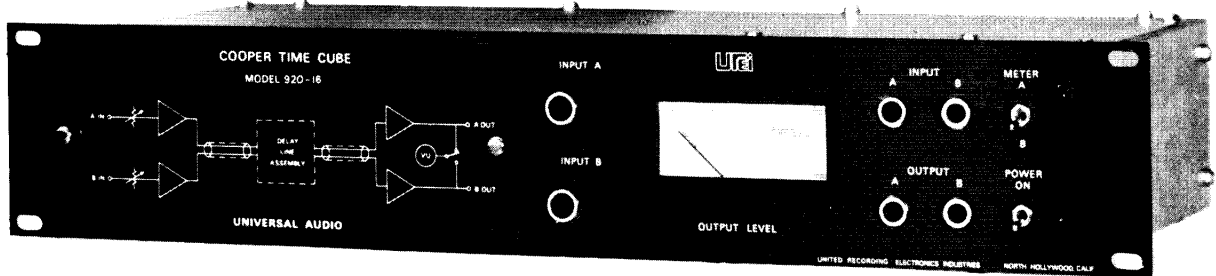


# Universal Audio COOPER TIME CUBE DUAL ACOUSTICAL DELAY LINE

MODEL  
920-16

## ELECTRONICS CHASSIS



Created specifically for recording studio and motion picture sound applications, the Cooper Time Cube provides TWO electronically independent delays of 16MS and 14MS in one compact, rugged system. Its excellent audio bandwidth, low distortion and 70 dB signal-to-noise make the Model 920-16 the best audio delay device available for the short delays required in professional recording.

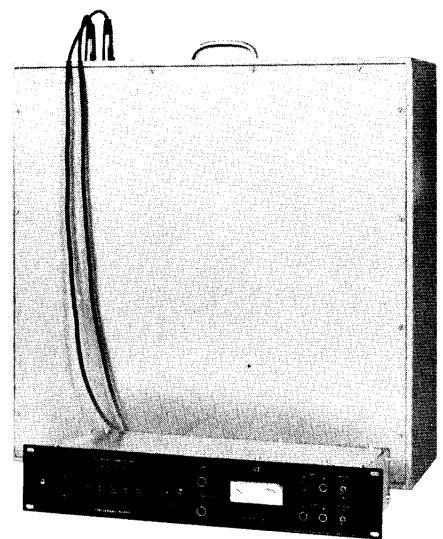
The Model 920-16 system utilizes original techniques developed by Dr. Duane H. Cooper of the University of Illinois and subsequent improvements by M. T. Putnam of UREI to bring complete respectability to the heretofore marginally feasible acoustical delay line.

The Cooper Time Cube system (illustrated at lower right) is comprised by: A rugged, grey-finished housing 24" X 24" X 9", which contains the two coiled acoustical delay lines and their respective transducers; a 3 1/2" X 19" rack-mounting electronics chassis containing power supply, four UA 1109 card-type amplifiers, equalizing networks, meter and operating controls, and two standard 25' microphone extension cables with XLR-3 type connectors for interconnecting the chassis and the housing.

## APPLICATIONS

- Creating "synthesized" Quadraphonic 4-channel tapes and records from 2-channel Stereo originals.
- Loudness Enhancement—the impression of increased intensity of a sound source without increased peak amplitudes.
- Spatial enhancement of Stereo or Quadraphonic recordings.
- Delaying "feed" to reverberation chambers or devices, to supply added dimension by delaying the first reflected sound before the onset of reverberation (the two Time Cube channels may be cascaded for 30MS delay for this purpose).
- Improving optical film recording by delaying audio to light valve or galvanometer, which prevents clipping of first transient peaks by the noise reduction system (Applicable to Westrex, RCA, Maurer or other film recording systems).

Electrical and physical specifications are listed on the reverse side.



COMPLETE SYSTEM



UNITED RECORDING ELECTRONICS INDUSTRIES

MOD  
920-

# TECHNICAL SPECIFICATIONS

## ELECTRICAL:

<b>FREQUENCY RESPONSE:</b>	$\pm 2\text{dB}$ 40Hz to 10kHz (typically $\pm 1.5\text{dB}$ )
<b>TOTAL HARMONIC DISTORTION:</b>	Less than 1% (typically less than 0.5%) at all program VU levels up to +4dBm output. Distortion does not increase at low levels. (Because of HF preemphasis, distortion measurements should not be made at full output.)
<b>SIGNAL-TO-NOISE RATIO:</b>	Greater than 70dB (15.7kHz noise bandwidth)
<b>INPUT SENSITIVITY:</b>	-20 to +20dBm for +4dBm output
<b>INPUT IMPEDANCE:</b>	600 $\Omega$ transformer isolated (floating)
<b>OUTPUT IMPEDANCE:</b>	Designed to work into 600 $\Omega$ load; transformer isolated (floating)
<b>NUMBER OF INPUTS:</b>	Two
<b>NUMBER OF OUTPUTS:</b>	Two
<b>CHANNEL SEPARATION:</b>	Greater than 40dB
<b>TIME DELAY:</b>	Channel A: 16MS Channel B: 14MS
<b>WOW &amp; FLUTTER:</b>	0%
<b>MAINS VOLTAGE:</b>	110-220 VAC, or 220-240 VAC (Switch on rear panel)
<b>CONTROLS:</b>	Input Gain (2) Output Meter Transfer Switch Power Off/On
<b>EXTERNAL CONNECTIONS:</b>	Line Cord Input Jacks (2) Tip-Ring-Sleeve (normalled to rear panel barrier strips) for permanent installations. Output Jacks (2) Tip-Ring-Sleeve (normalled to rear panel barrier strips) for permanent installations.

## PHYSICAL:

<b>ELECTRONICS CHASSIS:</b>	Width 19" Height 3½" Depth behind panel 7" (for mounting in standard 19" RETMA rack) Finish: Panel, black anodized aluminum, white letters. Chassis, cadmium plated steel.
<b>DELAY LINES HOUSING:</b>	Width 24" Height 24" Depth 9" Finish: ½" plywood, grey zolatone with top handle.
<b>INTERCONNECTORS:</b>	Two 25' standard two-conductor shielded microphone cables with XLR-3 type connectors furnished for coupling between electronics chassis and delay line housing.
<b>WEIGHT:</b>	Electronics Chassis: 12 pounds Delay Lines Housing: 36 pounds
<b>SHIPPING WEIGHT:</b>	62 pounds (includes both units and cables)

BEFORE PROCEEDING WITH COMPLETE UNPACKING  
AND SETUP, CONSULT UNPACKING AND INSPECTION  
INSTRUCTIONS ON PAGE 10.

MODEL 920-16  
COOPER TIME CUBE  
INSTRUCTION MANUAL

UNIVERSAL AUDIO

products of  
UREI

 **United Recording  
Electronics Industries**

8460 SAN FERNANDO ROAD, SUN VALLEY, CALIFORNIA 91352

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### DRAWINGS

D11688  
11195C

Schematic  
1109 Amplifier

1-2. APPLICATIONS. The Model 920-16 Cooper Time Cube is an extremely useful tool for modern sound recording, providing an additional new dimension for creative sound processing. Among the many uses for which the Time Cube is ideally suited are:

- a. Creating "synthesized" Quadraphonic 4-channel tapes and records from 2-channel stereo originals.
- b. Spatial enhancement of Stereo or Quadraphonic recordings.
- c. Loudness enhancement - the impression of enhanced intensity of a sound source.
- d. Delaying the "send" to reverberation chambers or other reverberation devices, to improve the illusion of a large room by approximating the longer dimension of the first order reflected sound ("early sound") preceding the onset of reverberation.

Following are suggestions for using the Model 920-16 in each of the above applications:

#### 1.2.1. QUADRAPHONIC SYNTHESIS OR ENHANCEMENT.

Although many opinions exist on the "proper" utilization of the four channels of a Quadraphonic system, a classic approach is to treat the "direct" sound as a stereophonic spread between the front pair of speakers, placing the listener in a logical position facing the performance. The rear speakers are used to provide "ambience" - which is defined as the environment within which the listener is enclosed. Original Quadraphonic recordings are often made by using conventional stereo microphone placement (or track placement) for the front channels, and by placing two microphones at some distance from the front of the performers (one toward each side of the studio or auditorium) to receive the "ambience" information for the respective left-rear and right-rear Quadraphonic channels. This technique has proved highly successful when skillfully used in good acoustic environments. Many studios or rooms, however, have poor acoustics, resulting in overly reverberant reproduction from the rear channels when the ambience microphones are placed far enough away from the performers to

## SECTION I

### GENERAL INFORMATION

1-1. DESCRIPTION. The Model 920-16 Cooper Time Cube is a dual channel audio delay line system, providing separate delays of 16MS (Channel A) and 14MS (Channel B). The two channels may be cascaded for a single delay of 30MS.

Delay is accomplished by utilizing the relatively slow velocity of sound wave transmission through air, as compared to the speed of electromagnetic waves or electric current through a conductor:

Speed of sound in air:	1130 feet per second
Speed of light or electricity:	186,000 <u>miles</u> per second

The speed of sound (MACH 1) Varies inversely with air pressure, so the specified time delays of the Model 920-16 will decrease slightly at high altitudes, but this effect is insignificant up to 5,000 feet at normal room temperatures. Therefore, the delay of sound through air, with respect to electronic signals through conductors can be approximated at .884 milliseconds per foot.

In the Model 920-16, an input signal to Channel A is amplified and pre-equalized, then used to energize a dynamic transducer at one end of a coiled rigid polyethelene tube containing 1 atmosphere air pressure. At the other end of the coiled tube is a special coupling assembly in which another transducer converts the acoustical signal to an electronic signal equivalent to the input, but delayed by the 16MS acoustical length of the sound column. This signal is then post equalized and re-amplified to line level. An input to Channel B is similarly processed through a second acoustical transmission line, having a time delay of 14MS.

While this technique has been tried for many years for less demanding applications, including cancellation of long-line "echoes" in telephone systems, its principle drawback has always been restricted usable bandwidth and poor transfer characteristics due to acoustic reflections in the transmission line. Dr. Duane H. Cooper, of the University of Illinois has solved these serious problems through an ingenious scientific method of terminating the line in an acoustical impedance which remains essentially constant throughout a greatly expanded audio bandwidth. Subsequent work by M. T. Putnam of UREI in developing acoustical equalizing techniques (patents applied for, U.S. Patent Office) has produced an even flatter frequency response and wider bandwidth.

### 1.2.1. (continued)

create an adequate delay. This situation can be greatly improved by placing the LR and RR ambience microphones closer to the performers, and subsequently (during re-recording, or dubdown) introducing additional delay into each rear channel by means of the dual 16MS and 14 MS Model 920-16. This results in the microphones "thinking" they are approximately 18 feet and 16 feet farther away, respectively, but the "presence" in the rear channels is materially improved.

1.2.2. HAAS EFFECT. Subjective experiments by Dr. Helmut Haas and others have evolved criteria for the well-known "Haas Precedence Effect". One result of this phenomenon is that if given sound sources A and B are each producing the same coherent information, but source B is delayed in time with respect to the listener's position, the ear will localize the sound as coming from A, while incoherent sounds present in Both A and B will remain "spatial" or unlocalized. Subjective experiments indicate that with source B delayed, its output level must be increased by a substantial amount to move the apparent source of coherent information back midway between A and B, which is where it would be aurally located if no delay were introduced.

It is this Haas Effect which permits the spatial enhancement described in 1.2.1., as well as the Quadraphonic Synthesis described later. Haas, Madsen and others have also determined that this effect can be created with a delay as short as 2MS, and that when the delay reaches approximately 35MS sound "fusion" ceases, and the delayed source B may be heard as a discernible echo of source A. For this reason, delay times of 16MS and 14MS have been chosen for the two channels of Model 920-16, to place them well within the range of sound fusion.

1.2.3. QUADRAPHONIC SYNTHESIS. The increasing popularity of 4-channel Quadraphonic reproduction creates a vast new market for program material recorded in this format. A tremendous library of 2-track stereophonic material exists, which would be difficult to re-create in Quad. As in the era of transition from monophonic to stereophonic recording, it is highly desirable to develop techniques for creation of acceptable 4-channel Quadrasonic product from existing 2-track masters. The Model 920-16 Cooper Time Cube can do this very successfully. Utilizing the Haas Effect phenomenon described in 1.2.2., a Left Rear "ambience" track can be created by delaying the

### 1.2.3. (continued)

"A" track of the stereo recording through the 16MS "A" channel of the Time Cube. Similarly, a Right Rear "ambience" track may be created by delaying the stereo "B" track through the 14MS "B" channel of the Time Cube. The original stereo A track now becomes the Left Front channel, and the stereo B track becomes the Right Front channel. A listener placed in the center of the Quad speaker array will now hear the "direct" stereophonic program in its natural Left Front/Right Front relationship, while the rear speakers will supply spatial ambience of the non-coherent "room sound" or reverberation products in the original recording. The result is a remarkably pleasing Quadraphonic approximation.

Since such Quad products may eventually be matrixed for 2-channel tapes or discs, and could be required to be compatible for monophonic reproduction, the slightly different delay times of 16MS and 14MS were chosen for the Model 920-16 to minimize "comb filter" effects which might be produced when recombining the four channels through a single speaker.

1.2.4. LOUDNESS ENHANCEMENT. The Model 920-16 can be very effective for "instrument doubling", or intensity enhancement of sound sources. For example, four violins playing in unison sound louder than a single violin, even when recorded and reproduced at the same peak energy level, because the resulting waveforms of the four instruments are not identical in their time /phase/ timbre relationships. By utilizing one of the delay channels of the Time Cube, and summing the delayed output with the "direct" source, the apparent loudness or intensity of the combined direct/delayed sound can be greatly enhanced without increasing the peak electrical level of the signal. Two sources can be separately enhanced simultaneously by using both A and B channels of the Time Cube. It is suggested that the delayed signal be mixed at approximately -3dB with respect to the direct signal, to avoid coloration of sound from possible "comb filter" effects which might result if the two are mixed in a 1:1 ratio (due to random phase additions and cancellations).

1.2.5. DELAYING ONSET OF REVERBERATION. In most modern music recording, acoustical environments are intentionally designed to have minimum reverberation, to allow maximum flexibility



### 1.2.5. (continued)

in microphone placement and "presence". Reverberation is added, either in the direct process or in later rerecording, as desired. There are many acceptable devices for creating reverberation, including live reverberant chambers, and reverberant plates or springs with suitable transducers. All of these devices, if well designed and properly used, can create a reverberation "decay envelope" which closely resembles that of a well diffused, live room. However, in all these devices, one important element is missing: A significant time interval between the introduction of the signal and the return of the first order reflections of that signal. It is this element of the "early sound" which defines for the listener the dimensions of the simulated environment. For many years, tape delay has been commonly used to add this dimension, by using the interval of time between the record and playback heads of a tape recorder to delay the "send" to reverberation devices. This has been helpful, but the technique has two major drawbacks: (1) professional quality tape recorders are bulky and expensive for this non-productive purpose; (2) Unless very high capstan speeds are used, the physical distance between standard recorder head stacks provide excessive delay.

The Model 920-16 solves both of these problems. At its modest cost and bulk, a Time Cube can replace an expensive recorder for this service, and requires no attention during use. By cascading channels A and B, 30MS of delay is available, which approximates a 40-foot first-order reflection preceding the onset of reverberation.

## ELECTRONIC SPECIFICATIONS

FREQUENCY RESPONSE:	$\pm 2$ dB 40Hz to 10kHz (typically $\pm 1.5$ dB)
TOTAL HARMONIC DISTORTION:	Less than 1% (typically less than 0.5%) at <u>all</u> program VU levels up to +4dBm output. Distortion does not increase at low levels. (Because of HF preemphasis, distortion measurements should not be made at full output).
SIGNAL-TO-NOISE RATIO:	Greater than 70dB (15.7kHz noise bandwidth).
INPUT SENSITIVITY:	-20 to +20dBm for +4dBm output
INPUT IMPEDANCE:	600 Z transformer isolated (floating)
OUTPUT IMPEDANCE:	Designed to work into 600 Z load; transformer isolated (floating)
NUMBER OF INPUTS:	Two
NUMBER OF OUTPUTS:	Two
CHANNEL SEPARATION:	Greater than 40dB
TIME DELAY:	Channel A: 16MS Channel B: 14MS
WOW & FLUTTER:	0%
MAINS VOLTAGE:	110 - 120 vac, or 220 - 240 vac (Switch on rear panel)
CONTROLS:	Input Gain (2) Output Meter Transfer Switch Power Off/On
EXTERNAL CONNECTIONS:	Line Cord Input Jacks (2) Tip-Ring-Sleeve Output Jacks (2) Tip-Ring-Sleeve, normalised to rear panel barrier strips for permanent installations.
INTERCONNECTIONS:	Two 25' standard XLR-3 type micro- phone extension cables furnished.

## SECTION II

### THEORY OF OPERATION

- 2-1. GENERAL. The Model 920-16 Cooper Time Cube consists of:
- a. Dual electronics chassis, with self contained power supply.
  - b. Delay line housing, containing both A and B transmission lines.
  - c. Two 25' XLR-3 type interconnecting cables.

A block diagram discussion of the theory of operation is given in the following paragraphs (refer to drawing D11683, schematic).

2-2. POWER SUPPLY. A Zener/transistor regulated power supply provides a regulated source of +30 vdc to the four UA 1109 card amplifiers. The 50/60Hz line voltage is supplied to transformer T1 through fuse F1 and the normally closed contacts of S1 on the front panel. Slide-switch S2 on the rear of the chassis provides optional operation from 110 - 120 vac or 220 - 240 vac. Plus 30 vdc is developed by rectifying the secondary voltage of T1 with diodes CR1 and CR2, and filtering with C1 and C2. This voltage is regulated by zener diode Zd1, R15 and transistor Q1.

2-3. INPUT AND SEND AMPLIFIERS. The following describes Channel A input and send circuitry, and also applies to Channel B with appropriate changes in component numbers:

Control INPUT A is a continuously variable bridged-T attenuator which, with 1109 amplifier A SEND and its associated feedback equalization network, and resistor R1 and C3 comprise the input amplification, pre-emphasis and drive power to the A CHANNEL send transducer in the delay line housing. Jack INPUT A is normalled to the left-half of barrier strip TB1 on the rear of the chassis. Permanent input connections may be made at the barrier strip; when a tip-ring-sleeve patch plug is inserted in jack INPUT A, the barrier strip inputs are disabled, and an input may be connected via the patch plug. The inputs are floating, but may be connected to an unbalanced source provided the grounded side is connected to C (sleeve of jack plug). The output of A SEND 1109 amplifier appears at SEND XLR-3 (male) chassis connector J3 on pin 3 ( $\pm$ ) and 1 (com). The equalizer components L1, C4, R6, C5, R7, R3, C6, R5, R2, C7 and trimpot R4 are physically

2-3. (continued)

located on the printed circuit board across the rear interior of the chassis, and provide high frequency pre-emphasis and midrange equalization which is factory adjusted to match the individual drive transducer A in the associated delay line housing. The equalizer is electronically enclosed in a feedback loop of 1109 amplifier A SEND when the amplifier is inserted into the system (#3 amplifier, left to right, as viewed from the front of the chassis with the face cover removed. 1109 B SEND amplifier is #4).

2-4. RECEIVE AMPLIFIERS AND OUTPUT. 1109 amplifier A RECEIVE and its associated post-equalization network amplify and equalize the output of the A channel receive transducer in the delay line housing. Output of the receive transducer enters the electronics chassis through pins 3 (+) and 1 (com) of XLR-3 type female connector J4 on the rear of the chassis, and appears at input pins 14 and 11 of the amplifier (#1 as viewed from left to right from front of chassis). A feedback equalizer composed of R16, R17, R18, C15, C16, C13, R20, R19, R22, C14, L3, C17 and trimpots R21 and R23 are located on the printed circuit motherboard in the inside rear of the chassis. This equalizer provides factory-adjusted calibration at low and high frequencies of the mating delay lines. The output of 1109 A SEND amplifier appears at barrier strip TB1 on the rear of the chassis, normalled through Jack OUTPUT A on the front panel.

2-5. METER. The front panel VU meter OUTPUT LEVEL is calibrated to read +4dBm at 0 with a 600 ohm load, and may be switched to either output A or B by the METER switch (S3) on the front panel.

2-6. DELAY LINES. The grey Delay Lines Housing contains both Channel A (16MS) and Channel B (14MS) transmission lines with their associated drive and receive transducers. Interconnections between the Electronics Chassis and the Delay Lines Housing are made by using the two 25' XLR-3 type standard microphone extension cables furnished with the system. The Model 920-16 is not critical to length of interconnecting cables, within reasonable limits (up to 150') and other standard, two conductor or 3 conductor shielded cables may be used to extend these connections, if desired. Pin 3 is A CHANNEL +, Pin 2 is B CHANNEL -, and Pin 1 is Com./Shield.

2-6. (continued)

The delay lines are suspended within the housing by special springs, and the entire housing is then filled with Flo-Pak styrofoam pellets to provide protection against shipping damage and additional isolation from outside ambient noise. In normal service it should never be necessary to open the housing. Acoustical equalization adjustments on various parts of the delay line assemblies are factory sealed, and no service should be attempted in the field. The one-year warranty will be invalidated by evidence of such attempts.

SECTION III  
INSTALLATION

3-1. UNPACKING AND INSPECTION. The special 330 pound test carton with its shock absorbing foam rubber corners, in which your Model 920-16 system was packed, was carefully designed and torture tested to insure maximum protection against shipping and handling damage. If, however, the outer carton shows evidence of such damage, carefully inspect the delay line housing and electronics chassis (packed in the separate enclosed carton). If they have been damaged, carefully preserve all packing materials, and notify the carrier of a possible claim for damage. SHIPPING DAMAGE CLAIMS MUST BE MADE BY THE CONSIGNEE. The following items are included, and should be checked for possible shortages:

- a. Delay line housing (2' X 2' X 9" grey enclosure)
- b. Electronics chassis, (packed in separate carton). Serial number must match serial number on grey housing.
- c. This instruction book.
- d. Two-part Warranty Card. This should be completed, and the return portion mailed immediately to activate 1-year warranty. (No postage required).
- e. Two 25' XLR-3 type microphone extension cables.

3-2. ELECTRONICS CHASSIS. Involved in installation of the electronics chassis are thermal and hum pickup considerations, input and output connections, mains power requirement, and routing of inter-connection cables to the delay line housing.

3.2.1. ENVIRONMENTAL. Although ambient temperature range is not critical, to prolong equipment life and achieve optimum performance, the 920-16 electronics should not be mounted directly over high heat producing equipment such as power amplifiers or power supplies. Since the 920-16 includes input transformers in both send and receive amplifiers, mounting near large transformers, motors or other large hum fields should be avoided, especially with respect to the lefthand section of the chassis, which contains the four 1109 card-type amplifiers.

3.2.2. INPUT AND OUTPUT. Connections for inputs and outputs are provided on screw-type terminal strips mounted on the rear of the chassis. These are clearly marked. Standard good engineering practice of using shielded two-conductor cables should be used, with the shields grounded at only one end of each cable. Since both inputs and outputs are transformer isolated (floating), the 920-16 may be interconnected to either balanced or unbalanced external circuits. If the inputs are unbalanced to ground, the grounded leads should connect to the C terminals to insure correct operation of the bridged-T input potentiometers. Source impedances should be 600 ohms. The outputs are designed to work into 600 ohm loads, either balanced or unbalanced, and will deliver +4dBm across the loads when the VU meter indicates 0.

3.2.3. MAINS POWER. As normally supplied, unless a tag on the AC power cord indicates otherwise, the Model 920-16 is supplied from the factory ready to operate from 110 - 120 vac, 50/60Hz. For 220 - 230 vac, 50/60Hz operation, a recessed slide switch is provided on the rear of the chassis, to the left of the two terminal strips. Using a small screwdriver in the horizontal slot of the switch, push down firmly until the numbers 230 appear at the top of the switch.

3.2.4. INTERCONNECTIONS. The two 25' shielded extension cables furnished with the Model 920-16 system plug into XLR-3 receptacles on the rear of the electronics chassis. These are alternately male and female to prevent inadvertent cross connections. If these cable lengths are insufficient to reach the chosen location for the delay lines housing, longer standard microphone extension cables may be used, or additional cables mated with those furnished, provided pair and shield continuity is maintained (per pin connections printed on the rear of the electronics chassis). The length of cables is not critical, although extremely long cables (exceeding 150') may cause slight loss of high frequencies due to shunt capacities.

3.3. DELAY LINES HOUSING. The 24" X 24" X 9" grey housing containing the A and B acoustical elements with their send and receive transducers is relatively immune to external ambient sounds. Tests indicate that a sound pressure level of 80DB at the enclosure will produce less than -60dBm at the outputs of the system (normal

### 3.3. (continued)

program output levels are +4dBm). While satisfactory results can be obtained for Quadraphonic synthesis or enhancement with the housing located in a control room with full monitor levels, for best results it is recommended that the housing be remotely located from sources of high acoustic energy. No electrical connections are required other than the two interconnecting shielded cables from the electronics chassis. (As with all microphone cables, routing in close proximity to power cables and strong hum fields should be avoided). ATTENTION IS CALLED TO THE PLACARD ON THE HOUSING WARNING AGAINST EXPLORATORY REMOVAL OF THE HOUSING COVERS, OR TAMPERING WITH THE ACOUSTICAL ELEMENTS.

The loose Flo-Pak insulation material is essential to handling protection of the spring-mounted delay lines, and for adequate acoustical isolation. The various factory-sealed adjustments on the coupling elements and matching stubs have been carefully set with swept frequency techniques for optimum performance within specified tolerances, and need no maintenance in normal use. The alignment procedures require specialized knowledge and equipment, and will not be described as they should not be performed in the field.



## SECTION IV

### OPERATING PROCEDURE

4-1. **GENERAL.** There are only three front panel controls associated with normal operation: INPUT A gain control, INPUT B gain control and METER transfer switch.

4-2. **INPUT LEVELS.** To set up proper operating levels once installation is complete, rotate both INPUT A and INPUT B controls fully CCW. Feed a sample program level into INPUT A (either through the rear terminals or front panel jack) at whatever normal "send" levels will be used (-20 to +20dBm). Switch METER switch to (up) position A. Rotate INPUT A gain control CW until OUTPUT LEVEL meter indicates 0 VU. If output is properly terminated in 600 ohms, the source program, delayed 16MS, will now appear at the A output at +4dBm. Repeat the procedure for Channel B, with the OUTPUT METER switch in the (down) B position. The Model 920-16 system is now ready for use.

4-3. **OPERATING CAUTIONS,** The Model 920-16 Cooper Time Cube is a sturdily designed, rugged system which requires minimum maintenance. The observance of the following cautions are advised:

4.3.1. **FREQUENCY RESPONSE MEASUREMENTS,** Because of high frequency pre-emphasis in the SEND sections of the Model 920-16, frequency response measurements should be made at -10dB on the OUTPUT LEVEL meter (-6dBm),

4.3.2. **EXCESSIVE HIGH FREQUENCIES,** To protect the driver transducer from damage due to excessive high frequency levels, the Model 920-16 is lightly fused (1/8A fuse for 110 - 120 vac operation). If average program levels producing OUTPUT LEVEL readings greatly in excess of 0 (+4dBm) are sustained, or if tapes are rewound without tape being lifted from the heads and the tape output is fed to the Model 920-16, the 1/8A fuse may open. If this occurs, the fuse should be replaced by a similar 1/8A Slo-blo fuse. **DO NOT FUSE HEAVIER** than 1/8A for 110 - 120 vac, or 1/16A for 220 - 240 vac.

## SECTION V

### MAINTENANCE

5-1. SEND AND RECEIVE AMPLIFIERS. The four plug-in card type amplifiers used in the Model 920-16 are standard Universal Audio Model 1109 card-type solid-state amplifiers, and are identical. All impedance strapping and equalization are accomplished on the motherboard into which the amplifiers are mated. This permits interchange of all amplifiers or substitution of another spare 1109 in the event one of the amplifiers should develop a malfunction. Should noise or distortion develop, or one channel become inoperative, first check continuity of the interconnect cables to the delay line housing, and verify input to the channel. If these check OK, test for a defective amplifier by substituting first the SEND, then the RECEIVE amplifier from the other channel. From left to right, following is the physical positioning of the plug-in amplifiers, as viewed from the front of the electronics chassis with the access door removed:

1. A Channel RECEIVE
2. B Channel RECEIVE
3. A Channel SEND
4. B Channel SEND

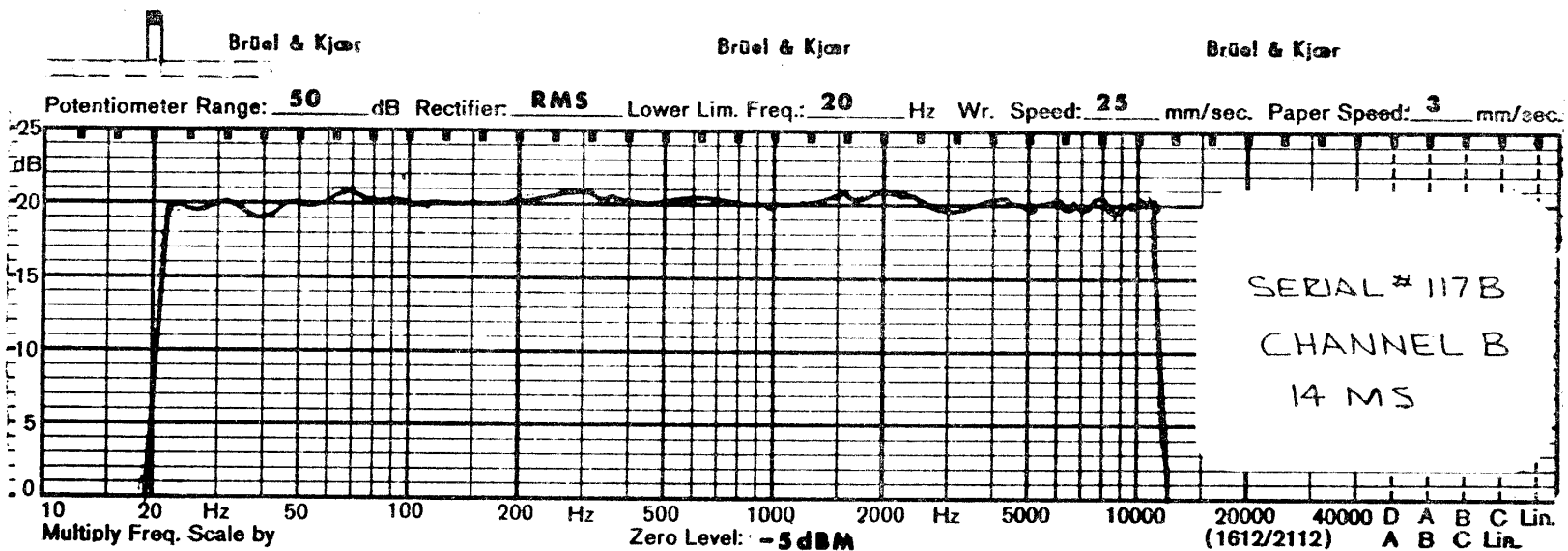
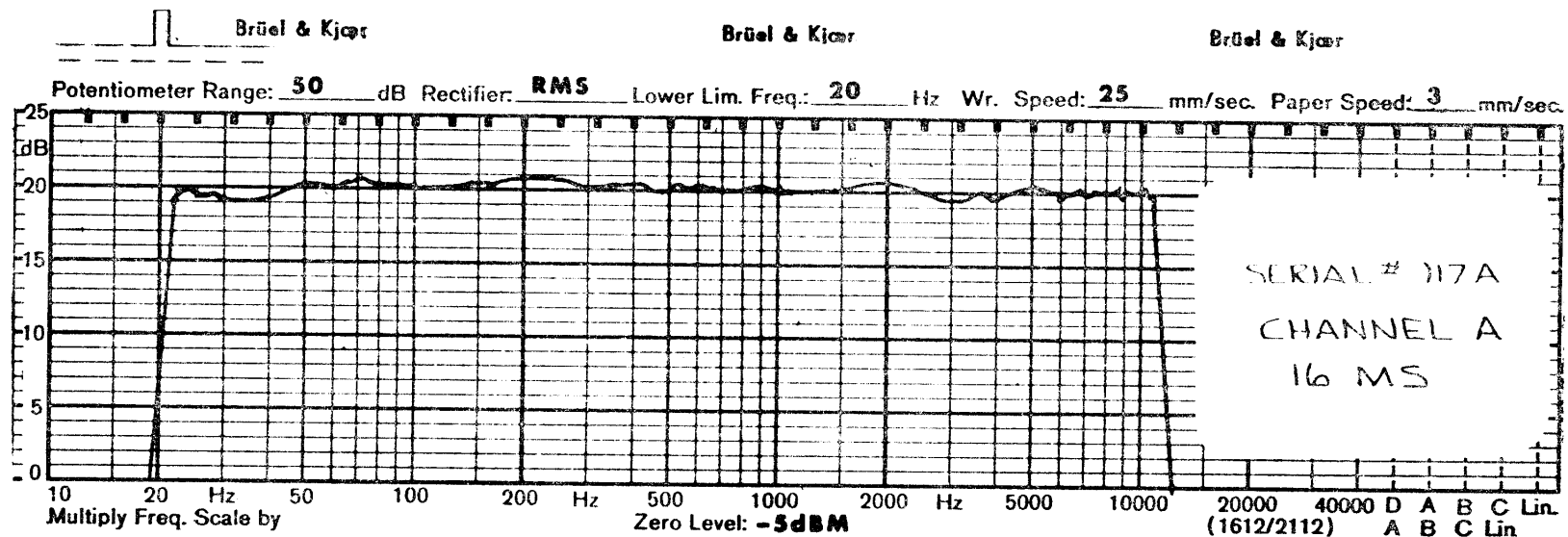
While the 1109 amplifier has proved very reliable in continuous service, all electronic devices are subject to random component failure. Where maximum reliance must be placed on minimum "down time" to avoid economic loss, it is recommended that a spare 1109 amplifier, which can be used as a backup for several Model 920-16's, be purchased.

5-2. POWER SUPPLY. The power supply incorporated in the electronics chassis is straightforward in design, and uses conservatively rated components for maximum reliability. Except for the fuse caution noted in 4.3.2. (Page 13) no special precautions need be taken. Should an electrolytic capacitor or diode fail, a competent technician should have no problem making field repairs if required, to avoid necessity of returning the unit to the factory for service.

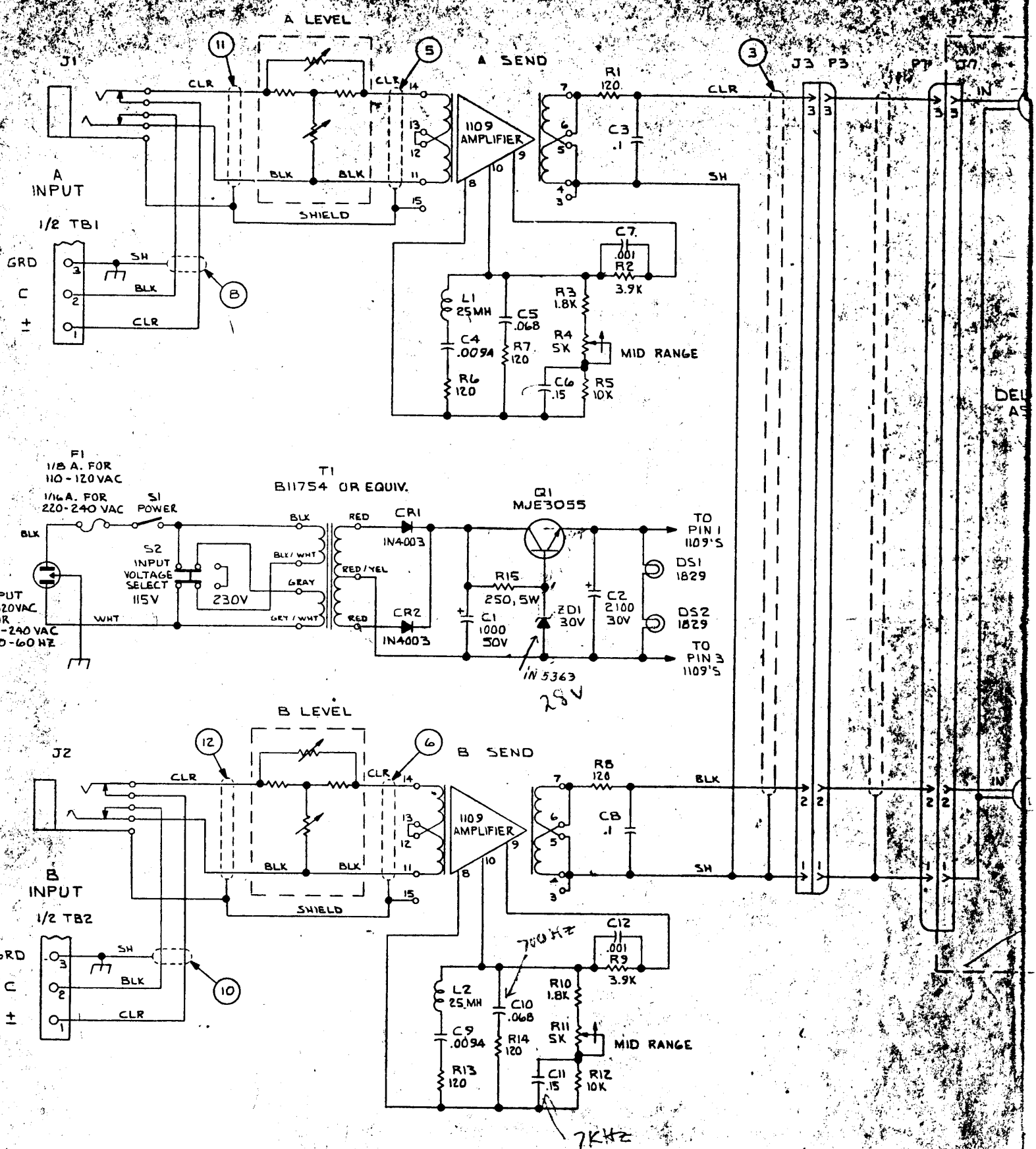
5-3. GROUNDING. Electrical codes require that the electronics unit be furnished with a three-wire AC line cord, with the grounding wire connected to the chassis. When the Model 920-16 is rack mounted in a metal rack, to which audio commons are also grounded, an AC potential difference between the AC line conduit ground and the rack (or associated audio equipment) may produce line "buzz" or hum, due to the ground loop. To eliminate this, it may be necessary to use a 3-wire to 2-wire adaptor between the line cord plug and the AC receptacle to break the ground.

# COOPER TIME CUBE MODEL 920-16

## TYPICAL FREQUENCY RESPONSE



NOTE: SCALE 1dB PER DIVISION

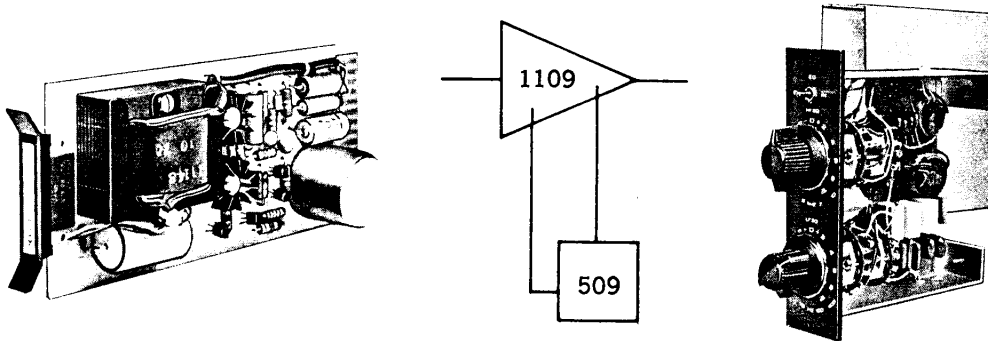


- 3. NUMBERS IN BALLOONS IDENTIFY SHIELDED WIRES AS MARKED IN UNIT
  - 2. ALL CAPACITOR VALUES ARE IN MICROFARADS
  - 1. ALL RESISTOR VALUES ARE IN OHMS ±5% 1/2W
- NOTES: UNLESS SPECIFIED



# Universal Audio SOLID STATE AMPLIFIER WITH ACCESSORY EQUALIZER

MODEL  
1109  
509



The 1109 Amplifier from U.R.E.I. is the latest of a very successful line of Universal Audio amplifiers, starting in 1957 with the Model 100, evolving through the well-known 1008 and 1016, the solid-state 1108, and now the all-new 1109. Preserving the ENVELOPMENTAL EQUALIZATION concept pioneered by Universal Audio, the 1109 combines newest state-of-the-art circuitry and packaging with the high reliability and performance always delivered by U.R.E.I. products.

Because the 1109 combines extreme low noise, (WITHIN 2 dB of the THEORETICAL LIMIT,) with high output capability (+30 dBm = A FULL WATT with 30 V supply) it can be used anywhere in the audio system, from microphone preamplifier through line amplifier. Input and output impedance matching, equalizer options, and gain adjustment are all accomplished on the mating edge connector. Therefore, all of the amplifiers in a system are completely interchangeable.

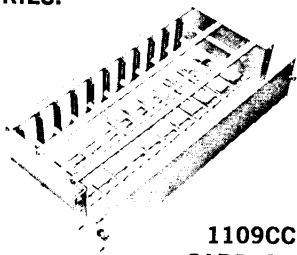
By changing one strap on the amplifier board, the 1109 may be powered optionally from dual polarity 15 VDC, or from single-polarity +24 to 30 VDC supply, without adding any components, and with no change in operating specifications.

ENVELOPMENTAL EQUALIZATION is achieved by electronically enclosing an external equalizer, the Universal Audio 509, within an active feedback loop of the amplifier, as shown in the block diagram above. The 1109/509 combination provides flexible equalization with no loss of gain. High frequency boost can be had at 2.5, 5, 7 or 10 kHz, and high frequency rolloff is at 10 kHz. Low frequency boosts are at 50, 70, 100 and 400 Hz, and low frequency rolloff is at 100 Hz.

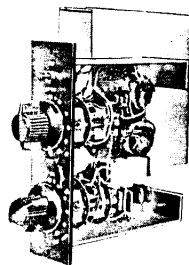
Detented switches provide boost or rolloff steps of 2, 4, 6, 9 and 12 dB for both high and low frequencies. An EQ IN/OUT switch is furnished to remove equalization completely without disturbing the settings. The 1109 Amplifier and 509 Equalizer may be separated by as much as 25 feet of single-pair shielded cable.

The 1109 Amplifier is a printed circuit card  $2\frac{3}{4}$ " X 6". An accessory 1109CC Card Cage holds eleven 1109's in  $3\frac{1}{2}$ " of rack space. The 509 Equalizer will mount on  $1\frac{1}{2}$ " centers, and occupies  $5\frac{1}{2}$ " of vertical panel space. Depth behind panel is  $5\frac{1}{2}$ ".

## ACCESSORIES:



1109CC  
CARD CAGE



509  
EQUALIZER



9C CONNECTOR

**Urei**

**UNITED RECORDING ELECTRONICS INDUSTRIES**

11922 VALERIO STREET, NO. HOLLYWOOD, CALIFORNIA 91605 TEL. (213) 764-1500

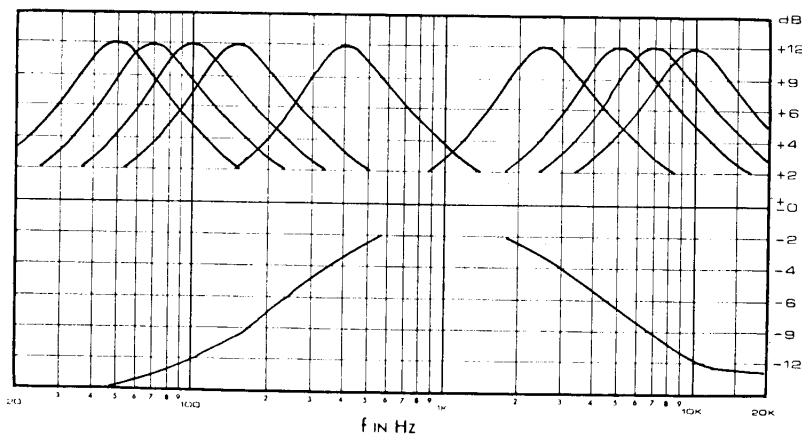
TELEX 65-1389

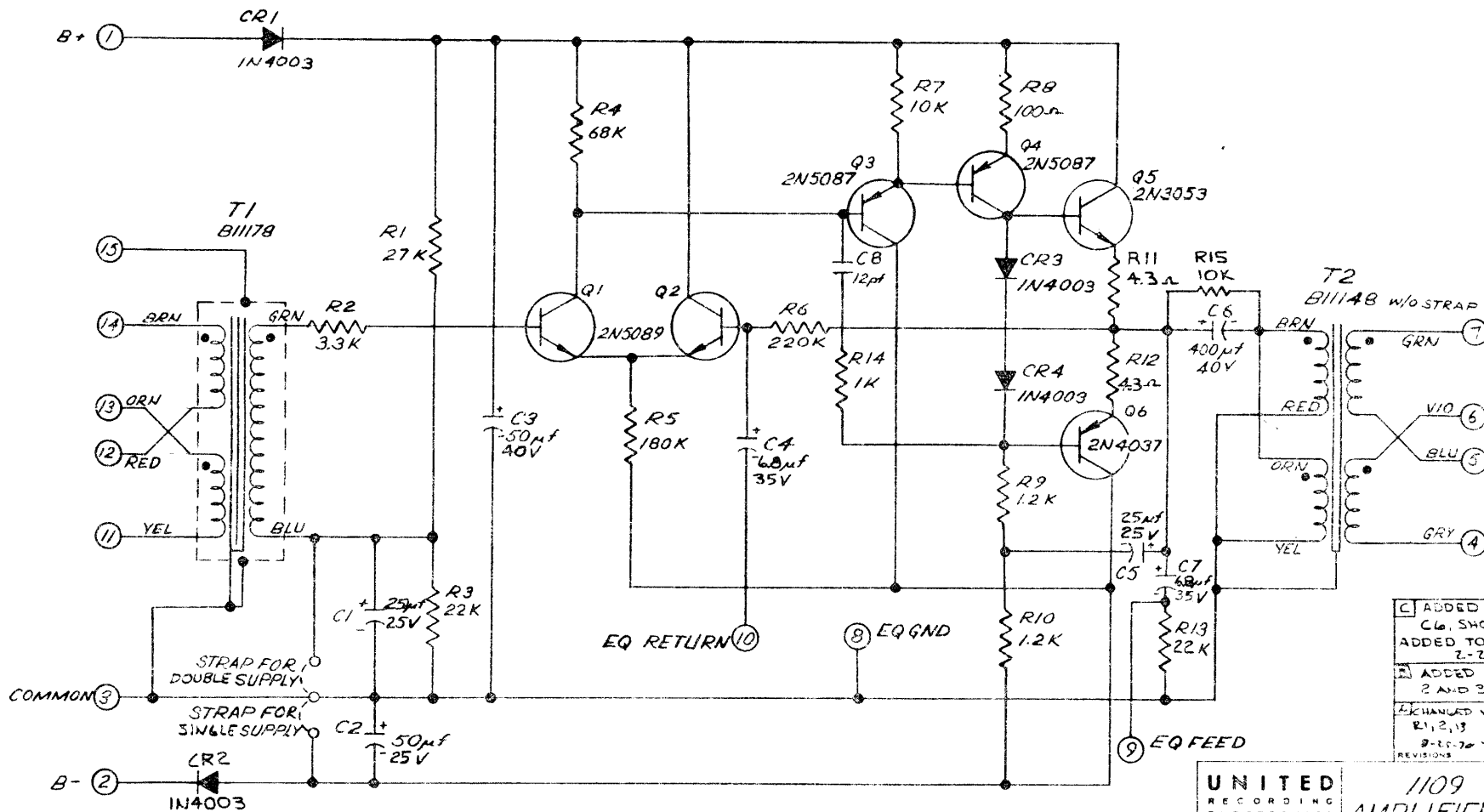
MODEL  
1109  
509

# TECHNICAL SPECIFICATIONS

- VOLTAGE GAIN:**
- 600 ohms input strapping**—Adjustable 30 to 50 dB from terminated 600 ohm source; Adjustable 35 to 55 dB from unterminated 600 ohm source.
  - 150 ohms input strapping**—Adjustable 36 to 56 dB from terminated 150 ohm source; Adjustable 41 to 61 dB from unterminated 150 ohm source.
- POWER OUTPUT:** +30 dBm maximum, with 30 VDC supply. Nominally +27 dBm for single output, +24 dBm each for dual outputs, with less than 0.5% total harmonic distortion from 30 to 20,000 Hz. Typical midband distortion is less than 0.05%.
- FREQUENCY RESPONSE:** ±0.5 dB from 30 to 20,000 Hz.
- SOURCE IMPEDANCE:** 150 to 600 ohms. Strappable at external connector.
- INPUT IMPEDANCE:** Nominally five times rated source impedance (secondary of input transformer virtually unloaded).
- LOAD IMPEDANCE:** Two separate output transformer secondary windings, each designed for 600 ohm load; or both may be paralleled for 3 dB higher power capability.
- NOISE:**  
(15.7 kHz equivalent bandwidth)
- Equivalent to an input signal of not more than:
    - 132 dBv from 150 ohm source.
    - 126 dBv from 600 ohm source. (This is within approximately 2 dB of theoretical limits).
- THERMAL ENVIRONMENT:** Up to +150 degrees Fahrenheit without derating.
- POWER SUPPLY OPTIONS:** +24 to 30 VDC, or ±15 VDC (strappable—no added components needed).
- POWER CONSUMPTION:** No Signal—typically less than 10 mA. At +12 dBm output—typically less than 17 mA. At +27 dBm output—typically less than 60 mA.
- EQUALIZATION OPTION:** May be used with Universal Audio Envelopmental Equalizer Model 509, with no change in operating parameters except voltage gain is fixed at:
  - 45 dB from terminated 600 ohm source.
  - 50 dB from unterminated 600 ohm source.
  - 51 dB from terminated 150 ohm source.
  - 56 dB from unterminated 150 ohm source.
- PHYSICAL:** 2<sup>3</sup>/<sub>4</sub>" X 6" glass epoxy printed circuit card. Gold plated contacts to mate with standard 15-pin edge connector. (See accessory list below)
- ACCESSORIES:**
- 1109CC CARD CAGE** is designed to hold up to eleven 1109 amplifier cards. Supplied complete with edge connectors and front cover. Requires 3<sup>1</sup>/<sub>2</sub>" vertical space in standard 19" USASI rack enclosures.
  - 509 EQUALIZER** for remote equalization of one 1109 amplifier. Requires only one two-conductor shielded pair for interconnection with amplifier. May be mounted on 1<sup>1</sup>/<sub>2</sub>" centers, to be compatible with contemporary vertical faders, etc. Panel size 1<sup>1</sup>/<sub>2</sub>" X 5<sup>1</sup>/<sub>2</sub>". Depth behind panel 5<sup>1</sup>/<sub>2</sub> inches.  
 High Frequency Attenuation: -2, -4, -6, -9, -12 dB at 10 kHz.  
 High Frequency Peaking: +2, +4, +6, +9, +12 dB at 2500, 5000, 7000 and 10,000 Hz.  
 Low Frequency Attenuation: -2, -4, -6, -9, -12 dB at 100 Hz.  
 Low Frequency Peaking: +2, +4, +6, +9, +12 dB at 50, 70, 100, 400 Hz.
  - 9C CONNECTOR.** Standard 15-pin edge connector to mate with 1109 Amplifier Card. (Not required when 1109CC card is used). Has gold bifurcated contacts.

MAXIMUM OBTAINABLE EQUALIZATION





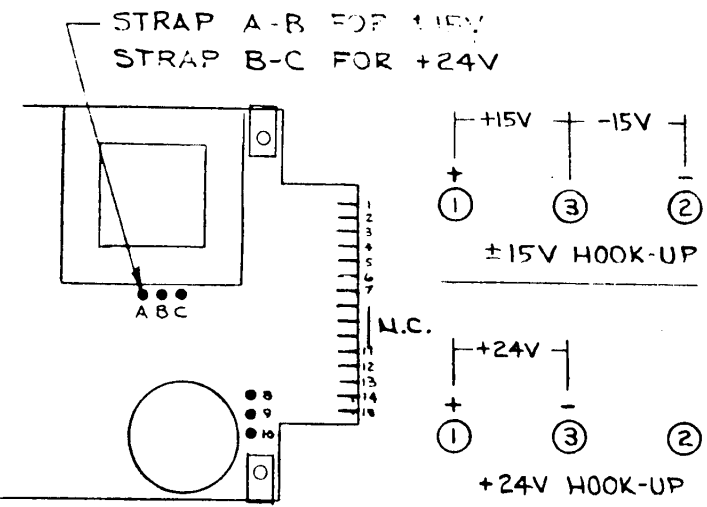
[C] ADDED R15 ACROSS  
 C6. SHOULD BE  
 ADDED TO ALL UNITS  
 2-21-72 KC  
 [A] ADDED NOTES  
 2 AND 3 9-9-72 J  
 EXCHANGED VALUES OF  
 R1, R13  
 9-15-70 J  
 REVISIONS

- 3. \* Q5 + Q6 ARE MATCHED PAIR
- 2. \* Q1 + Q2 ARE SELECTED FOR LOW NOISE
- 1. NO'S IN BALLOONS INDICATE PIN NO'S ON CIRCUIT CARD CONNECTOR

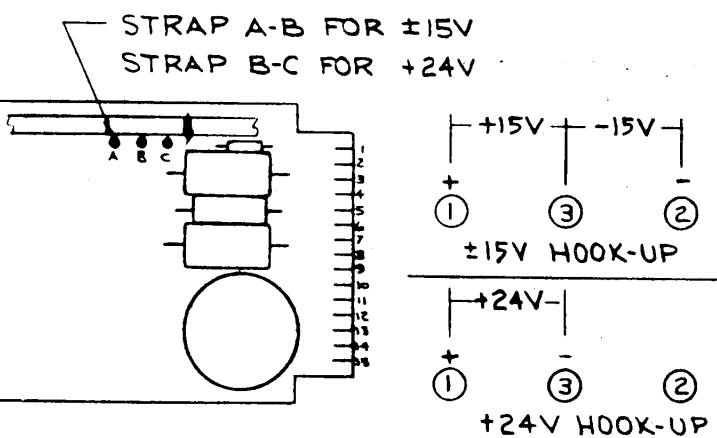
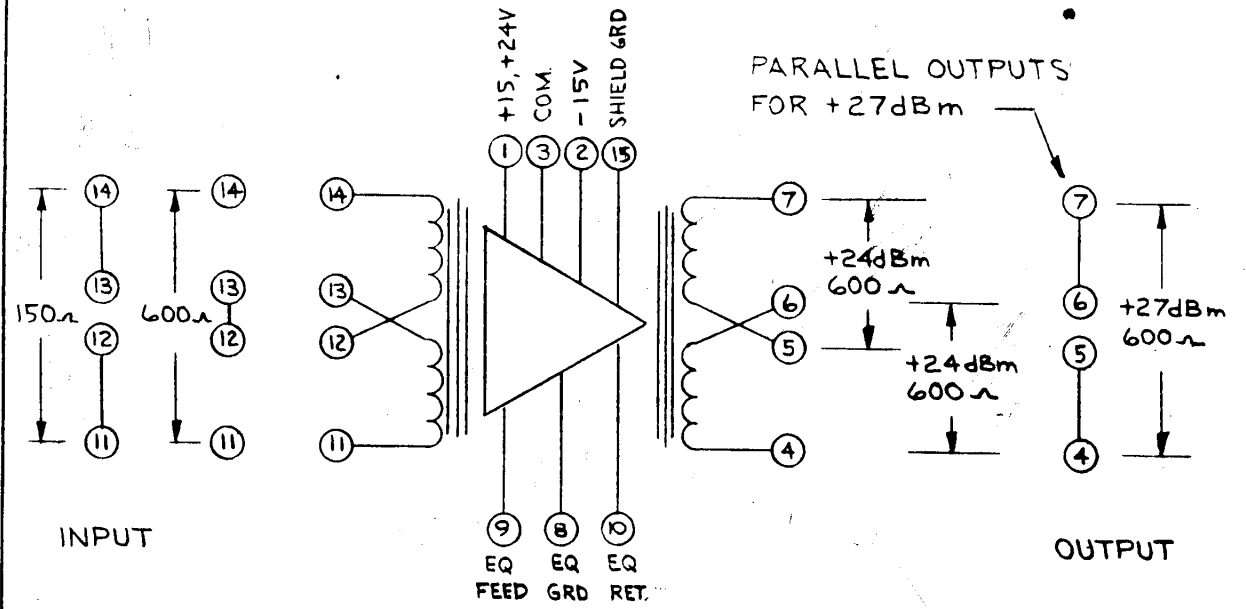
NOTES:

<b>UNITED RECORDING ELECTRONICS INDUSTRIES</b>		<b>1109 AMPLIFIER CARD</b>	
DEPARTMENT	DATE	ISSUE MODEL	
LOS ANGELES CALIFORNIA	4-27-70	1109 2109	
CHECKED	APPROVED		
<i>[Signature]</i>	<i>[Signature]</i>		B11195C

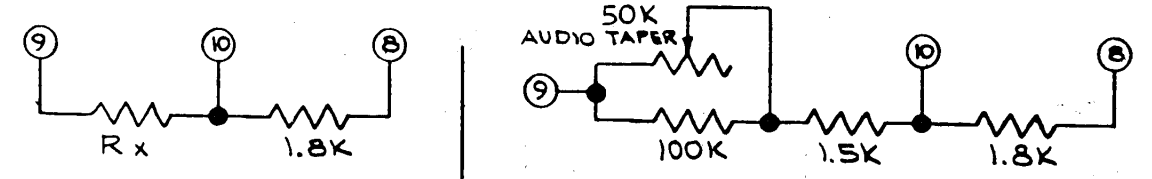




2109 AMPLIFIER

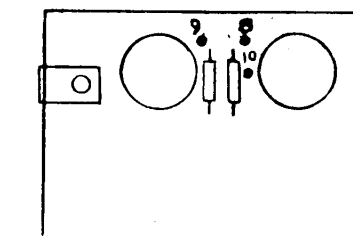


1109 AMPLIFIER



30dB  $R_x = 1.5K$   
40dB  $R_x = 9.1K$   
50dB  $R_x = 36K$

FIXED GAIN      VARIABLE GAIN  
FOR 1109 ONLY



509/2109 EQUALIZER (RFF)

# COOPER TIME CUBE

MODEL 920-16

## PRODUCTION CALIBRATION PROCEDURE

- ✓1. Refer to Figure 5 for test equipment setup for line calibration.
- ✓2. Connect delay line with standard test cables using test fixture # 920-2 leave electronics power off.
- ✓3. Place 3/4" sticker tab next to letter identifying line as A or B type and mark sticker with serial number corresponding to electronics serial number.
- ✓4. Perform cursory initial inspection of line assembly to verify the following:
  - ✓A. Driver housing is seated firmly all the way in, bottoming out on "O" Ring in driver coupler. That there is sufficient silicon grease at coupler end of housing.
  - ✓B. Ditto for Receiver housing.
  - ✓C. Make certain all screws are in "Tee" Block and bottomed out (this may be checked by index marks on adjusting wrenches).
  - ✓D. Make certain all cemented joints to "Tee" block and driver coupler are firm and tight.
  - ✓E. Remove Stub nipple and verify the following:
    - ✓a. That the 3kHz compensator is approximately 1/4" from block end of nipple.
    - ✓b. That the poly cotton is completely filling the space between 3kHz compensator and foam absorber in stub. The foam absorber in stub should be almost

flush, or within 1/4" of the "Tee" end of the green tubing. Reconnect and tighten clamp.

F. Inspect cork end of stub to see that foam damping is not more than 1" from end and not less than 3/4" and inspect cork to verify 3/16" hole is clear.

G. Inspect 2'9" hole under damping clamp to see that it is clear.

H.

I.

J.

5. Turn both gain controls CCW, (off). Turn on electronics and set manual oscillator to approximately 1kHz: Advance gain control for output level of -5 dBm (NO MORE). Rock oscillator back and forth to average out peaks and dips and reset average level for -5 dBm out at approximately 1kHz. Verify that 10kHz receiver equalizer is CCW, L.F. receiver equalizer is approximately middle of its range at 100Hz, and that send mid range is approximately in the middle of the range at 700Hz.

6. Sweep manual oscillator from 1kHz to 5kHz and make rough initial adjustment of 3kHz compensator as shown on Figure 2. Then reverify 1kHz reference level and reset for -5 dBm if required.

7. Sweep range from 100Hz to 1kHz and verify that the response in this range is reasonably normal; i. e.  $\pm 1 \frac{1}{4}$  dB. If excessive anomalies occur refer to Figure 1. for possible causes.

Keep in mind the L. F. receiver equalizer may be adjusted, but if it must be adjusted for complete maximum or minimum then other conditions are not normal and the cause should be located rather than correct it with excessive use of electronics EQ.

8. Before proceeding to attempt further refinement of calibration of the complete line we must check to see that the R50 driver has L. F. clearance. Feed 100Hz and increase level to +10 dBm <sup>(50V hole in stub)</sup> output. (Switch meter on electronics to other channel to prevent meter damage). Observe waveform on scope. If waveform at 100Hz is bad and the response is similar to that shown in Figure #5, this indicates that the diaphragm is striking the resonator cover plate and does not have adequate clearance at L. F. This may be easily fixed by carefully bending out the cover plate to provide clearance, with a special tool. (Have Simisky perform this operation, which should be infrequently required.)

After checking 100Hz at high levels, reset nominal output level to -5 dBm before proceeding further.

9. Sweep range between 30Hz and 100Hz and adjust response via method outlined in Figure #1, using as a final touch up the L. F. electronics E. Q. to obtain a response  $\pm 1$  dBm from 40Hz to 1kHz. Most anomalies below 100Hz ~~to 1kHz~~ relate to the stub and air leaks; most anomalies in the 100Hz to 1kHz range relate to driver housing damping and air leaks. Both response ranges

9. (cont'd)

get fouled up by excessive monitor levels or high ambience noise levels. (Silence is golden!)

✓ 10. Now that response is reasonably flat from 40Hz to 1kHz adjust 3kHz compensator nipple for a more refined optimum using techniques outlined in Figure #2.

✓ 11. Investigate response from 1kHz to 10kHz, noting frequencies of major peaks and dips. Pay particular note to a sharp hole or "icicle" in the range of 6.7kHz to 7.2kHz. Set oscillator on center frequency of hole in this range and see if it is possible to bring it up by increasing pressure and forcing the R70 receiver housing into the "Tee" further. (It takes two to "Tee"; have someone help here). **Too much pressure may cause peak at 8 to 8.5 kHz.**

[\*Note: There are two different type diaphragms used by Shure in the R50 driver. One in their current standard type (off the shelf) R50 designated as part # 99A350B. This type has a decided deep notch of 3 to 5 dB in this critical 7kHz range and may be modified by adding a small drop of Permabond 747 cement to the diaphragm through the center hole. Type # 99A350B may also be made useable by another method of adding mass to the R50 resonator cover in minor cases. We are trying to avoid the use of the above type # 99A350B but some may sneak thru. The preferred type (a special for UREI) R50 # 99H350B has only a minor hole, i.e. 1 or 1/2 dB at approximately 7kHz. The pressure adjustment of the receiver housing will usually cure this. (As an added comment for future reference, this preferred type R50

11. (cont'd)

# 99H350B does have a slight hole in the 9kHz region which is easy to deal with.) ]

- ✓12. After eliminating to the greatest degree possible the 7kHz region notch, re-sweep the 1kHz to 10kHz range manually, noting the maximum peaks or dips. Then proceed to correct the lowest frequency in this range first, and work upward in frequency by the methods outlined on Figure #3. Always keep in mind that there is considerable interaction between the dipping screws D1, D2 and the peaking screws P3, P4, P5, P6, P7. Always try to achieve flat response with the least number of adjustments. Use the back screws P6 and P7 last. In order to standardize procedure, use D1 to take out the lowest frequency peak and D2 for the highest. (Example: Assume two peaks at 5kHz and 8.5kHz. Use D1 for 5kHz and D2 for 8.5kHz). P3 has much more peaking effect than any of the others because of its larger diameter. So, logically, we would use it to smooth out the deepest notch, or the lowest frequency notch which is unacceptable. If you reach a point of confusion after having adjusted all screws and have still not brought the line in spec., then start all over by bottoming out all screws (to wrench calibration marks) and do it over step by step, noting interaction of peak and dip screws. You will find in many instances that you actually can get the line in spec with fewer adjustments than first indicated.
- ✓13. Record the results of your final calibration with the level recorder. Try to achieve  $\pm 1$  dB even tho the spec is  $\pm 2$ .

13. (cont'd)

Apply glyptol to the screws in a positive, careful manner and re-verify the response on the level recorder. Mark the final curve as follows:

1. Date
2. Serial Number (A or B)
3. Use suffix O. B. (out of box). The lines will be re-calibrated in box. Example: 3/28/72 131•B O. B.

14. ✓ Mark line OK on serial number sticker, and add your initials.

✓15. After production personnel have assembled the A and B lines together and mounted them in the grey housing, the completed unit and its electronics chassis will be returned for an additional calibration check before sta-pak material is added and the covers installed. For this test, use two standard cables. Then proceed as follows:

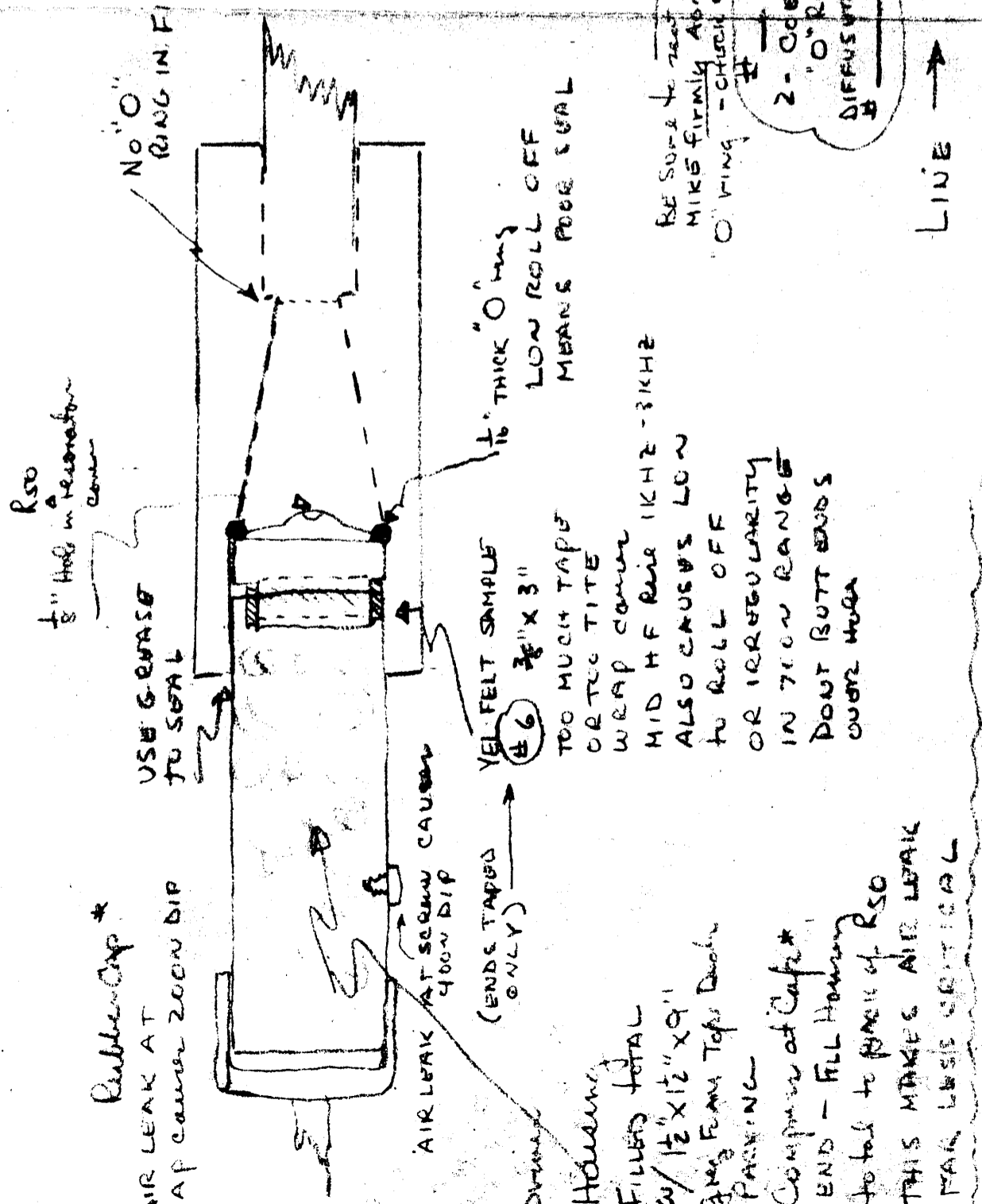
- ✓ A. ~~Set both switches on the fixture to "A", and~~ <sup>With input and output test patchcords in "A", and</sup> Using reference level of -5 dBm manually sweep from 30Hz to 10kHz and compare with original sweep record of A line to see that no significant change has occurred.
- ✓ B. Switch both ~~switches~~ <sup>patchcords</sup> to "B", and repeat (A).
- C. While feeding signal to "B" line, check output of "A" for crosstalk. This should be less than -45 (-40dBm) at 1kHz and less than -25 (-20dBm) at 10kHz.
- D. Then feed "A" line and note crosstalk in "B" output.

E. After checking crosstalk, make final sweep response on level recorder for each channel, and compare with "O. B." traces. If no change has occurred, mark "OK" on tag on grey housing and add your initials. Add the date, serial number A and B to the final level recorder cruves, and the suffix I. B. (In box).



14MS LINE SPECTRUM # 2972

15.82 ft. = 15' 9 3/4" = 14MS  
18.08 ft. = 18' 1" = 16MS



Rubber Cap \*  
AIR LEAK AT  
AP corner 200W DIP

USE GREASE  
TO SEAL

NO "O"  
RING IN FINAL

AIR LEAK AT SCREW CAUSES  
400W DIP  
(ENDS TAPED  
ONLY)

VEL FELT SAMPLES  
#6 3/8" X 3"  
TOO MUCH TAPE  
OR TEE TITE  
WRAP CORNER

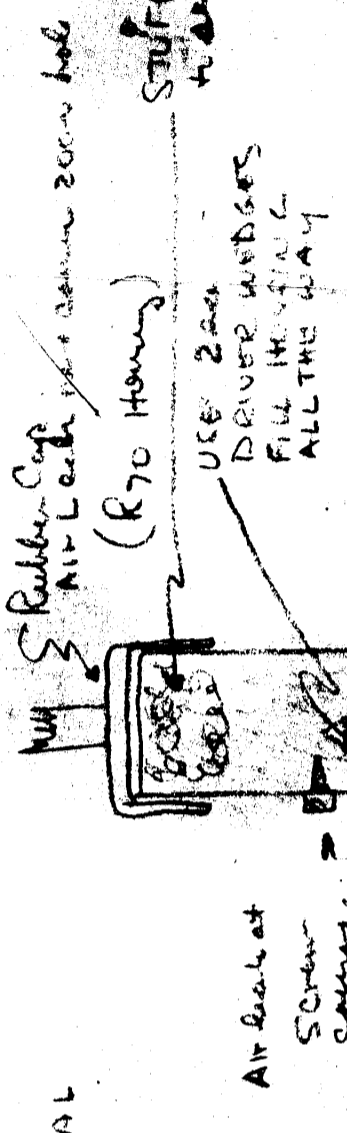
1/16" THICK "O" RING  
LOW ROLL OFF  
MEANS POOR SEAL

MID HF RANGE 1KHZ - 3KHZ  
ALSO CAUSES LOW  
TO ROLL OFF  
OR IRRREGULARITY  
IN 700W RANGE  
DONT BUTT ENDS  
OVER WELD

Housing  
FILMS TOTAL  
1/2" X 1 1/2" X 9"  
FIBRE FIBRE TAPES Double  
PACKING

Comparison of Cap. \*  
ENDS - FILL Housing  
total to peak of R50  
THIS MAKES AIR LEAK  
RISK LESS CRITICAL

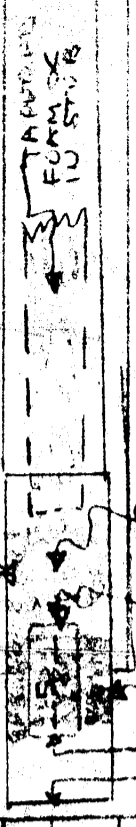
EP! When making performance measurements  
don't get out of Box Monitor  
as R70 will pick up any out of  
phase potentials and low values  
will result in a shift of resonance measurements



2 PADS 7/16" X 1" X 3/16"  
POLY FELT "FAST KING"  
LOOSELY TAPED TO HOLD IN PLACE

THESE #4-40  
USED TO FILL IN  
HOLES 8.5" - 11KHZ  
RANGES (BOTH SIDES  
OF HOLE, FRONT + BACK)  
(PEAKING @ 60)

ADJ FOR BEST RESPONSE  
TAKING OUT 200W PEAK



CONCENTRIC  
WRAP OF  
#12 FOAM PAD  
1 7/8" X 1 1/2" X 1/4"  
FOR 16MS 1/2" X 2"  
\* 1 1/2" X 2 1/2" ROLLER  
OF #10  
THIS PAIR OF  
CF REC AUGUSTIC 124  
IS #10 SAMPLE POLY BUTYLE  
LIGHT THERE IS A QUILTING  
BATT - IF LEFT OUT  
IT CAUSES A HOLE AT  
250W/IF THE DEGREE  
OF RESONANCE IS

OTHER POLY (SPECIAL)  
STREAM IS 1" DIA  
FOR 16MS RANGE

THIS #11 ADJ.  
USED TO FILL  
IN HOLES (CAUSES SLOW RISE  
6-8 KHZ RANGE  
(PEAKING @ 60)

ALWAYS START WITH  
DIP + PEAKING SCREWS FLUSH  
Then 6-32 ADJ.  
used to insert diff.  
(to take out peak)  
4.5KHZ to 7KHZ RANGE  
(DIP FILTER)

(TAPED & WRAPPED  
SCREWS)