16 Asymmetrical Voltage Generator							
Point	P161-1 -130V	P163-3	P163-2	X161-3	X162-4	X162-6	X162-8
Name	Bias Min	Bias Max	Bias cp	P	G	Sg	P
Read	-6.4	-22	—	—	—	—	—
K Open	→		-10.7	-2.3	✓	130	232
K Closed	→		-11.6	-.8	✓	110	186

Diagram No. 17 - Clock Switch			
Point	X174-2	X172-1	X173-2
Name	Relay Energized		
Read	~~48~~ 158	81	76

AP-4
11-23-66
Date of Test
Station 6/6/67
Serial No 9

FACTORY TEST DATA
Asymmetrical Wave Switch

Diagram No. 18- Power Supply

Point	X181-4,6	X182-4,6	X181-2,8	X182-2,8	X151-7,8	X141-2,7	AC	J	K
Name	HV/HV	HV/HV	5v ac	5v ac	6.3v	6.3v	Amps	V183	V184
Read	365/365	259/259	5.1	5.0	6.18	6.25	.57	14.8	15.5

Point	A	B	C	D	E	F	G	H	I
Name	+Input	1st Filt	B++	B+	-Input	1st Filt	2nd Filt	-210	-150
Read	310	300	289	277	280	268	252	-207	-141

Dynamic Tests of Asymmetrical Generator Diagram 16

Test No	Jack	No Sig	50Hz	200	1K	5K
1	161	~~-45~~				
2	161	-122	87	80	76	76
1	162					
2	162					

KUMA

9

FACTORY TEST [illegible] Date 6/8/67

Equipment Unit

Positions	30	50	70	100	200	400	1K
Lo Lo off	0	+.3	+.2	+.1	0	0	0
Lo Lo in	-19.5	-19.5	-7.5	.3	0	-.1	0

Equip	400	1K	2K	3K	3½K	4K	5K	6K	8K
off	0	0	0	0	0	-.1	-.1	-.2	-.4
1	-.2	0	+.8	+1.8	+2.0	+1.9	+1.2	+.2	-.1
2	-.9	0	+2.2	+4.2	+4.7	+4.5	+3.5	+1.2	+.1
3									
4									

Insertion Loss = 9.5 db

To Balance Audio Pilot

1. Turn on "Osc" to Pos 3

Set Function 1 to pos 5
Adjust Manual Control to meter #1 reads +10
Set K Bal 1 To Null in low tone

Set Manual Control to meter #1 reads 0
Set P Bal 1 TO Null

Work Back & forth until Null is achieved

Switch function switch #1 To pos 1

Set function switch #2 to pos #5

Repeat above using Meter #2

Set K Bal 2 to Null
Set P Bal 2 to Null