Service Notes
on
ENTRON MODEL APL
PRE-AMPLIFIERS

ENTRON APL PRE-AMPLIFIERS

SPECIFICATIONS

BANDWIDTH		6 MEGACYCLES
MAXIMUM GAIN IN DB AT VIDEO CARRIER FREQUENCY:		
	APL-2	100 DB
	APL-3	95 DB
	APL-4	90 DB
	APL-5	87 DB
	APL-6	85 DB
FREQUENCY RESPONSE OVER VIDEO RANGE (Fig. 3)		± 1.5 DB
MAX. OUTPUT LEVEL IN DB ABOVE 1 MILLIVOLT (AT VIDEO CARRIER LEVEL)		52 DB (0.4 VOLT)
MIN. INPUT FOR MAX. OUTPUT (1 MILLIVOLT REFERENCE LEVEL)		-26 DB (50 uv)
INPUT IMPEDANCE (UNBALANCED)		75 OHMS
OUTPUT IMPEDANCE (UNBALANCED)		75 OHMS
AGC: MAX. OUTPUT VARIATION FOR 60 DB INPUT VARIATION		2 DB
TUBE COMPLEMENT:	(1)	5654
	(1)	6J6
	(6)	6CB6
NET WEIGHT		5 LBS.
SHIPPING WEIGHT		6 LBS.
DIMENSIONS	WIDTH	3"
	LENGTH	19"
	DEPTH	4 1/2"
MOUNTING	RACK	19"
FINISH	BLACK WRINKLE OVER SILVER PLATE	
POWER REQUIREMENTS:	225 VOLTS AT 50 MA. DC MAX.	
	150 VOLTS AT 12 MA. DC MAX.	
	6.3 VOLTS AT 2.5 AMPS. AC	

ALL POWER REQUIREMENTS FOR 4 APL UNITS ARE MET BY PSR-1 ENTRON POWER SUPPLY

SERVICE NOTES ON ENTRON MODEL APL PRE-AMPLIFIERS

GENERAL: The following information and service data is presented for use only by properly qualified and trained tv technicians or engineers. In no case should radical changes in circuit design or incorrect parts replacements be made. Proper performance is greatly dependent upon correct alignment and use of standard replacement parts as specified in the attached parts list.

IDENTIFICATION: Each APL is identified by a number. APL-2 is the Entron identification of a pre-amplifier designed for service on channel 2. APL-2-3-4-5-6 are used on the corresponding channels in each case.

FUNCTION: The function of the APL is to select the proper band of frequencies required for presentation of the picture and sound information and to reject signals outside the pass-band; to amplify the video and sound signals for driving the MUE-5 mixer and to maintain a constant output within 2 db for input signal variations up to 60 db.

GROUNDING: There are three types of grounds to consider: chassis, inter-chassis or rack bonding, and external. If parts in an APL unit are replaced, be sure to avoid disturbing wiring as much as possible, to use short direct connections to original factory wired ground points in order to prevent oscillation. Bonding of APL units situated in a rack is accomplished using flexible braid supplied and the grounding lugs on each APL. Allow sufficient slack for an APL to be removed or to avoid tension, but keep bonding as short and direct as practicable. Be sure lugs are secure since an intermittent contact may cause excessive or annoying noise. An external ground to a pipe sunk in the earth, for protection of personnel in the event of short circuits or lightning, is specified by most Fire Underwriters where equipment is insured. Ground cable of this kind should be a number 8 or larger insulated or bare copper wire.

ALIGNMENT: Full information on alignment is given under ALIGNMENT in these Service Notes. Alignment should not be attempted without proper equipment, as specified, and proper understanding of alignment techniques.

DESCRIPTION: The APL pre-amplifier is a stagger tuned r-f amplifier which achieves a 6 mc. band-pass characteristic of the type indicated in Fig. 3. The nominal peaking frequency of each stage is specified under Alignment. The stages may be identified by reference to the various tubes. The tube functions are as follows:

SYMBOL	FUNCTION	TYPE
VT-1	R-F INPUT TRIODE (converted from pentode)	5654
VT-2	PARALLEL GROUNDED GRID DUAL TRIODE	6J6
VT-3	R-F AMPLIFIER PENTODE	6CB6
VT-4	R-F AMPLIFIER PENTODE	6CB6
VT-5	R-F AMPLIFIER PENTODE	6CB6
VT-6	R-F AMPLIFIER PENTODE	6CB6
VT-7	R-F AMPLIFIER PENTODE (output)	6CB6
VT-8	R-F AMPLIFIER PENTODE (AGC STAGE)	6CB6

CIRCUIT DESCRIPTION: The input signal is applied via input jack J-1 (See Fig. 1) to a tap on the r-f coil in the first stage. A similar tapped output circuit is used from the plate r-f coil of VT-7 to output jack J-2 via C-68, affording simplicity of coil construction and proper impedance matching.

CASCODE CIRCUIT: VT-1 and VT-2 work together in a special cascode circuit which has very low inherent noise. The plate of VT-1 is coupled to the cathode of VT-2 directly. VT-2 functions as a grounded grid r-f amplifier, the grid being connected effectively to ground at signal frequencies by C-27. VT-2 is the equivalent of a single triode. VT-1 is a pentode so connected as to be an equivalent triode. The cathode of VT-2 is connected to an r-c combination consisting of R14-C9 for cathode bias. Effectively, the plate resistances of VT-1 and VT-2 are in series.

TRAPS: Two wave traps are incorporated in the APL circuit, for the purpose of attenuating adjacent channel sound signals. They are tuned as described under ALIGNMENT. The traps are located in the grid circuits of VT-3 and VT-5. Referring to Fig. 3, note that the traps are tuned for maximum steepness of low frequency slope of the response curve so that level of adjacent channel sound is at least 10 db down from picture carrier level of channel to which APL is tuned.

STAGGER TUNED R-F AMPLIFIER: The stages between VT-2 and VT-7 are conventional stagger tuned r-f amplifiers. The plate circuit of VT-7, however, uses capacitor tuning and has a tapped coil for feeding an output circuit.

AGC CIRCUIT: The agc circuit is somewhat unusual and worthy of close examination. Amplified agc is afforded by the gain of VT-8 which has a high Q plate circuit permitting a sharp selectivity characteristic to be obtained in this agc stage. The VT-8 stage is sharply tuned to the video carrier output of VT-7. The output of VT-8 is applied to a series circuit consisting of rectifier 3, rectifier 2 and C-44. The signal output is also applied to the series circuit consisting of C-58, rectifier 1 and C-44. Rectifiers 1 and 2 form a half-wave voltage doubler circuit for development of agc negative bias. Rectifier 3 is a special type having a very high ratio of front to back resistance. When not conducting, the resistance is 10 megohms or higher, permitting rectifier 3 to serve as a load for the rectifier 2 circuit. When conducting, the resistance of rectifier 3 is very low so that it can function as a positive clamp practically equivalent to a short circuit should the agc line go positive. This may occur if the channel to which the APL is tuned goes off the air. The sole function of rectifier 3 is to act as a diode load impedance of very high value for conditions where the agc line is negative and to act as a short circuit should the positive threshold bias be applied to the line in the absence of an incoming r-f signal. Its importance in the circuit should be fully realized since, if omitted or defective, rectifier 3 would cause severe oscillation and instability in the absence of an incoming signal and the lack of development of negative agc bias.

As a temporary expedient, if an incoming signal is present and rectifier 3 is defective, a 1 megohm resistor may be used as a diode load. To prevent oscillation, a diode of the rectifier 1 or 2 class may be used as a positive clamp temporarily but should be replaced as soon as practicable with a rectifier 3 diode.

AGC FILTERING: The agc line is filtered by the usual r-c decoupling circuits, such as R-47, R-46, R-37, R-35 and associated capacitors C-57, C-56, C-54, etc. However, the time constant of the agc is purposely made rather long to prevent sync suppression and replacements of parts in this circuit should be made using only exact components originally specified. A changed part value would result in incorrect time constant and faulty agc action.

THRESHOLD BIAS: The agc is equipped with a threshold bias control which permits setting the level at which the agc starts operating. Because of this action of R-48, which is controlled by a knob on the chassis, the output level can be adjusted to any desired value within the range of the threshold control.

AGC JACK: An agc jack is provided to permit convenient measurement of agc voltages and is connected to the agc line via R-45. This jack also affords a means of applying a fixed bias during alignment as explained under ALIGNMENT in these service notes.

TYPICAL TROUBLES: No matter how carefully designed and produced, electronic equipment may occasionally develop faults. The following is a summary of some usual and unusual troubles, with appropriate remedies.

TYPICAL SERVICE TROUBLES

OUTPUT LEVEL LOWER THAN NORMAL: Check setting of threshold control which may have been changed inadvertently. Check tubes and source voltages. Check input signal level with field strength meter and be sure all cable connections are correct and tight. Normally, the agc will hold the output at the desired level; if not, the agc may be at fault and should be checked as described below.

As alignment affects gain, realignment may be required. However, in view of the fact special alignment equipment is needed, as specified in Alignment, be sure alignment is absolutely necessary before disturbing original alignment. A simple means of testing is to connect a standard, well shielded tv receiver to the APL output. If the picture is clear and undistorted, alignment is probably correct. If the tv set overloads due to high signal level at the input, use a pad between the APL and set, adjust the threshold control, or both. If available, by all means use a sweep generator and oscilloscope to get an accurate indication of alignment which should be equivalent to the response curve shown in Fig. 3.

SEVERE OSCILLATION: Make certain all tube shields are firmly in place and that bonding straps to each APL or converter are in place and properly secured. Check cable connections. Improper grounding of a cable might result in feedback and oscillation. The usual cause of oscillation in a high gain r-f amplifier, assuming shielding is correct, is a defective by-pass condenser in a plate return or screen return circuit. In checking condensers in a tv receiver or ordinary radio, suspected units may be shunted and the effect noted; tests are made with the chassis upside down or on edge and power on. In checking APL units, such tests cannot be made because of the very high gain and high operating frequencies. The cover must be in place while the unit is operating if oscillation is to be prevented. This is particularly true when there is no input signal and no agc bias since, then, gain is a maximum.

Suspected condensers should be checked by a replacement method, being certain to place the new condenser in the exact position occupied by the old one, and to use the same grounding point. Occasionally, a heater circuit by-pass may become defective and allow common coupling between stages, inducing oscillation. Such units are best checked by replacement, making one replacement at a time and in that way isolating the defective capacitor.

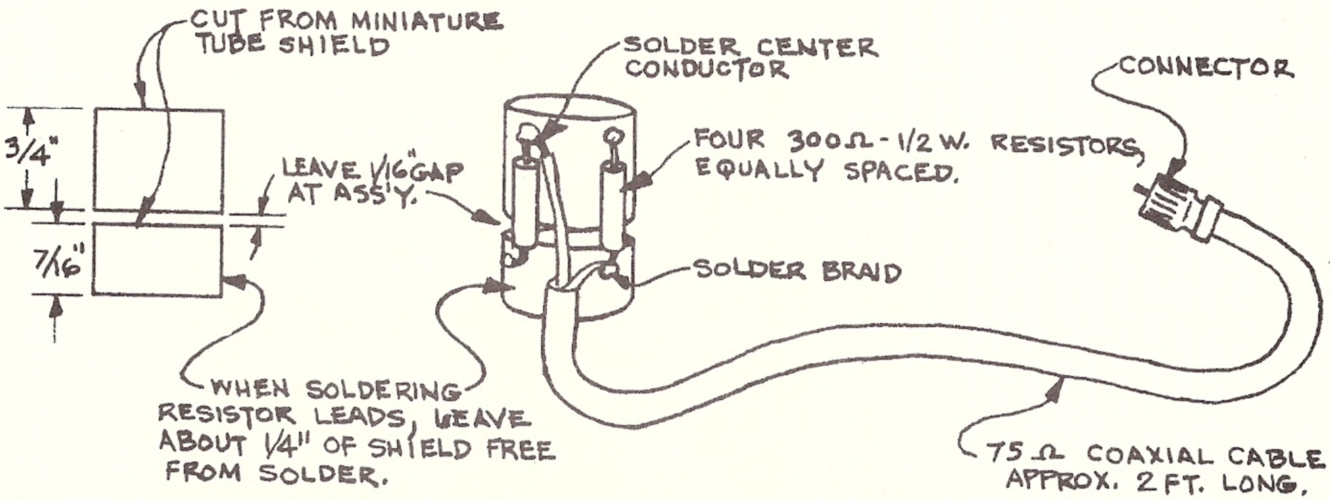
Severe oscillation with no input signal applied may be due to triggering of the r-f amplifier by noise pulses when rectifier 3 is defective and does not act as a positive clamp for the positive threshold bias. A subnormal bias means high gain and a tendency to oscillate, but the condition is severely aggravated by a positive bias due to a faulty clamping diode such as rectifier 3. The rectifier can best be checked by trying another and noting effect on performance of the APL. If the oscillation is not due to an APL fault, check the PSR-1 power supply.

EXCESSIVE NOISE: The first stage in the pre-amplifier is probably most critical in this respect since any noise generated here will be amplified by succeeding stages. VT-1 and VT-2 can be checked by replacement if suspected of being noisy. A weak signal will cause amplifier noise and gain to go up. A result may be an intolerable amount of noise due to a faulty antenna or transmission line input. The level of the signal can be checked with a field strength meter. If the signal input is 50 microvolts or higher and noisy output is obtained from the APL, there may be a fault in the APL unit. A better visual indication may be obtained by connecting a good, well shielded, tv receiver to the transmission line that has been disconnected from the APL input. If a clear, steady picture is obtained, look for a fault in the APL; if not, check the antenna and transmission line circuit.

A frying or hissing sound may be due to a faulty carbon resistor causing noise modulation of an r-f stage. A periodic or intermittent noise occurring at a slow rate may be due to some thermal defect in a poorly soldered joint or in a defective component, such as a tube. Microphonic or ringing noises may also be caused by faulty tubes. Loose trimmers or coils may cause intermittent noise and may be noticeable only when some vibration is present.

FAULTY AGC ACTION: If the signal input to the APL is steady, the agc will have relatively little effect and will primarily reduce the gain to a degree dependent on the input. However, a faulty agc may erratically change the gain of the APL or fail to smooth out variations in the signal level as the input fluctuates. To check the agc and gain functions separately, an isolation technique may be used. With the agc tube removed from its socket and threshold control set for minimum threshold voltage, a 5 volt negative bias is applied to the agc jack and a 100 microvolt input signal to the APL input. The output is terminated in the 75 ohm impedance of a field strength meter. If the output remains constant, the APL is not faulty or intermittent exclusive of the agc. To check the agc stage, pull out VT-7 and put back the agc tube, VT-8. Remove the 5 volt negative bias from the agc jack and connect a dc vacuum tube voltmeter at this point. Apply a 1 millivolt signal from a generator to the output jack of the APL and note the reading of the voltmeter. As the generator output is reduced slowly, the agc voltage should decrease in step with the generator output reduction at a slow rate. If sharp changes are noted or no variation is obtained, there is a fault in the agc system. VT-8 may be checked by replacement and this also applies to the rectifiers in the clamp and voltage doubler circuits. However, one replacement should be made at a time, to discover the particular element that is faulty.

INTERMITTENT OPERATION: First, be sure the input signal is not intermittent. Check it with a field strength meter. If the fault is in the APL, attempt to isolate the trouble by using the following technique. (Once the trouble is localized to a specific stage, further localization is an easy matter to discover the defective item.) A useful device for trouble shooting consists of a special tube shield as shown in the following sketch:



The top portion of the shield is held to the bottom portion by four resistors spaced 90^{o} apart around the tube shield circumference. The 300 ohm resistors form a 75 ohm load for the signal generator. Referring to Fig. 1, if it is desired to inject a signal into the VT-4 stage, the device is placed around VT-3 and VT-2 is pulled out. Then, by capacitive coupling to the plate of VT-3, the generator signal is applied to the VT-4 input. If the signal output, then, is normal and does not vary, the trouble is localized to a stage ahead of VT-4. If the signal does cut off or is abnormal, the fault is localized to VT-4 or a succeeding stage. In this way, the device saves time in speeding up a servicing diagnosis.

VOLTAGE TESTS: Voltages cannot be checked at tube sockets because of the high gain and high operating frequencies which make the operation critical. Source voltages may be tested however, preferably at the PSR-1 output terminals. Minimal variation in plate supply potential may be expected as agc changes plate and screen currents but screen potentials should be constant because they are regulated. The cover plate must be on the APL at all times during operation and tests to prevent oscillations. Source voltages are indicated directly on the schematic, Fig. 1.

SIGNAL DISTORTION: In general, signal distortion will be caused by multipath transmission, incorrect impedance matching, strong interference from noise sources, misalignment or by any of the conditions which may affect the high gain r-f circuits of an ordinary tv receiver. However, the head-end equipment is far more critical than a receiver since it may serve as a source for dozens or hundreds of tv receivers. The experience gained in interpretation of faulty picture presentations in servicing tv receivers may be applied successfully to interpreting service troubles in head-end equipment, bearing in mind essential differences. Signal distortion may be due to an inherent fault in the APL or to circuits ahead of it such as the antenna and transmission line associated with the APL input.

This discussion will be limited to APL faults. System or transmission faults are discussed in the Field Service Manual. The most likely cause of signal distortion would be a change in alignment or misalignment. APL units must be aligned as described under ALIGNMENT. Assuming no interference, misalignment will produce signal distortion. With interference and misalignment or changed alignment, signal distortion will be exceptionally severe.

Adjacent channel interference occurs as the result of beats between carriers or any carrier and any sideband present at the APL input. The selectivity characteristic of the strip offers discrimination or rejection against carriers and sidebands of adjacent channels. The center frequency of the f-m sound is 1.5 mc. away from the adjacent channel picture carrier, so that a coarse beat pattern may be developed if sound traps are not correctly tuned.

If the strip lacks proper selectivity due to misalignment or changed alignment, sidebands of an adjacent channel may beat with the desired carrier and produce an interfering image corresponding to the program not wanted. The most prominent feature of this upper adjacent image is the vertical blanking bar which becomes visible owing to the unequal transmission times from the two stations. The blanking bar moves from side to side when the two programs arise from unsynchronized scanning sources and the motion gives rise to the term "windshield wiper" interference.

If the sound is not attenuated properly, because of mistuning of the traps, horizontal dark bars may appear on the picture tube of the tv set used as a monitor. The width of the bars varies with the audio frequency, the intensity of the bars is proportional to the amplitude of the signal and when both frequency and amplitude of sound vary, ripples may appear on the screen of the picture tube.

If beats occur between adjacent channel carriers and the strip selectivity is poor due to misalignment or faulty shielding, modulation of the beat at the field scanning rate of 60 cps and the line-scanning rate of 15,750 cps may cause a 60 cps buzz and a 15,750 cps hiss in the reproduced sound at the tv receiver. The basic trouble may be phase modulation at the transmitter which is aggravated by the misalignment condition of the strip, and would not be noticeable otherwise.

If the higher frequencies are attenuated, fine detail in the picture may appear blurred. A dip in the mid-band portion of the response curve may show up as a faulty contrast over part of the picture, or a brushed paint effect. Lack of shading may be due to attenuation of the picture carrier due to a dip in the response curve at the picture carrier frequency.

Incorrect background shading of the picture may be caused by 60 cycle hum modulation due to cathode to heater leakage in an r-f amplifier tube, or plate modulation of the tube at 120 cycles due to a fault in the PSR-1 filtering action. Such troubles are rather uncommon since the tubes are carefully selected and high quality components are used in the PSR-1.

ALIGNMENT PROCEDURE

TEST EQUIPMENT REQUIRED:

1. Dual Mega-Marker Sr. (Kay Electric Co., or equivalent)
2. Mega-Sweep 111-A (Kay Electric Co., or equivalent)
3. DuMont 304-A Oscilloscope, or equivalent
4. Crystal Detector (Entron, Inc. or equivalent) Model VHFD
5. Regulated bias supply with shielded plug and cable.

TEST EQUIPMENT CALIBRATION:

1. Warm up all test equipment at least 30 minutes.
2. Connect Marker output to low output jack of Model 111-A Sweep Generator.
3. Connect high output of Mega-Sweep to vertical (Y) input of Dumont 304-A oscilloscope via crystal detector.
4. Check calibration by setting marker to channel desired and observing scope.

ALIGNMENT OF APL

1. First, familiarize yourself with location of each trimmer, adjustable coil, tube location. Referring to circuit diagram Fig. 1, and top view, Fig. 2, the locations can be found. They are as follows:

C-24	Grid Input of VT-1
L-1	Plate Circuit of VT-2
L-2	Plate Circuit of VT-3
L-3	Plate Circuit of VT-4
L-4	Plate Circuit of VT-5

L-5	Plate Circuit of VT-6
C-22	Plate Circuit of VT-7
L-9	Grid Circuit of VT-3
L-11	Grid Circuit of VT-5

2. Before starting alignment, screw wave trap slugs L-9 and L-11 out, as far as possible, (do not damage) to tune them out of pass-band. Apply -5 volts bias via AGC test jack. Set threshold control for minimum AGC action (Full clockwise)

3. Adjust trimmers in following order, retouching later as necessary:

3.1	L-1	Picture
3.2	L-3	Picture
3.3	L-2	Sound
3.4	L-5	Sound
3.5	Input (C-24)	Center
3.6	Output (C-22)	Center
3.7	L-4	Center

4. At beginning of alignment, gain may be low. As gain is brought up by tuning, keep amplitude of trace on scope no higher than 10 divisions with vertical gain control set at maximum and output of generator being reduced as necessary.

5. Adjust the response curve to duplicate that shown in Fig. 3. Adjust the sound carrier of the channel so that it is 9 to 11 db below the picture carrier level. The top portion of the curve should be flat within $\pm$ 1 1/2 db.

6. Tune traps T-1 and T-2 for maximum steepness of low frequency slope so that level of adjacent channel sound is at least 10 db down from picture carrier level of channel to which APL is tuned.

APL GAIN

EQUIPMENT REQUIRED:

1. Hewlett Packard Signal Generator (or equivalent)

2. Field Strength Meter

PROCEDURE:

1. The gain will vary according to conditions of bias, alignment, tubes and parts tolerances. The figures given below are typical values obtained in checking production. The gain is for zero bias, without AGC.

Chassis	Gain	(Input is not to exceed 10 microvolts)
APL-2	100 db	
APL-3	95 db	
APL-4	90 db	
APL-5	87 db	
APL-6	85 db	

2. The gain setup is shown in Fig. 5. The above figures are for the picture carrier of each channel. Output level can be varied by the adjustment of the threshold control.

AGC TEST

EQUIPMENT REQUIRED: Same as for gain tests.

PROCEDURE:

1. Set up signal generator to give an unmodulated r-f output of 10 millivolts at the center frequency of the channel covered by the APL and apply this signal to the APL input.

2. Set threshold control for maximum AGC action (Full counter-clockwise)

3. Connect FSM to APL output and adjust it to give an output level indication of zero db.

4. Reduce r-f input from 10 millivolts reference down to 50 microvolts, observing level of APL output as this is done. The AGC should hold the output level constant within 2 db over the above specified range.

AGC ALIGNMENT

TEST EQUIPMENT REQUIRED:

1. Vacuum Tube Voltmeter (Triplett or equivalent)
2. Hewlett Packard Signal Generator (or equivalent)

PROCEDURE:

1. Remove VT-6
2. Insert VTVM probe into test jack and ground other lead of VTVM to chassis.
3. Set VTVM to read voltages of the order of -15 volts.
4. Set AGC threshold control to approximate mid-point.
5. Apply power to APL.
6. Insert proper video carrier frequency into output jack J-2 of APL from signal generator.
7. Tune AGC coil for peak reading on VTVM.
8. Rotate threshold control and see if VTVM goes to zero or possibly positive. The positive reading should not exceed .02 volt.

CHANNEL FREQUENCIES: The picture and sound channel carrier frequencies are tabulated below for convenient reference:

CHANNEL		PICTURE CARRIER FREQUENCY, MC.	SOUND CARRIER FREQUENCY, MCS.
Number	Mcs.		
2	54-60	55.25	59.75
3	60-66	61.25	65.75
4	66-72	67.25	71.75
5	76-82	77-25	81.75
6	82-88	83.25	87.75

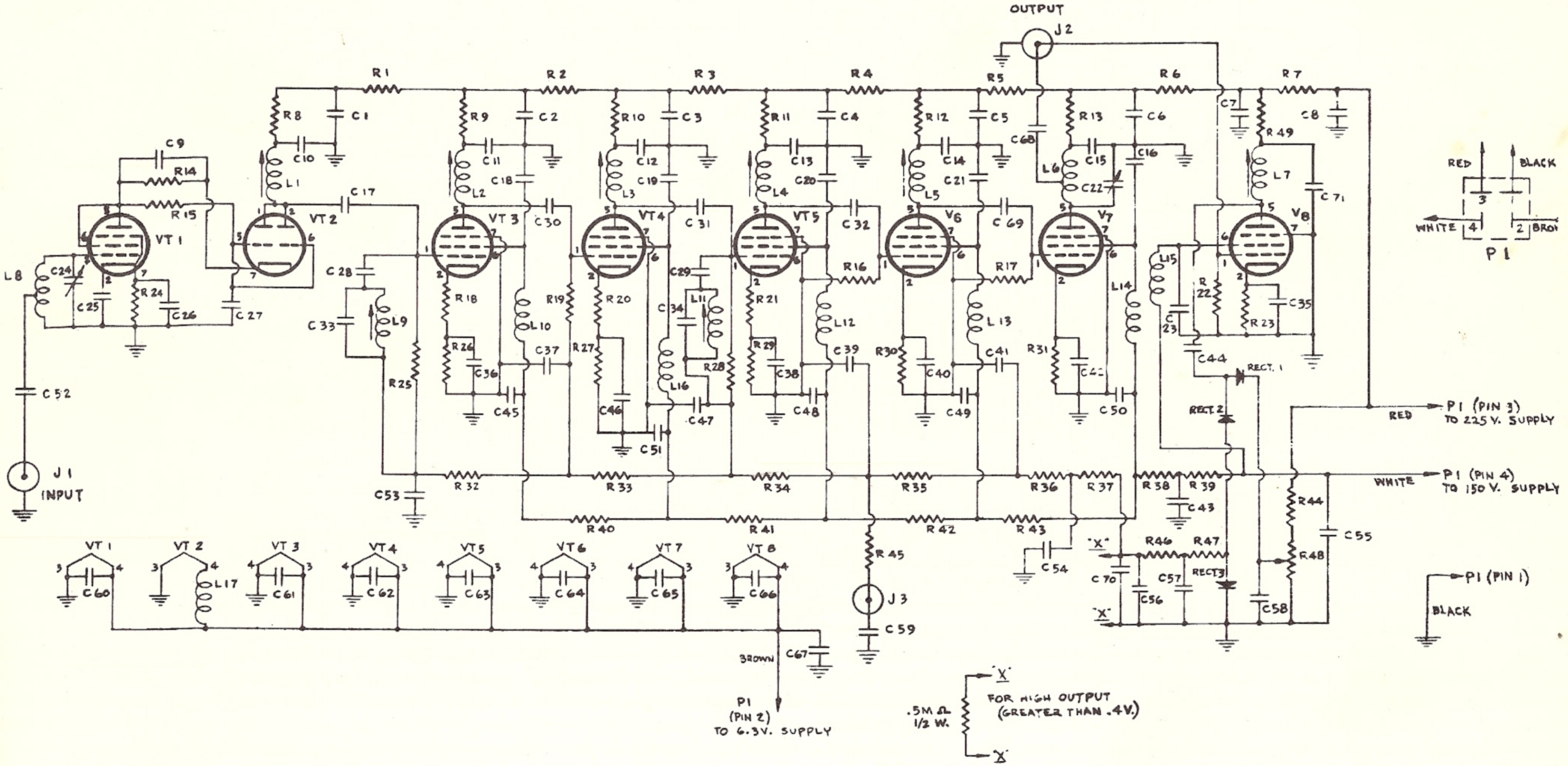
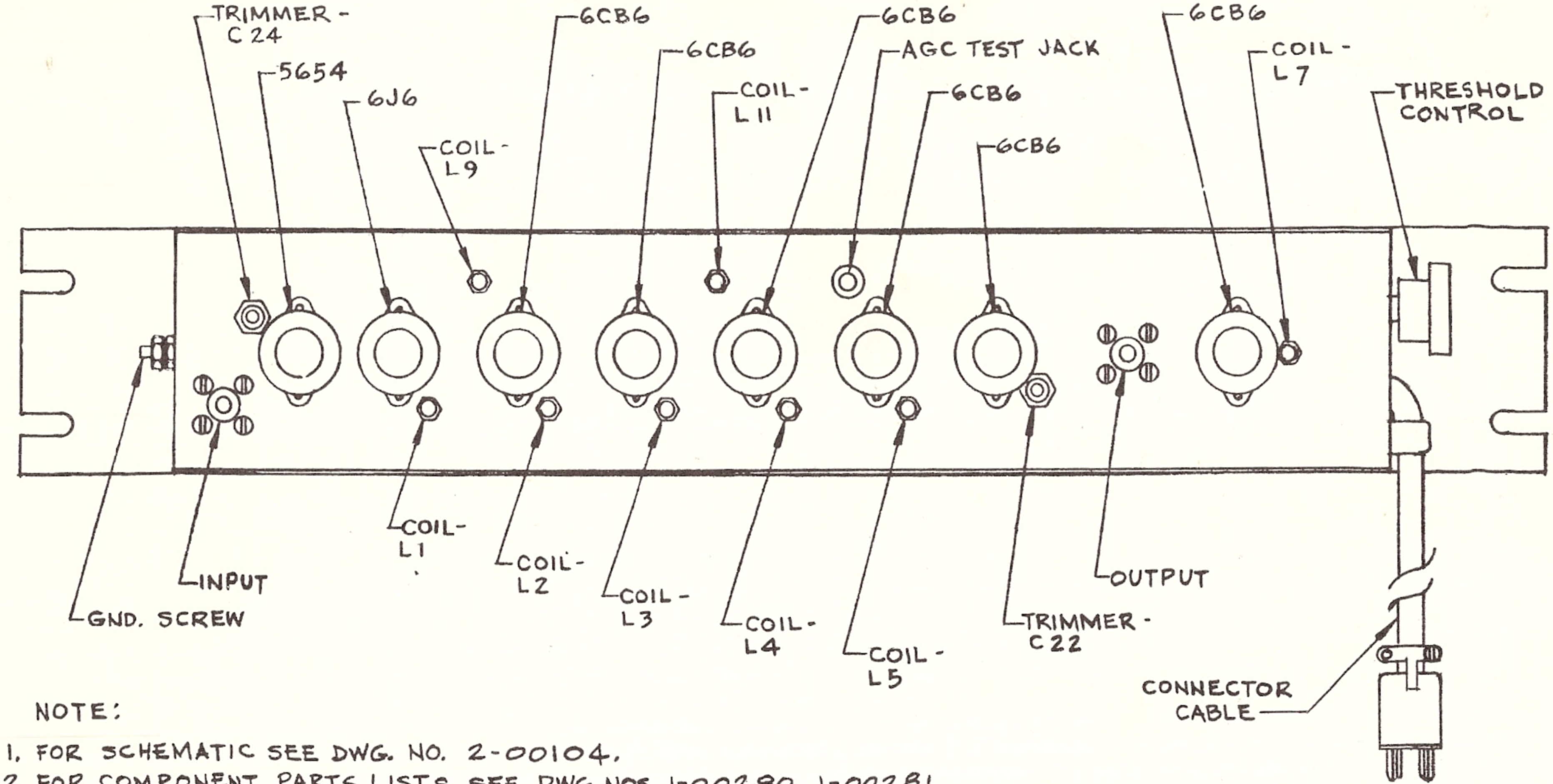


Fig. 1

DRAWN BY	DATE	LOW BAND PREAMPLIFIER CHANNEL 2-6	entron CORPORATED
JM	28JUN54		
CHECKED BY	DATE	MODELS APL-2-6 SCHEMATIC	BLADENSBURG MARYLAND
APPROVED BY	DATE		
SCALE: NTS		DO NOT SCALE THIS DRAWING	DWG. NO. 2-00104

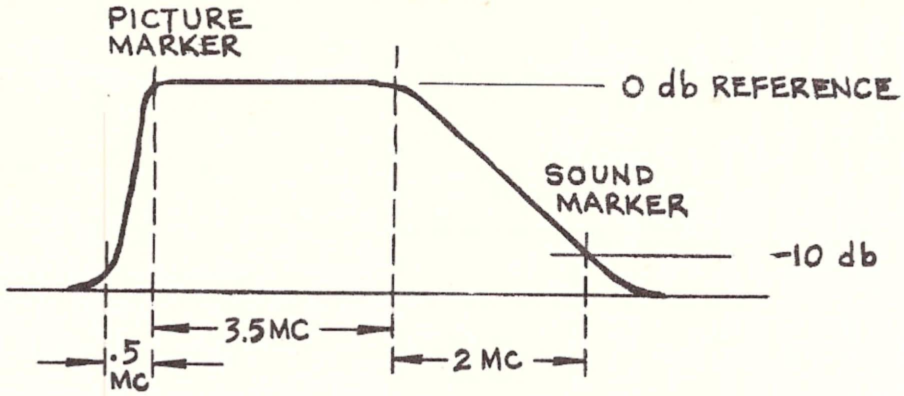


NOTE:

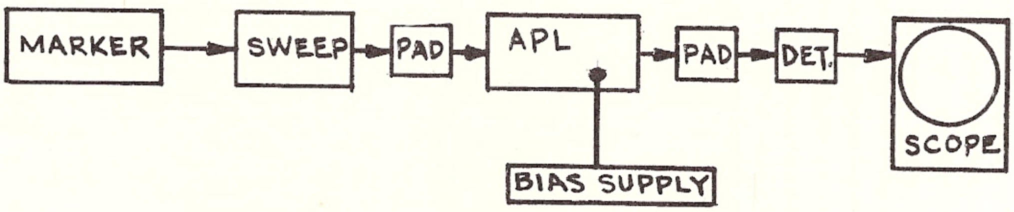
1. FOR SCHEMATIC SEE DWG. NO. 2-00104.
2. FOR COMPONENT PARTS LISTS SEE DWG. NOS. 1-00280, 1-00281, 1-00282, 1-00283, 1-00284.
3. FOR MASTER PARTS LISTS SEE P.L. NOS. 1-0011, 1-0012, 1-0013, 1-0014, 1-0015.

DRAWN BY	DATE	OUTLINE DRAWING TOP VIEW	entron INCORPORATED
JM	22 JUL 54		
CHECKED BY	DATE	LOW BAND PREAMPLIFIER MODELS APL-2-6	BLADENSBURG MARYLAND
APPROVED BY	DATE		
SCALE: 1/2	DO NOT SCALE THIS DRAWING	DWG. NO.	1-00279

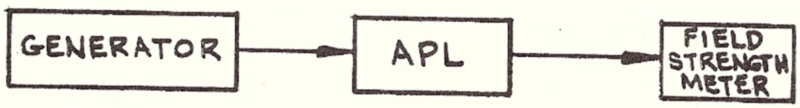
FIG. 2



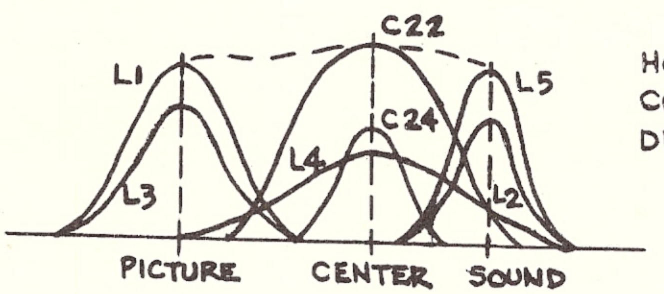
APL RESPONSE CURVE - FIG. 3



ALIGNMENT SET-UP - FIG. 4



GAIN SET-UP - FIG. 5



HOW STAGGER TUNING COMBINES CURVES FOR DESIRED TOTAL CURVE.

FIG. 6

APL ALIGNMENT DATA

GENERAL ELECTRICAL PARTS LIST
APL - Con't.

CIRCUIT DESIGNATION	COMPONENTS	ENTRON DRWG. NO.
R-32,R-33,R-34,R-35,R-36 R-37,R-45	4.7K ohms 1/2W ± 20%	
R-44	180K ohms 1/2W ± 10%	
R-46,R-47	1M ohms 1/2W ± 10%	
C-28,C-29	1.5mmf ± 10%	
C-33,C-34	15mmf ± 10%	
C-9,C-17,C-30,C-31,C-32, C-69	300mmf ± 20%	
C-27	1200mmf ± 20%	
Rect.1, Rect.2	IN54	
Rect.3	CK739	
C-56,C-57	.1mf	
VT-1	5654	
VT-2	6J6	
VT-3,VT-4,VT-5,VT-6, VT-7,VT-8	6CB6	