Recording Room

INSTRUCTION AND SERVICE MANUAL

(Third Edition)

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Concertone

20/20 RECORDER, TWR - 1 (OR 2)

Berlant Concertone

BERLANT CONCERTONE
FACTORY SERVICE DIVISION

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INSTRUCTION AND SERVICE MANUAL

BERLANT BROADCAST RECORDER, BRX-1 (OR 2)

TABLE OF CONTENTS

WARRANTY

The BERLANT BROADCAST TAPE RECORDER is fully guaranteed against defects in material or workmanship for a period of 90 days from date of purchase.

Under this warranty, Berlant Concertone agrees to replace any part which, when examined at the factory, shall prove to have been defective. This warranty does not cover tubes or any Recorder which has been tampered with or altered outside the factory, or which has been subject to misuse, accident, or abuse, or on which the serial number has been altered or removed.

Before returning any Recorder or Parts, please write us for instructions. All shipments must be prepaid.

To protect your rights under the factory warranty, you must fill out and mail the enclosed card immediately on receipt of your Berlant Recorder. This Warranty is in lieu of all others, express or implied, and <u>does not take effect unless the Warranty Request Card supplied with each Recorder is properly filled out and returned to us</u>.

BERLANT CONCERTONE

4917 W. JEFFERSON BLVD.

LOS ANGELES 16, CALIFORNIA

INSTRUCTION AND SERVICE MANUAL

CONCERTONE 20/20 RECORDER, TWR-1 (OR 2)

Table of Contents

A. OPERATING INSTRUCTIONS

I - GENERAL INFORMATION

The Concertone 20/20 Recorder, Model TWR, consists of two sections: the Recorder Drive Mechanism, TWD, and the 20/20 Recorder Amplifier, TWA.

The drive mechanism is assembled on a rigid ribbed aluminum plate, 19 inches wide and 14 inches high, designed for mounting on a standard relay rack, consolette or console, or into a portable carrying case. It may be operated in any position from vertical to horizontal. All mechanical and electrical functions necessary to the function of the tape drive are self-contained.

The amplifier contains all the elements necessary to supply the erase and record heads of the mechanism with power, and to amplify the signal from the playback head to meet the requirements of a 600-ohm zero level distribution line. The amplifier is assembled on a shock mounted chassis with a supporting framework 19" wide and 5-1/4" high, suitable for mounting on a standard relay rack or into a portable carrying case. A cable from the back of the drive mechanism connects to the amplifier by multiple pin connectors.

The drive mechanism accommodates all size reels up to and including the standard NARTB 10-1/2" professional reel. Instantaneous selection between 15 inches per second and 7.5 inches per second tape speed is provided, with automatic correction of equalization. Tape speed is governed by the combination of a two-speed capacitor induction motor, flywheel, capstan, and air circulation blower constructed as a demountable unit.

Tape spooling is done by two shaded pole motors, rated for continuous duty. Each of these motors is mounted directly beneath the reeling spools and the centering spindle of the reel flange is the extension of the motor shaft. There are no belts, rubber idlers, or clutches in the entire mechanism.

II - SPECIFICATIONS

TAPE SPEEDS:	Instant selection of 15"/Sec. or 7.5"/Sec.
FREQUENCY RESPONSE:	Usable response from 20 to 20,000 cps. ± 2db from 40 to 15,000 cps at 15"/Sec. ± 2db from 50 to 12,000 cps at 7.5"/Sec.
SIGNAL TO NOISE RATIO:	55 db as measured by proposed NARTB standard (400 cps at 3% T.H.D.)
TOTAL HARMONIC DISTORTION:	2% at Zero V.U.
TOTAL FLUTTER AND WOW:	Less than 0.1% RMS at 15"/Sec. Less than 0.2% RMS at 7.5"/Sec.
REWIND AND FAST FORWARD:	Less than 60 secs. for 2500 feet
HEAD MOUNTING:	Interchangeable bracket mounting up to FIVE heads
METER INDICATION:	Bias current, record level, output level
MONITOR OUTPUT:	From tape or input signal
SIGNAL MIXING:	Variable from line and microphone
INPUT IMPEDANCE:	One megohm on high impedance microphone input 50/250 ohms balanced or unbalanced with plug-in transformer # T-3344 200,000 ohms unbalanced bridging input
INPUT SENSITIVITY:	1 MV on microphone input .06 volt on bridging input
OUTPUT IMPEDANCE:	Cathode follower. 600 ohms balanced output with plug-in transformer #T-2560
OUTPUT LEVEL:	6 volts from cathode follower output Zero DBM across 600 ohm line
FILAMENT SUPPLY:	D.C. on all filaments
DIMENSIONS:	Drive mechanism, 14"x19" Mounting depth, 6-1/2" below panel Amplifier, 5-1/4"x19", mounting depth 6" below panel
WEIGHT:	Drive mechanism, 35 LBS. Amplifier, 10 LBS.
TUBE LIST:	2-12AX7; 1-12AT7; 2-12AU7; 1-12BH7; 1-6X5GT
POWER REQUIRED:	220 Watts, 60 cycles, 115 volts

The Drive Mechanism, TWD, (Fig. 1) is mounted in relay rack, console, or carrying case by four #10-32 fillister head screws and washers. Four slots are provided on 11" x 18-1/2" centers to match standard rack mounting dimensions. Portable cases supplied by Berlant Associates are fitted with mounting studs to match.

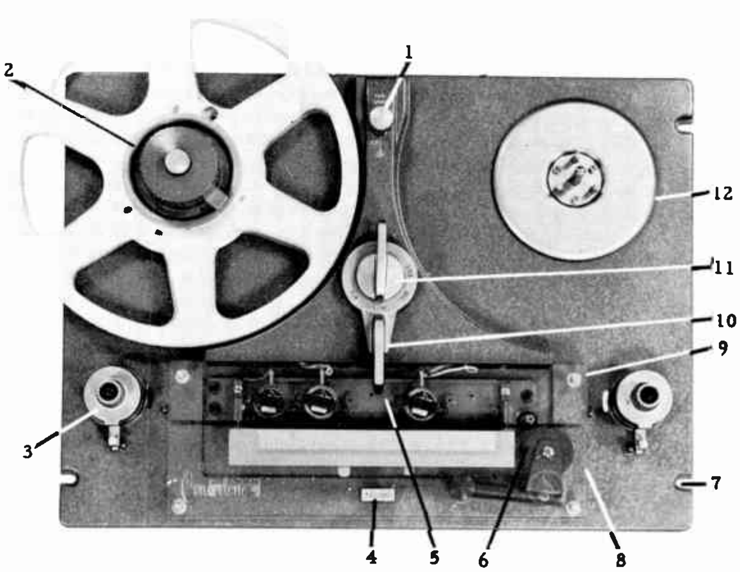
Before mounting on relay rack or console, check for clearance of 10-1/2" reels over any ornamental trim or protrusions of the rack.

Insure an adequate flow of cool air for ventilation, with particular attention to air access for the Flywheel-Blower (Fig. 5). When mounting the drive between the horizontal and 45° angle in a console, it is recommended that the panel be mounted on spacers to provide 1/8 inch clearance between the panel and the console, to prevent possible heat entrapment.

The Amplifier, TWA, (Fig. 2), is mounted by four fillister head #10-32 screws, using the decorative trim washers provided with the amplifier. Ventilation should be provided, as for any other electronic amplifier of similar size.

The amplifier and the drive mechanism may be mounted in any relationship permitting connection by the cable provided on the drive mechanism. For maximum signal to hum ratio, the amplifier panel should be spaced 3-1/2" below the transport. A standard blank panel can be used to fill the space between.

Connect the cables from the drive mechanism to the matching connections on the back of the amplifier chassis. Connect the power cable from the amplifier to a proper power source.



1. Speed Selector Switch
2. Reelok
3. Tape Tension Arms
4. Record Button
5. Head Assembly
6. Pressure Roller
7. Mounting Slots
8. Lower Head Cover
9. Upper Head Cover
10. Tape Drive Control Lever
11. Tape Spooling Control Lever
12. Reel Mounting Flange

Fig. 1 DRIVE PANEL, FRONT VIEW
(HEAD COVERS GHOSTED)

Connect input and output wiring as required, in accordance with instructions in Section IX.

IV - DRIVE MECHANISM CONTROLS

The basic controls of the TWD Drive Mechanism (Fig. 1) are concentrated in a dual lever system located at the approximate center of the panel.

1. Tape Drive Control Lever - normally pointing directly to the front of the panel. This lever has three positions in addition to the neutral "Stop." These are marked, "Run," "Cue" and "Edit."

2. Tape Spooling Control Lever - normally pointing directly to the rear of the panel. This lever swings 120° each side of "Stop" to control speed and direction of fast-forward and rewind spooling of tape reels.

3. Speed Selector Switch - located at the back center of the panel. This knob controls speed and equalization of the tape in "Run" condition.

4. Record Button - A rectangular button in the front center of the head cover, controlling the "Record" and automatic erase function. This control is interlocked with the "Run" position of the Tape Drive Control Lever.

5. The Tape Drive Control Lever is interlocked with the Tape Spooling Control Lever, and actuating either lever automatically locks the other.

6. Tape Tension Arms - These are located at the right and left of the tape loading slot. They lock out of position while tape is being loaded. When engaged, they equalize tape motion and stop the recorder in the event of tape failure or at end of reel.

V - AMPLIFIER CONTROLS

The arrangement of controls on the TWA Amplifier Panel (Fig. 2) is the result of extensive investigation into the simplest combination which will satisfy the widest professional requirements.

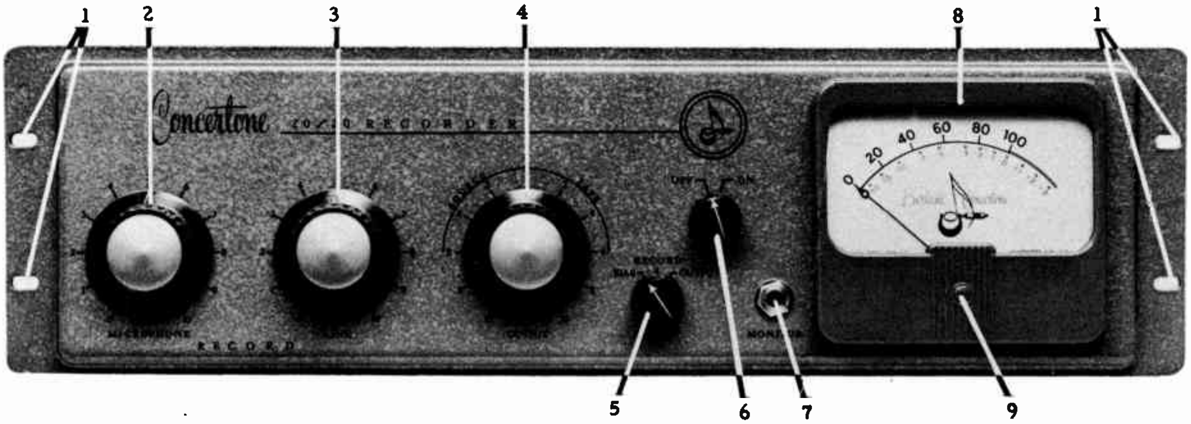
The Microphone Level Control is calibrated in 10 steps from 0 to 10, with maximum gain at 10.

The Line Level Control is calibrated identically and controls the line record level independently of the Microphone Level Control.

From 0 at the center position, the Output Level Control is calibrated in five steps to 10 on each side. The scale to the left of center is marked "Source," and indicates the output amplifier gain directly from the incoming signal. The scale to the right of center is marked "Tape," and indicates the output from the tape.

The Meter Switch has three positions: "Bias," "Record" and "Output," to measure the output of each on the meter.

The Power Switch controls the 115-volt supply to both amplifier and drive mechanism, and is marked "Off" and "On." The illumination of the meter face indicates when the recorder is switched "On." When the Power Switch is in the "Off" position, the bridging input is automatically connected through to the output jack. With the recorder connected between a source (such as a preamplifier) and a power amplifier, the recorder may be by-passed by merely turning off the Power Switch.



1. Mounting Slots
2. Microphone Level Control
3. Line Level Control
4. Output Level Control
5. Meter Switch
6. Power Switch
7. Headphone Monitor Jack
8. Meter
9. Zero Adjust

Fig. 2 AMPLIFIER, FRONT VIEW

VI - TAPE LOADING PROCEDURE

The exclusive Berlant Concertone Reelok serves as a lock for RMA type hubs, and as a combination centering device and lock for NAB hubs. To lock either reel in place, proceed as follows:

1. Center the Reelok over the spindle and drive pins of the spooling flange.
2. See that flange fits snugly on reel.
3. Push in the center button of the Reelok as far as it will go.

To unlock the reel, press the release lever on the side of the Reelok. To load tape:

1. Set the Tape Drive Control and Tape Spooling Control Levers to "Stop."
2. Load the full reel of tape on the supply flange, and fasten with Reelok.
3. Place the empty reel on the take-up flange, and fasten with Reelok.
4. Turn the left hand tape tension knob counter-clockwise and the right hand tape tension knob clockwise until the tension arms lock on the detents.
5. Draw the free end of the tape around the supply roller, through the head slot, and around the take-up roller.
6. Fasten the end to the take-up reel.
7. Turn the take-up reel once or twice to fasten tape securely.
8. Release the tension arms to engage the tape.

For best results, the use of 10-1/2" reels is recommended.

VII - OPERATING PROCEDURE

With tape in place, the Tape Drive Control Levers set at "Stop," and the Power Switch "On," turn the Speed Selector Switch to the desired tape speed.

To Make a Recording: Hold down the Record Button while moving the Tape Drive Control Lever to "Run" position. Turn the Meter Switch to "Record."

To Monitor The Recording: Turn the Output Level Control to the left to monitor the incoming signal, to the right to hear the signal being played back from the tape. This A-B comparison may be made without affecting the recording. The meter also may be switched to read output level after proper record level has been set.

At End Of Recording: Return the Tape Drive Control Lever to "Stop." The Record Button will be released automatically, making accidental erasure impossible.

To Play Back A Recording: Rewind tape to beginning of reel. Move the Tape Drive Control Lever to "Run." Turn the Meter Switch to "Output." Turn the Output Level Control to the right ("Tape") until the desired level is obtained. To end the playback, return the Tape Drive Control Lever to "Stop."

VIII - CUING AND EDITING

Fast spooling of the tape in either direction is governed by the Tape Spooling Control Lever. Tape speed may be varied as desired by rotating this control lever. A cue or edit spot is located in the following manner:

1. Determine the approximate location by manipulating the Tape Spooling Control Lever as indicated above.
2. Having found the approximate location, return the Tape Spooling Control Lever to "Stop."
3. Move the Tape Drive Control Lever to the left to the "Cue" position. (This wraps the tape around the heads, releases the brakes, and leaves the reels under motor tension.)
4. While listening, move the reels in either direction by hand. The location of an exact cue or edit spot may now be determined.

When an exact cue spot is located in Step 4 above, then:

1. Return the Tape Drive Control Lever to "Stop" until the tape is to be played.
2. When the tape is to be played, turn the Tape Drive Control Lever to "Run."

After an exact editing spot is located in Step 4 above, then:

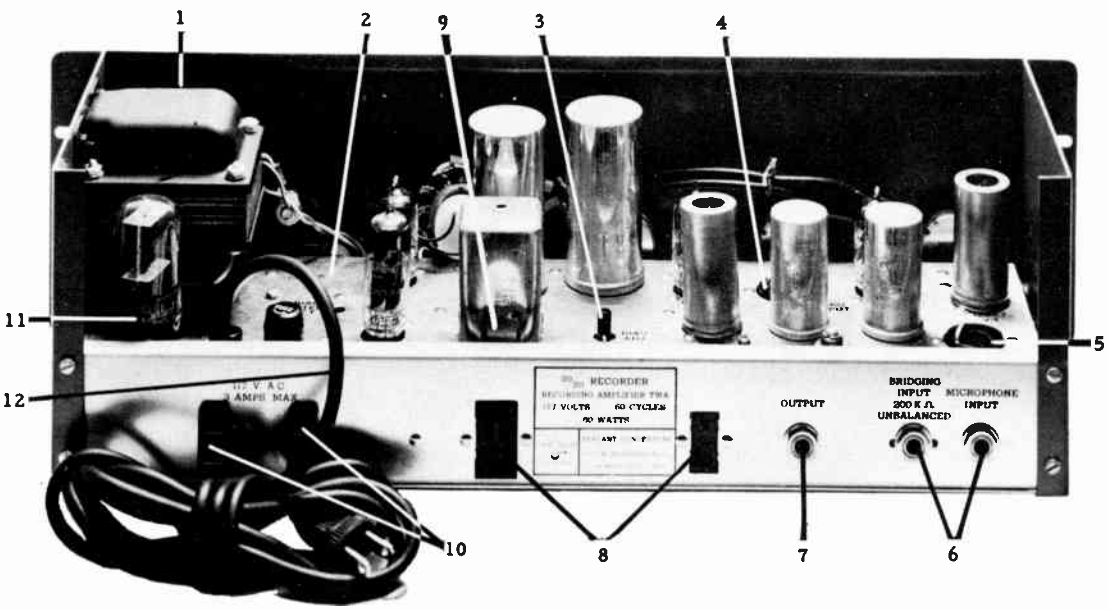
1. Move the Tape Drive Control Lever from "Cue" to "Edit." (This applies the brakes and opens the head closure fully.)
2. Mark the tape with a grease pencil directly over the gap in the playback head, or
3. Scissors may be inserted, moved into position at the playback gap, and the tape cut accurately.

The importance of clean contact between the heads and the tape cannot be over-emphasized. This must be considered a part of operational procedure, rather than maintenance. In many recording studios the heads are cleaned before every recording is made or played back, but under average conditions cleaning heads each ten hours of use will give excellent results.

Before loading the tape, move Tape Drive Control Lever to "Edit." Dampen a clean piece of fabric, such as fine muslin, with alcohol and carefully wipe the pole pieces of the heads with the muslin wrapped across the ball of the index finger. It is not necessary to saturate the cloth. A small amount of alcohol is enough.

Occasional attention also should be paid to the capstan and pressure roller. Remove the lower head cover by grasping each end and pulling away from the panel. This casting, as well as the upper head cover, is located by two dowel pins anchored into the main plate. The covers are held in place by friction springs located inside the castings. With the cover removed, clean the capstan and the rubber pressure roller in the same manner as the heads. Replace the head cover by locating it on the two dowel pins and pushing it back in place. Make sure the Record Button is properly aligned to fit the opening in the cover.

Although slow decay characteristics are built into the circuitry to prevent magnetization of the heads, with resultant noise (hissing and crackling) and loss of high frequency response, it is wise to demagnetize the heads at the same time they are cleaned. Head demagnetizers are supplied by various manufacturers at very reasonable prices. They should be used in accordance with instructions. Always be sure the recorder is switched off when the demagnetizer is used.



1. Power Transformer
2. Bias Meter Set
3. Bias Level Adjust
4. Output Transformer Socket
5. Input Transformer Socket
6. Input Jacks
7. Output Jack
8. Connectors to Heads
9. Erase Oscillator Coil
10. Power Outlets
11. Fuse Post
12. Power Cord

Fig. 3 AMPLIFIER, TOP AND REAR VIEWS

X - INPUT AND OUTPUT CONNECTIONS

Two inputs are provided on the TWA amplifier (Fig. 3). The microphone input is a 3-wire jack connected to an octal socket designed to permit adaptation to a wide variety of inputs by plug-in transformers and other accessories. With the socket strapped for continuity, the input is for a high impedance (1 megohm) microphone.

For 50/250 ohm balanced and unbalanced microphones and other low level sources, refer to connection diagrams shown in Fig. 4.

The 200,000 ohm bridging input is designed for connection to standard high impedance, phono level lines, or to bridge unbalanced studio lines, or to bridge from one side to ground of balanced lines.

The output connection is by a 3-contact jack coupled to the output tube through an octal socket and accommodating a plug-in transformer to convert the output from a cathode follower giving a 6-volt maximum signal to a 600 ohm balanced line zero DBM signal.

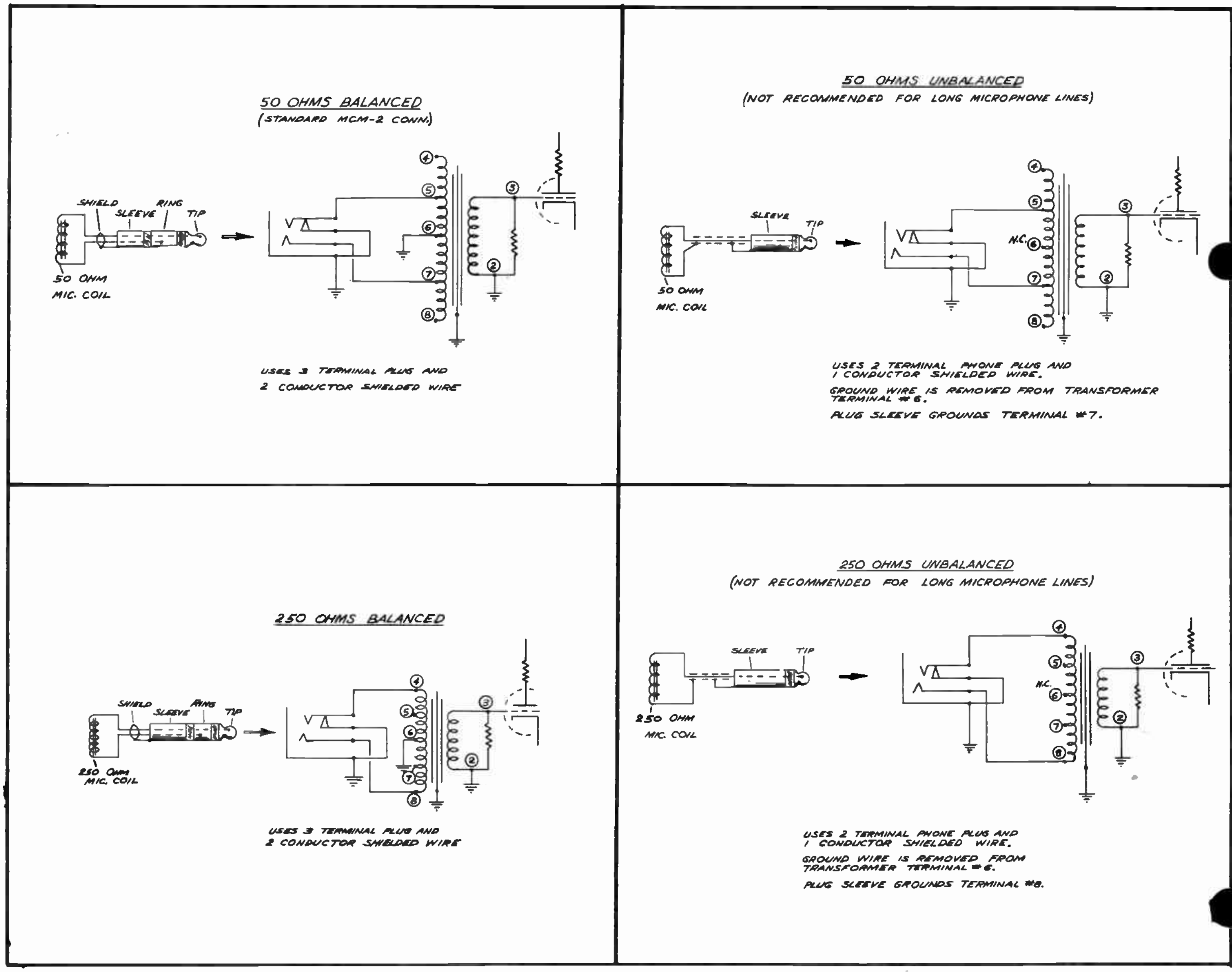


Fig. 4 INPUT CONNECTIONS

XI - METER SWITCH

The fourth knob from the left on the amplifier panel (Fig. 2) is marked "Meter." This knob switches the meter circuit to read any of three positions.

The first position, marked "Bias," reads the value of bias current being supplied the record head, as a means for rapidly determining the proper operation of erase and record circuits when all circuits are working properly. The meter should read 100 on the scale if properly set in accordance with instructions in the maintenance section of this manual.

In the second position, marked "Record," the meter reads the modulation level of the audio signal being recorded. On the scale, 100 represents the point at which a standard level is recorded on the tape. A recording made at this point and played back at zero level output will have a total harmonic distortion content of 1 to 2%. An intermodulation distortion test (SMPTE) signal at the same level will give a reading below 4%.

In the third position, "Output," the meter indicates the signal level at the output jack of the amplifier, and at the monitor jack on the face of the amplifier panel.

XII - OUTPUT LEVEL CONTROL

The third knob from the left is marked "Output" and controls the level and origin of the signal at the output jack. Turning the knob to the left from the center zero position, into the area marked "Source," picks up and amplifies the signal being fed into the recorder. Turning the knob to the right from zero position into the area marked "Tape," picks up and amplifies the signal being played back from the tape.

XIII - RECORD LEVEL CONTROLS

The first knob on the left is marked "Microphone," and controls the level of the microphone signal being recorded on the tape. The record amplifier is activated by the record switch on the drive mechanism, and will be effective, as will the "Record" function of the meter, only when the Record Button on the drive mechanism is depressed. To pre-set record level while tape is not in motion, hold this button down and set Microphone Level Control to the level desired, using the meter as an indicator.

The second knob on the left is marked "Line" and controls the level of the bridging input signal being recorded on the tape. Both controls are independent and may be used to mix two signals on the tape.

B: MAINTENANCE PROCEDURES

I - BIAS LEVEL ADJUSTMENT

Recorded signal level, distortion and frequency response are all affected by bias level. The bias level is set at the factory to give optimum results on red oxide, plastic base tape. The meter reading at "Bias" position has been adjusted to read 100 for this bias setting. Aging of components and other factors may cause the bias level to change.

Procedure for resetting bias level to restore optimum performance, or to obtain the best results from a specific brand or type of tape is as follows:

1. With the recorder off, zero the meter by the screw adjustment on the front.
2. Turn the record amplifier on and run for at least 10 minutes, until all components are at normal operating temperature.
3. Feed a 1000-cycle note into the recorder, setting a record level of 80 on the meter.
4. Switch the meter to "Output." Set output level to give any convenient reference reading on the meter.
5. Turn bias adjust control (Fig. 3) on amplifier chassis counter-clockwise, decreasing bias.
6. Slowly return bias adjustment control clockwise, as you watch the output meter. Increase bias slowly, until meter reaches maximum reading, and begins to fall. Continue increasing bias until meter indicates decrease of 1/2 to 1 DB in output of tape. Remember there is a time delay of 1/10 second between record and playback functions.

This represents the optimum setting for general recording purposes. The reason for going past maximum response is to establish a safety margin for variations in tapes and operating conditions.

Reducing the bias below optimum increases high frequency response and also distortion. Increasing the bias beyond this point decreases high frequency response and distortion.

II - BIAS METER SET

Following the bias level adjustment, the meter reading should be checked, and if necessary, reset to give a reference reading of 100 for purposes of checking bias level from time to time.

The meter reading may be reset to 100 by the screwdriver adjustment on the chassis (Fig. 3), marked "bias meter set."

III - FREQUENCY RESPONSE CHECK

In music, substantially all frequencies above 5000 cycles are overtones of fundamental notes of lower frequency. These overtones are of greater diminished amplitude than the fundamental notes. The amount of pre-equalization required in a wide range recording amplifier to correct for tape characteristics is considerable. Consequently, it is necessary to run frequency checks at very low input levels so that the full equalization can be realized within the limits of the overall gain of the amplifier.

Concertone Recorder equalization follows closely the NARTB standard, and because of the nature of power distribution in the musical spectrum as stated above, faithful reproduction will result if the following frequency check method is followed.

1. The equipment required is an audio oscillator and an audio frequency millivoltmeter capable of reading the audible spectrum. These two instruments should be checked together to determine their combined correction factor.

   The output of the audio oscillator should be free of hum and noise in order to obtain correct readings.

2. Connect the audio oscillator output to the bridging input of the amplifier. Recording a 1000-cycle signal, adjust the controls until the meter on the amplifier reads minus twenty with the Meter Switch in the "record" position.

3. Connect the output of the amplifier into the audio voltmeter.

4. Record various frequencies such as: 50, 100, 1000, 10,000, 15,000 cycles for a period of around three to five seconds each.

5. Play back the recorded frequencies with the amplifier Output Level Control set on "Tape" at such a point as to give around .5 volts on the audio voltmeter. Correct the output readings by the amount determined in step one.

IV - HEAD ALIGNMENT PROCEDURE

If frequency response on the recorder becomes deficient, and it is not due to dirt on the heads, worn heads, or excessively high bias adjustment, misalignment of the heads may be the cause.

To align the playback head, first remove the head cover castings, then clean and de-magnetize heads, capstan and pressure roller. Load the recorder with a standard alignment tape, which is available from your distributor. Run the recorder at 15 inches per second tape speed. Turn the Meter Switch to "Output" and the Output Level Control to a point on the "Tape" scale to give any convenient reference reading on the meter from the 12KC signal.

Slowly turn the adjustment screw on the playback head. If the meter reading goes down, turn the screw in the other direction. If the meter does not go beyond the reference reading during this process, the head does not need adjustment.

METHOD A. To align the record head: turn the output gain down to 0, disconnect the record head leads, and transfer the playback head leads to the record head. This head will now function as a playback head during the adjustment. Repeat the above alignment procedure for the record head. After adjustment is completed, return the leads to their original positions.

METHOD B. Replace the standard alignment tape with a reel of blank tape, and operate the recorder in record position while feeding in a 12 KC signal from a signal generator, at a level of minus 20 DB. Set playback level to give any convenient reference reading on the meter, and align the record head as the playback head was aligned. (Remember, there is a time lag of a fraction of a second while the tape is moving from the record to the playback head.)

Adjust the record head until the maximum response is obtained from the playback.

V - PRESSURE ROLLER ADJUSTMENT

There are two adjustments on the pressure roller mount and arm. These may need resetting after replacing a pressure roller, or to compensate for wear on it.

If the pressure roller has been replaced, the first adjustment to be made is to parallel the face of the roller to the drive capstan. Loosen the cap screw on the end of the arm, and align the roller until it is vertically parallel to the capstan. Tighten the cap screw until it is solidly seated.

Next loosen the lock screw at the center of the roller bracket and adjust for lateral displacement. The center of the pressure roller should be about 1/8" to the right of a line through the center of the capstan. The bracket must be adjusted by rotating it around the lock screw as an axis until the pressure roller will run in contact with the capstan with no skew action. Tighten set screw until it is seated solidly.

The third adjustment must be made when a pressure roller is replaced or to compensate for wear. This is the roller arm pressure adjustment nut, on the threaded rod fitted through the arm locked to the bottom of the pressure roller arm pivot shaft. With the recorder in operation, loosen this adjustment nut until the pressure roller does not drive the tape. Then turn in the opposite direction until pressure roller engagement is positive, and flutter and wow are at a minimum. Do not exert more than the minimum amount of pressure necessary to achieve this effect or undue wear on the capstan and motor bearings may result.

VI - TENSION ARM ADJUSTMENT

The tape tension arms (Fig. 1) have a dual function: they serve to eliminate tape slack while absorbing small reeling irregularities, and to turn off the recorder mechanism if the tape is broken or exhausted.

If the tension is too great, the cut-off switch will be actuated unnecessarily. If the tension is not great enough, the cut-off switch will not actuate.

To readjust the tension, loosen the lock nut on the screw protruding (below the panel) through the boss supported by three ribs. (Fig. 5) Turn the screw in the direction of spring actuation to increase tension, or in the opposite direction to decrease tension. Then tighten the nut to lock.

VII - BRAKE ADJUSTMENT

There is only one adjustment on the brake assembly. (Figs. 5 & 6) This is a single bracket fastened to a slider arm by two lock screws, activated by the brake cams on Tape Drive Control Lever shaft.

To Adjust: With the recorder off, place the Tape Drive Control Lever in "Run." Loosen the two brake adjust lock screws and move the brake adjust bracket back until the brake arms are lifted clear of the brake drums by 1/16 inch. Tighten the brake adjust lock screws until firmly seated. Return Drive Control Lever to "Stop," and turn Tape Spooling Control Lever to each side. As the brake drums revolve, check to insure clearance of brake arm pads from drums.

VIII - LUBRICATION

To insure maximum trouble-free operation, self-lubricating bearings have been used wherever possible. Normal maintenance lubrication is required only on the two spooling motors.

Place 5 drops of Gulfcrest A or Standard C oil in both oil holes on each motor after 500 hours of operation or at three month intervals. After operating the recorder, remove any excess oil that is forced out of the bearings by the initial run.

The drive motor requires lubrication only once a year. Details of this procedure will be found under Section III of REPAIRS AND SERVICE.

IX - FUSES

The amplifier is protected by a quick change fuse mounted in a fuse extraction post on the back of the amplifier. The drive mechanism is protected by a similar unit on the top of the Control Chassis on the back of the recorder.

Replace fuses ONLY with fuses of the same type and size. Otherwise the equipment is not properly protected against damage.

Fuse failure is an indication of either excessive line voltage, wrong type of current supply, or malfunction within the equipment. The cause of failure should be investigated before replacement.

X - NOTES AND COMMENTS

C. REPAIRS AND SERVICE

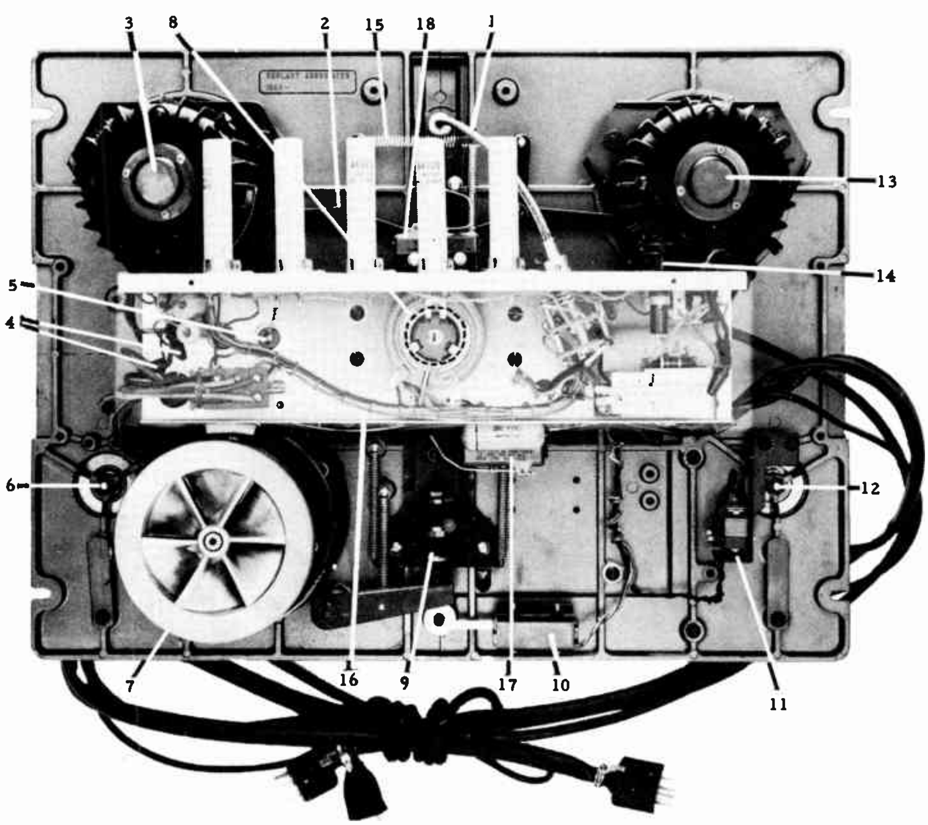
Because The Concertone 20/20 Recorder completely eliminates all clutches and/or belts in driving and spooling tape, service problems are greatly simplified.

If malfunctions are not corrected by the adjustments outlined in the section on maintenance, the following information will guide the service man in locating and repairing the defect.

I - DRIVE CONTROL CIRCUITRY

By removing the dust cover on the control chassis (Fig. 5), access is obtained to all voltage points necessary to check proper electrical functioning of the drive mechanism. The circuit diagram gives voltage readings for various conditions of operations.

If the readings in "Run" position are the same as for "Stop" position, check the operation of the microswitch, S_1. The switch should actuate before motion of the Tape Drive Control Lever to "Run" position is completed.



1. Speed Change Control Cable	10. Record Switch
2. Brake Arm	11. Cut-off Switch
3. Take-up Motor	12. Tape Tension Adjust Lock nut
4. Motor Disconnect	13. Supply Motor
5. Drive Motor Capacitor	14. Fuse Post
6. Tape Tension Adjust Lock nut	15. Brake Tension Spring
7. Drive Motor	16. Junction Box Cover
8. Tape Control Cam Assembly	17. Microswitch, S_1
9. Pressure Roller Adjust	18. Microswitch, S_2

Fig. 5 DRIVE PANEL, REAR VIEW (Junction Box Ghosted)

II - SPOOLING MOTOR REMOVAL

With the recorder detached from the power source, remove the dust cover from the control chassis and unscrew the wire nuts which connect the motor leads. Compress the strain relief until it falls free of the hole. Remove the reel mount flange plate by taking out the three screws. Remove the three nuts holding the motor mounting plate, and remove the motor from the mechanism.

Do not disturb the setting of the nuts between the motor mounting plate and the main mechanism panel, or it will be necessary to readjust for reel height and alignment. If the spindle is removed from the motor shaft, it must be replaced exactly or the height of the motor mounting plate must be readjusted.

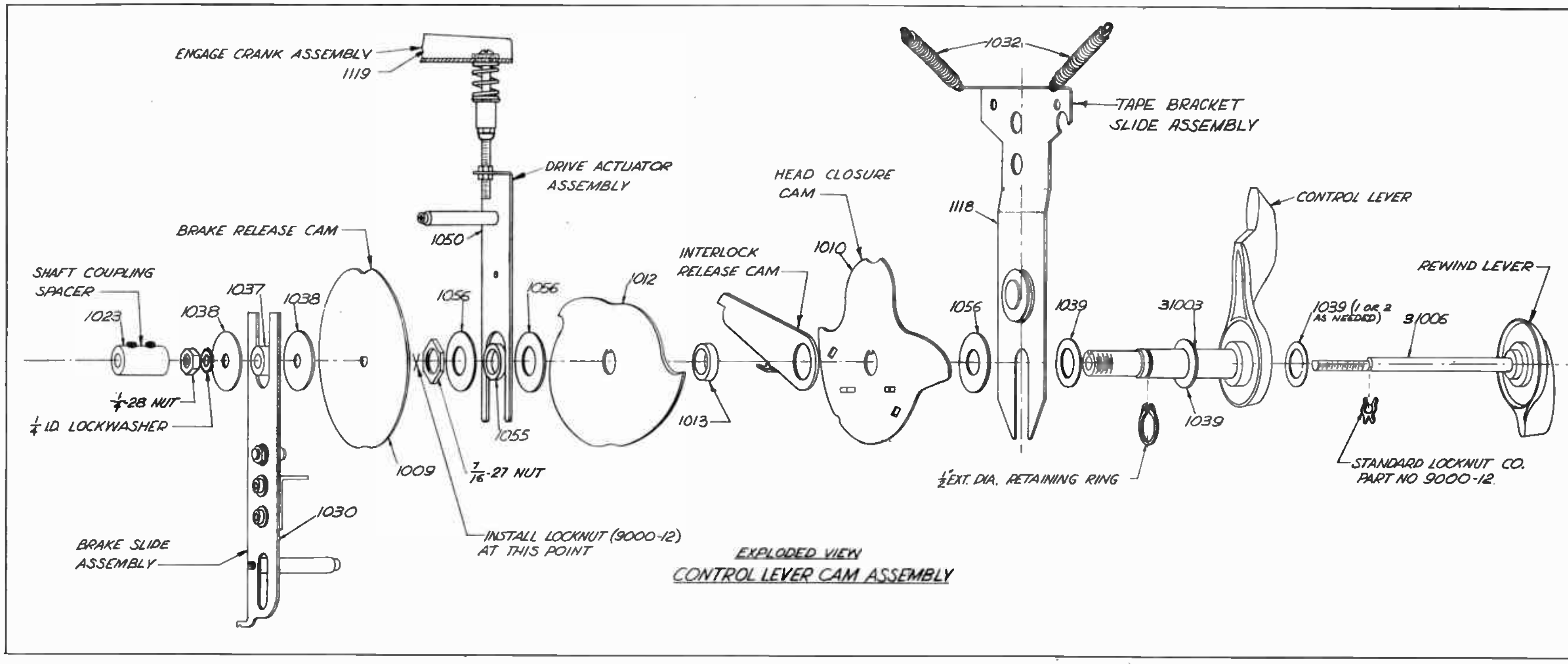
Replace all components in reverse order. Height and alignment adjustment is by the nuts between the motor plate and the main panel. When properly set, the tape will spool accurately between reel flanges, and the reel will be parallel to the surface of the main plate.

III - MOTOR CONTROL

The TWD transport incorporates a time delay relay for the purpose of boosting the current through the reeling motors during the start of the run condition. After a period of approximately four seconds the relay relaxes and reduces reeling power for cooler operation.

The selenium rectifier charges the 80 mfd capacitor during the stop condition. When the Control Lever operates the motor disconnect switch, AC is removed from the rectifier input. The capacitor then discharges through the relay until its charge is depleted and the relay armature springs out.

Lubricate the drive motor (detail #7, Fig. 5) by placing 5 drops of 10 SAE motor oil in each of the two oil holes. This lubrication is to be performed only once a year.



IV - CONTROL CAM ASSEMBLY Fig. 6

To service cam assembly (Fig. 5), disconnect head leads and unfasten cut-off switch. Remove control chassis dust cover and unplug all three motor connectors. Loosen fastening on shaft coupling between rewind control lever shaft and rheostat on control chassis. Loosen lock screw of flexible shaft coupling to speed selector switch and release from shaft. Remove four screws holding chassis to mounting bracket and lift chassis clear of panel. Access to the cam assembly is now possible.

The exploded view of the cam assembly (Fig. 6) shows the proper order and relationship of cams, followers and spacers. The lock rings are released by squeezing the protruding fingers. After disassembly is completed, the control levers may be lifted out of the panel from the top. The shafts are pressed into the levers, and cannot be removed from them.

Reassemble in reverse order, and make any necessary adjustments of brake and tape pressure roller assemblies. Note that the rheostat must be centered in run position.

V - TAPE TENSION ASSEMBLIES

Each tape tension assembly (Fig. 1) may be taken down by removing the lock nut holding the assembly to the main panel, then lifting roller and tension arm from the top of the panel. Note the location and order of spacers, washers and spring assembly. The bearings in this mechanism are dry bearings, and no lubrication should be used. Cleanliness must be observed on reassembly. Readjust tension in accordance with maintenance service instructions.

VI - HEAD MOUNT GUIDES

The head mount guides may be replaced, if worn, or rotated to present a fresh surface by loosening the lock screw on the side of each guide. The guide may be moved forward or backward by loosening the screw clamping it to the head mount. This controls the amount of wrap of the tape around the heads. Both guides must be set to keep the head shield mount parallel to the head mount. Distance from the front edge of the head mount plate to the front bottom edge of the shield mount should be about 1/16" to give proper wrap of tape on heads. Guides must be seated within the groove on head mount plate, and firmly fastened, otherwise tape will not align properly.

VII - NOTES AND COMMENTS

D. ELECTRONIC SERVICE DATA

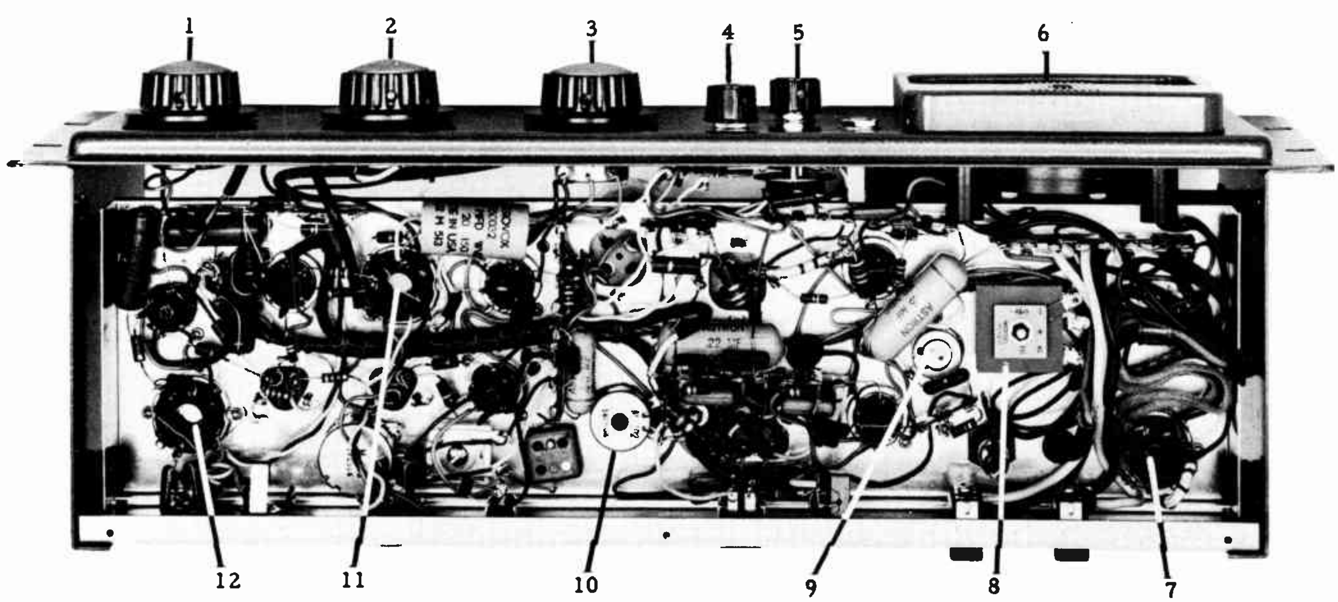
The 20/20 Recorder Amplifier TWA, complete with power supply, is mounted on a 5-1/4" x 19" relay rack panel and performs the following functions:

Record amplification
Playback pre-amplification
Output amplification
Erase and bias generation
Bias level indication
Record level indication
Output level indication

(A schematic diagram of the electronic circuitry is cemented inside the dust cover of the amplifier TWA.)

I - POWER SUPPLY

This supply is conventional with the exception of the D.C. heater supply for the low level tubes. A full wave bridge selenium rectifier and a 22-volt winding on the power transformer furnish approximately 24 volts D.C. to the 500 MFD filter capacitor. All the low level tube heaters are in series parallel across this 24 volt supply.



1. Microphone Level Control
2. Line Level Control
3. Output Level Control
4. Meter Switch
5. Power Switch
6. Meter
7. B+ Rectifier
8. Filament Rectifier
9. Bias Meter Set
10. Bias Adjust Potentiometer
11. Output Transformer Socket
12. Input Transformer Socket

Fig. 7 AMPLIFIER, BOTTOM VIEW

II - BIAS AND ERASE OSCILLATOR

V3, a type 12BH7 dual triode, is used in this circuit as a balanced Colpitts oscillator. Bias current for the record head is taken out of a secondary winding through the bias current control. Erase voltage is taken from the two plates through coupling capacitors to the erase head. Aside from the bias current adjustment there are no adjustments on the bias oscillator.

Frequency of oscillation will vary in the vicinity of 50 KC, depending on components.

III - RECORD AMPLIFIER

This portion of the amplifier uses two dual triode tubes in cascade to raise the input signal from microphone level to a level sufficient to drive the record head. V1, - type 12AX7, is coupled to input signals through two connectors. (Both stages of V1 are connected as conventional triode amplifiers.) The first V1A, connects to a 3-contact microphone input through an octal socket labeled T-3344. Coupling to various inputs is described in the Instruction Manual, X. The output of this stage is fed to the grid of the second stage through the Microphone Level Control potentiometer. Bridging input is fed in through another potentiometer and into the same grid.

The output of V1 is used to drive a two stage feedback amplifier consisting of the two triode sections of V2. Equalization is controlled by the feedback voltage generated across the 15,000 ohm resistor in the ground return lead of the record head. The amount of voltage fed back at each frequency to the V2a cathode is determined by the reactive elements in the feedback loop. The result is a record current curve which increases with frequency from a thousand cycles up. When the recorder is being used at 7.5 inches per second a .004 mfd capacitor is connected across the first cathode of V2 to provide a sharp rise at 15 K.C. When the speed is 15 inches per second, the .004 mfd capacitor is not used. This switching is done automatically when the speed is changed.

IV - PLAYBACK PREAMPLIFIER

The very low output of the playback head is brought up to usable level by V6, type 12AX7. This tube is connected as a two-stage feedback amplifier with bass boost determined by the feedback path. The ratio of resistance and capacitance determines the playback response curve. The gain of the amplifier is inversely proportional to frequency up to approximately two kilocycles. Beyond that point the gain is determined by the setting of the 15 K.C. adjustable trimmer capacitor.

The lead connecting the playback head to the amplifier input is of double shielded construction. The inner shield is driven by the voltage developed across V-6A cathode resistor. The function of the driven shield is to minimize the capacity effect inherent in the cable. Without the driven shield arrangement, the playback head would self resonate in the audio band causing poor response characteristics.

V - OUTPUT AMPLIFIER

The signal from V6 is fed to one side of a center tapped 200,000 ohm potentiometer. The center tap is grounded, and the other side is bridged across the output of the record preamplifier stage, ~~V16,~~ VIB The variable tap of the potentiometer acts as a fader control feeding the grid of the first stage of V4, type 12AT7, connected as a conventional voltage amplifier. The second stage of V4 is a cathode follower feeding the output jack through strapped octal socket, labeled T-2560. Removing the straps and plugging in the matching transformer converts the cathode output to a 600 ohm balanced zero level line output.

Capacity of a shielded line has very little effect on the output and can be run as far as several hundred feet, if needed.

VI - METER CIRCUITRY

Metering is by a V.T.V.M. circuit using V5, type 12AU7, as an extremely stable amplifier and vacuum tube voltage doubler rectifier. The first stage is operated as a conventional triode, the second stage is diode connected, with the cathode biased by the voltage drop across the cathode resistor of the first stage. Voltage doubler rectification is by a germanium diode, CK-706A. The selector switch connects the grid of the VTVM to the various circuits to be metered. The record circuit is bridged at the plate of V2B, the bias signal is trapped out by an RC network consisting of two 100K resistors, a .00025 and a .00015 capacitor, to eliminate bias leakage affecting the meter. The bias circuit is bridged at the return of the record head circuit through a .001 capacitor. A 2000 ohm variable resistor permits setting the meter reading to 100 for the value of bias required by the tape, giving a standard reference point in checking bias circuit operation. The output circuit is bridged at the cathode of the cathode follower output stage V4b.

VII - COMPONENTS

Several facts should be noted about the components used in this amplifier. The resistors in the cathode and plate circuits of the first and second record and first and second playback stages are of the deposited carbon variety. These resistors are very quiet. In case one of them should ever have to be replaced, the replacement must be of the same type. Ordinary composition resistors will bring up the hiss level.

The capacitors used in the bias oscillator have been matched in production to within five per cent to preserve symmetry. The actual value of the matched pairs is not critical since the bias frequency is not critical. It is important, though, that the positive and negative halves of the bias waveform be identical.

VIII - FREQUENCY RESPONSE

Technicians unfamiliar with tape recorder techniques frequently make response tests and, due to incorrect methods, condemn the recorder as not having high frequency response even though their ears are satisfied with the music they hear. This common error is due to ignorance of the equalization scheme required to make a high fidelity magnetic tape recorder work. It is common practice to record with a rising record current versus frequency curve in order to keep hiss down to a satisfactorily low level. This is true of disc recording as well and fortunately is quite compatible with the energy content of most music.

Bearing this pre-emphasis in mind, it can be seen that a 15,000-cycle signal strong enough to saturate the tape will require a much lower level input than will a 1000-cycle signal for the same amount of saturation. If both signals were fed in at the level required for full modulation at 1000 cycles, the 15,000 cycle signal would be saturated at an early stage and the pre-emphasis would be nullified. The result would be apparently poor high frequency response. On the other hand, if the response check were made at a level twenty db lower, the response would be excellent.

The TWA amplifier incorporates two adjustments in the playback amplifier. The 5 K.C. adjust pot is used to set the mid-range response with respect to the low frequencies. In order to achieve a compromise between the two speeds without using complicated switching, the 5 K.C. adjust is set so that at 7.5" the 5 K.C. response is down 1-1/2 db with respect to 1 K.C. With this setting the 5 K.C. response at 15" will likely show a 1-1/2 to 2 db rise. A similar compromise is made at 15 K.C., using the 15 K.C. adjustable trimmer. If one speed is to be used predominately, the adjustments can be made to favor the desired speed.

IX - VOLTAGE POINTS

Two voltages are given for each important point on the schematic. The upper is valid if the Record Button is down, the bottom value applies otherwise.

X - NOTES AND COMMENTS

PARTS LIST

31001	Lower Head Cover
31002	Upper Head Cover
31003	Control Lever Assembly
31006	Rewind Lever Assembly
1009	Brake Release Cam
1010	Head Closure Cam
1011	Interlock Release Cam
1012	Pressure Roller Cam
1013	Spacer, Interlock Tumbler
1014	Spring, Interlock Tumbler
1023	Shaft, Coupling Spacer
1031	Brake Slide
1032	Brake Slide Spring
1034	Brake Adjust Tab
1035	Brake Cam Pawl
1036	Brake Slide Spacer
1037	Brake Cam Spacer
1041	Brake Lever, Take-Up
1043	Brake Lever, Supply
1045	Brake Arm Shaft
1046	Brake Felt Pad
1054	Pin, Microswitch Actuating
1055	Spacer, Actuator Slide
1059	Mounting Bracket, Control Switch
1065	Roller Assembly 1-1/2" dia.
1068	Pressure Roller Arm
1069	Pressure Arm Shaft
1075	Shaft, Interlock
31080	Record Button Assembly
1083	Sleeve, Record Shaft
1084	Collar, Record Shaft
1085	Spring, Record Shaft
1086	Tape Tension Roller Assembly
1089	Mounting Plate, Switch
1094	Detent Pin, Damper
1095	Spring, Damper
1098	Retainer, Detent Pin
31099	Tape Damper Shell Assembly
31102	Head Mount Bracket
31103	Tape Guide Bracket
1104	Head Clamp
1105	Head Clamp Spring
31111	Tape Engage Bracket
1112	Spring Retainer
1113	Spring
1114	Head Shield
1116	Slide, Tape Bracket
31120	Reelok
31130	Reel Motor Assembly
1131	Spindle Assembly
31137	Reel Flange
31141	Speed Change Knob
1142	Speed Change Shaft
1152	Bracket, Microswitch
T-7812	Power Transformer
K-100	Erase and Bias Oscillator Coil
M-102	Bias Adjust Control
M-104	Level Controls
M-106	Fader Control
M-110	Rheostat
R-102	Meter Switch
3U-100	Meter -O- 1 M. A. DC 4-1/2"
R-126	Speed Change Switch
R-128	Switch, Power/Standby
R-110	Cutoff Switch
R-114	Record Switch or Reeling Motor Control Switch
X-100	Speed Change Switch, Flexible Shaft Coupling
FB51	Torque Motor, Take-up
FB50	Torque motor, Supply
TWD-1	Bodine Drive Motor

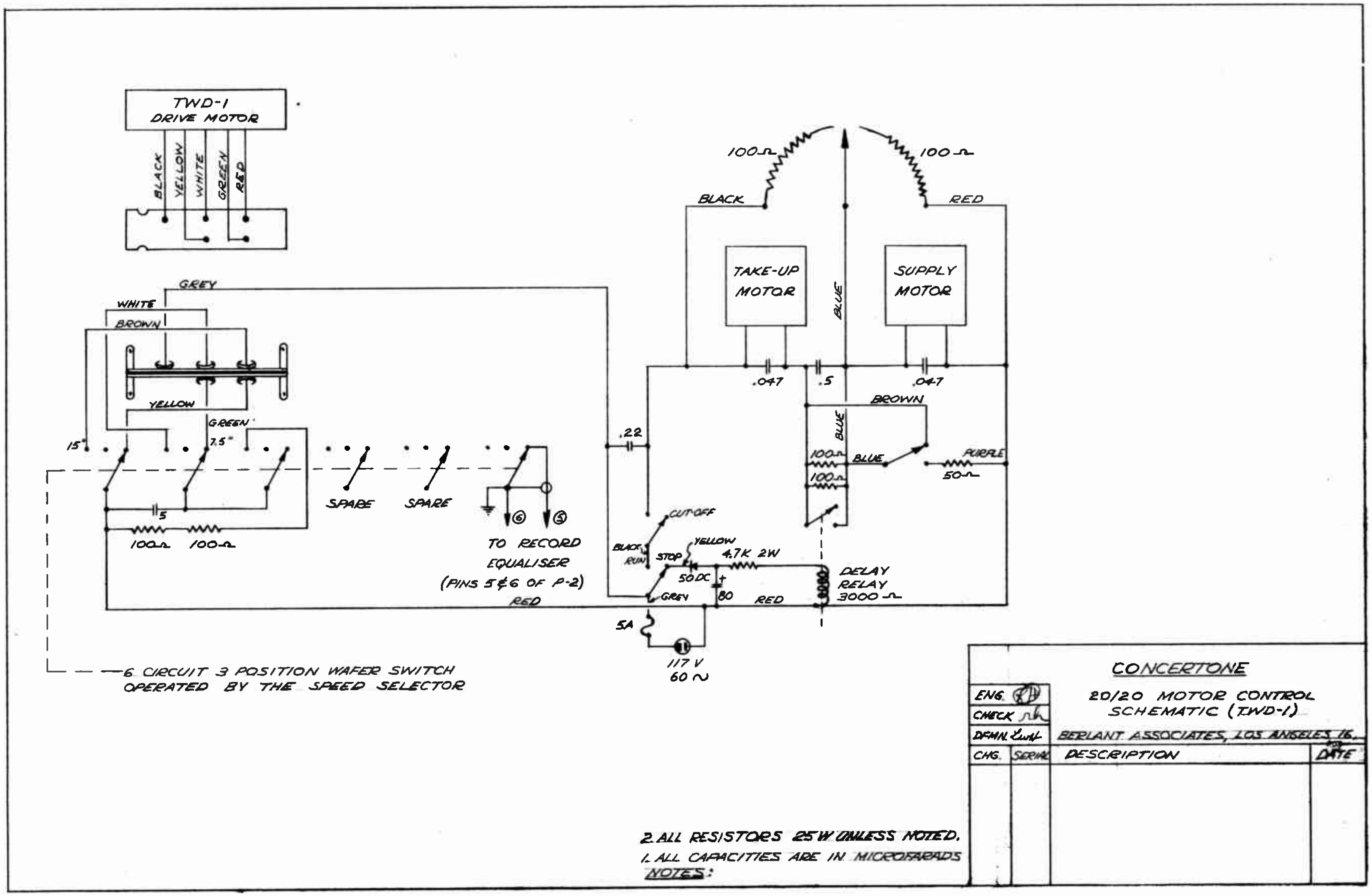


Fig. 8 SCHEMATIC, DRIVE TWD

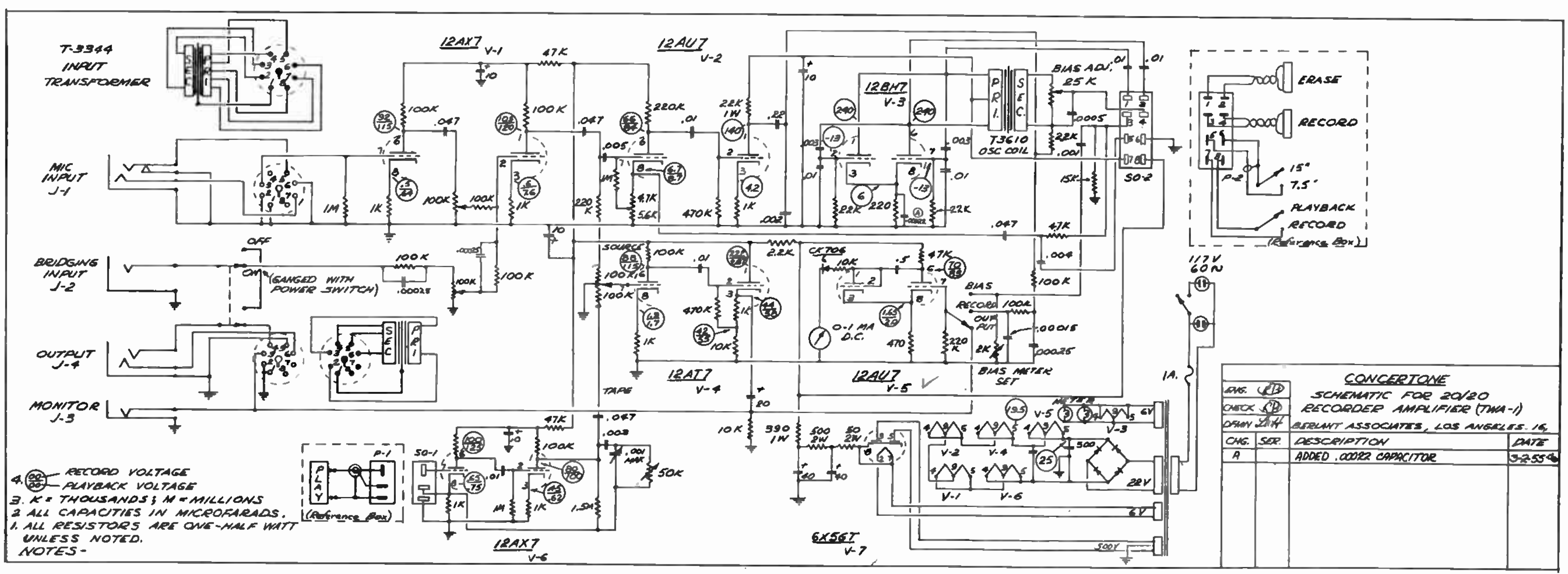


Fig. 9 SCHEMATIC, AMPLIFIER TWA

I - GENERAL INFORMATION

The Berlant Broadcast Recorder, Model BRX-1, consists of two sections: the Broadcast Recorder Drive Mechanism, BRX-D, and the Broadcast Recorder Amplifier, BRX-P.

The drive mechanism is assembled on a rigid ribbed aluminum plate, 19 inches wide and 14 inches high, designed for mounting on a standard relay rack, consolette or console, or into a portable carrying case. It may be operated in any position from vertical to horizontal. All mechanical and electrical functions necessary to the function of the tape drive are self-contained.

The amplifier contains all the elements necessary to supply the erase and record heads of the mechanism with power, and to amplify the signal from the playback head to meet the requirements of a 600-ohm zero level distribution line. The amplifier is assembled on a shock mounted chassis with a supporting framework 19" wide and 5-1/4" high, suitable for mounting on a standard relay rack or into a portable carrying case. A cable from the back of the drive mechanism connects to the amplifier by multiple pin connectors.

The drive mechanism accommodates all size reels up to and including the standard NARTB 10-1/2" professional reel. Instantaneous selection between 15 inches per second and 7.5 inches per second tape speed is provided, with automatic correction of equalization. Tape speed is governed by the SYNCHRONOUS DRIVE, an integrated combination of two speed hysteresis synchronous motor, flywheel, capstan, and air circulation blower constructed as a demountable unit.

Tape spooling is done by two capacitor start and run torque motors, rated for continuous duty. Each of these motors is mounted directly beneath the reeling spools and the centering spindle of the reel flanges is the extension of the motor shaft. There are no belts, rubber idlers, or clutches in the entire mechanism.

II. - SPECIFICATIONS

Tape Speeds:	Instant selection of 15"/Sec. or 7.5"/Sec.
Frequency Response:	± 2db from 40 to 15,000 cps at 15"/Sec. ± 2db from 50 to 13,000 cps at 7.5"/Sec. (down not more than 4db at 15,000 cps.)
Signal to Noise Ratio:	55db as measured by proposed NARTB standard (400 cps at 3% T.H.D.)
Total Harmonic Distortion:	2% at Zero V.U.
Timing Accuracy:	Better than 99.8%
Total Flutter and Wow:	Less than 0.1% RMS at 15"/Sec. Less than 0.2% RMS at 7.5"/Sec.
Rewind and Fast Forward:	Less than 60 secs. for 2500 feet
From Stop to 15"/Sec.:	0.1 second
Head Mounting:	Interchangeable Bracket mounting up to FIVE heads.
Meter Indication:	Bias current, record level, output level.
Monitor Output:	From tape or input signal.
Input Impedance:	One megohm on high impedance microphone input. 50/250 ohms balanced or unbalanced with plug-in transformer #T-3344 200,000 ohms unbalanced bridging input
Input Sensitivity:	55db on microphone input 0.1 volt on bridging input
Output Impedance:	Cathode follower. 600 ohms balanced output with plug-in transformer #T2560
Output Level:	6 volts from cathode follower output +4 DBM across 600 ohm line
Filament Supply:	D.C. on all filaments
Dimensions:	Drive mechanism, 14"x19" Mounting depth, 6" below panel Amplifier, 5-1/4"x19", mounting depth 6" below panel
Weight:	Drive mechanism 35 LBS. Amplifier 10 LBS.
Tube List:	2-12AX7; 1-12AT7; 2-12AU7; 1-12BH7; 1-6X5GT
Power Required:	160 Watts, 60 cycles, 115 volts

The Drive Mechanism, BRX-D, (Fig. 1) is mounted in relay rack, console, or carrying case by four #10-32 fillister head screws and washers. Four slots are provided on 11" x 18-1/2" centers to match standard rack mounting dimensions. Portable cases supplied by Berlant Associates are fitted with mounting studs to match.

Before mounting on relay rack or console, check for clearance of 10-1/2" reels over any ornamental trim or protrusions of the rack.

Insure an adequate flow of cool air for ventilation, with particular attention to air access for the Synchronous Drive (Fig. 5). When mounting the drive between the horizontal and 45° angle in a console, it is recommended that the panel be mounted on spacers to provide 1/8 inch clearance between the panel and the console, to prevent possible heat entrapment.

The Amplifier, BRX-P, (Fig. 2) is mounted by four fillister head #10-32 screws, using the decorative trim washers provided with the amplifier. Ventilation should be provided, as for any other electronic amplifier of similar size.

The amplifier and the drive mechanism may be mounted in any relationship permitting connection by the cables provided on the drive mechanism.

To secure maximum signal to hum ratio, the amplifier should be spaced 3-1/2" from the transport unit.

Connect the cables from the drive mechanism to the matching connections on the back of the amplifier chassis. Connect the power cable from the amplifier to a proper power source.

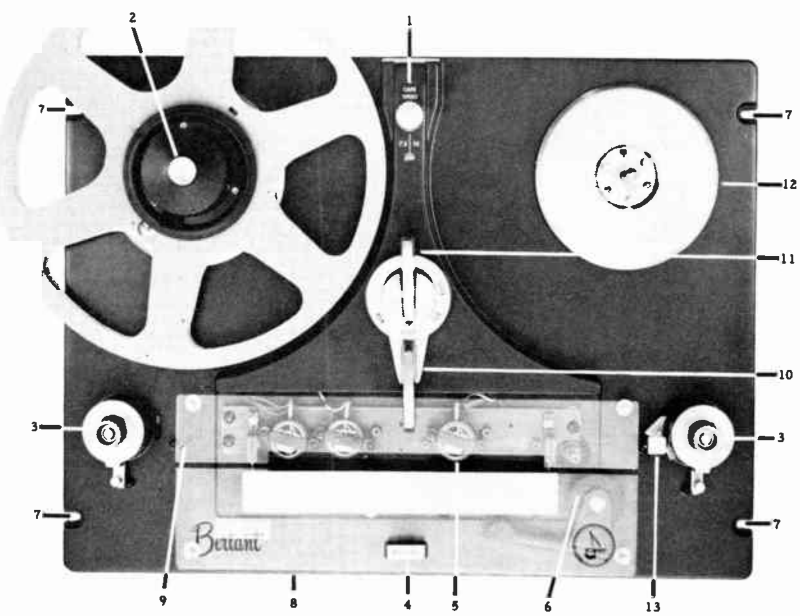


FIG. 1
DRIVE PANEL, FRONT VIEW (Head Covers Ghosted)

1. Speed Selector Switch
2. Reelok
3. Tape Tension Arms
4. Record Button
5. Head Assembly
6. Pressure Roller
7. Mounting Slots
8. Lower Head Cover
9. Upper Head Cover
10. Tape Drive Control Lever
11. Tape Spooling Control Lever
12. Reel Mounting Flange
13. Tape Motion Regulator

Connect input and output wiring as required, in accordance with instructions in Section X.

IV - DRIVE MECHANISM CONTROLS

The basic controls of the BDX-1 Drive Mechanism (Fig. 1) are concentrated in a dual lever system located at the approximate center of the panel.

1. Tape Drive Control Lever - normally pointing directly to the front of the panel. This lever has three positions in addition to the neutral "Stop." These are marked, "Run," "Cue," and "Edit."

2. Tape Spooling Control Lever - normally pointing directly to the rear of the panel. This lever swings 120^{o} each side of "Stop" to control speed and direction of fast-forward and rewind spooling of tape reels.

3. Speed Selector Switch - located at the back center of the panel. This knob controls speed and equalization of the tape in "Run" condition.

4. Record Button - a rectangular button in the front center of the head cover, controlling the "Record" and automatic erase function. This control is interlocked with the "Run" position of the Tape Drive Control Lever.

5. The Tape Drive Control Lever is interlocked with the Tape Spooling Control Lever, and actuating either lever automatically locks the other.

6. Tape Tension Arms - These are located at the right and left of the tape loading slot. They lock out of position while tape is being loaded. When engaged, they equalize tape motion and stop the recorder in the event of tape failure or at end of reel.

V - AMPLIFIER CONTROLS

The arrangement of controls on the amplifier panel (Fig. 2) is the result of extensive investigation into the simplest combination which will satisfy the widest professional requirements.

The Microphone Level Control is calibrated in 10 steps from 0 to 10, with maximum gain at 10.

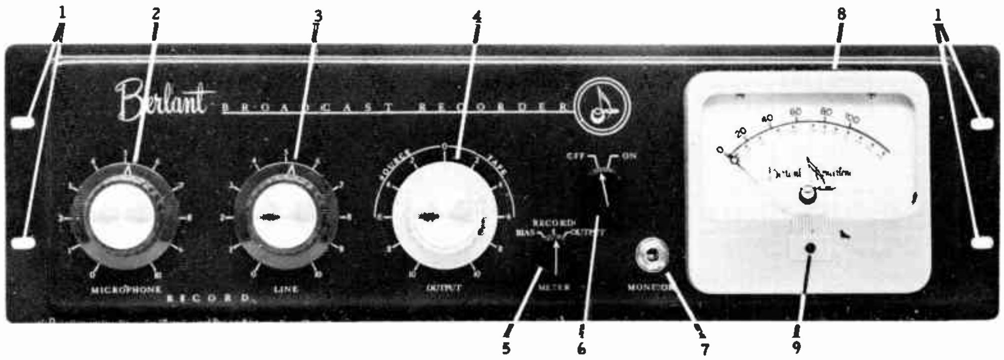
The Line Level Control is calibrated identically and controls the line record level independently of the Microphone Level Control.

From 0 at the center position, the Output Level Control is calibrated in five steps to 10 on each side. The scale to the left of center is marked "Source," and indicates the output amplifier gain directly from the incoming signal. The scale to the right of center is marked "Tape," and indicates the output from the tape.

The Meter Switch has three positions: "Bias," "Record," and "Output," to measure the output of each on the meter.

The Power Switch controls the 115 volt supply to both amplifier and drive mechanism, and is marked "Off" and "On." The illumination of the meter face indicates when the recorder is switched "On."

An optional feature, available with this amplifier upon request, allows the bridging input to be automatically connected through to the output jack when the Power Switch is in the "Off" position. This connection is shown by dotted lines in the electronic schematic, Fig. 9, page 25. Connected between a source (such as a preamplifier) and a power amplifier, the recorder may be by-passed by merely turning off the Power Switch.



1. Mounting Slots
2. Microphone Level Control
3. Line Level Control
4. Output Level Control
5. Meter Switch
6. Power Switch
7. Headphone Monitor Jack
8. Meter
9. Zero Adjust

FIG. 2 AMPLIFIER, FRONT VIEW

VI - TAPE LOADING PROCEDURE

The exclusive Berlant Concertone Reelok serves as a lock for RMA type hubs, and as a combination centering device and lock for NAB hubs. To lock either reel in place, proceed as follows:

1. Center the Reelok over the spindle and drive pins of the spooling flange.

2. See that flange fits snugly on reel.

3. Push in the center button of the Reelok as far as it will go.

To unlock the reel, press the release lever on the side of the Reelok. To load tape:

1. Set the Tape Drive Control and Spooling Control Levers to "Stop."

2. Load the full reel of tape on the supply flange, and fasten with Reelok.

3. Place the empty reel on the take-up flange, and fasten with Reelok.

4. Turn the left hand tape tension knob counter-clockwise, and the right hand tape tension knob clockwise until the tension arms lock on the detents.

5. Draw the free end of the tape around the supply roller, through the head slot, and around the take-up roller.

6. Fasten the end to the take-up reel.

7. Turn the take-up reel once or twice to fasten tape securely.

8. Release the tension arms to engage the tape.

For best results, the use of 10-1/2" reels is recommended.

VII - OPERATING PROCEDURE

With tape in place, the Tape Control Levers set at "Stop." and the Power Switch "On," turn the Speed Selector Switch to the desired tape speed.

To Make A Recording: Hold down the Record Button while moving the Tape Drive Control Lever to "Run" position. Turn the Meter Switch to "Record." Set the Microphone Level Control or the Line Level Control (depending upon which input is being used) to a point where the maximum signal peaks do not exceed 100 on the meter scale.

To Monitor The Recording: Turn the Output Level Control to the left to monitor the incoming signal; to the right to hear the signal being played back from the tape. This A-B comparison may be made without affecting the recording. The meter also may be switched to read output level after proper record level has been set.

At End of Recording: Return the Tape Drive Control Lever to "Stop." The Record Button will be released automatically, making accidental erasure impossible.

To Play Back A Recording: Move the Tape Drive Control Lever to "Run." Turn the Meter Switch to "Output." Turn the Output Level Control to the right ("Tape"), until the desired level is obtained. To end the playback, return the Tape Drive Control Lever to "Stop."

VIII - CUING AND EDITING

Fast spooling of the tape in either direction is governed by the Tape Spooling Control Lever. Tape speed may be varied as desired by rotating this control lever. A cue or edit spot is located in the following manner:

1. Determine the approximate location by manipulating the Tape Spooling Control Lever as indicated above.

2. Having found the approximate location, return the Tape Spooling Control Lever to "Stop."

3. Move the Tape Drive Control Lever to the left to the "Cue" position. (This wraps the tape around the heads, releases the brakes, and leaves the reel under motor tension.)

1. Return the Tape Drive Control Lever to "Stop" until the tape is to be played.

2. When the tape is to be played, turn the Tape Drive Control Lever to "Run."

When an exact editing spot is located in step 4 above, then:

1. Move the Tape Drive Control Lever from "Cue" to "Edit." (This applies the brakes and opens the head closure fully.)

2. Mark the tape with a grease pencil directly over the gap in the playback head, or

3. Scissors may be inserted, moved into position at the playback gap, and the tape cut accurately.

IX - CLEANING THE HEADS

The importance of clean contact between the heads and the tape cannot be overemphasized. This must be considered a part of operational procedure, rather than maintenance. In many recording studios the heads are cleaned before every recording is made or played back, but under average conditions cleaning heads each ten hours of use will give excellent results.

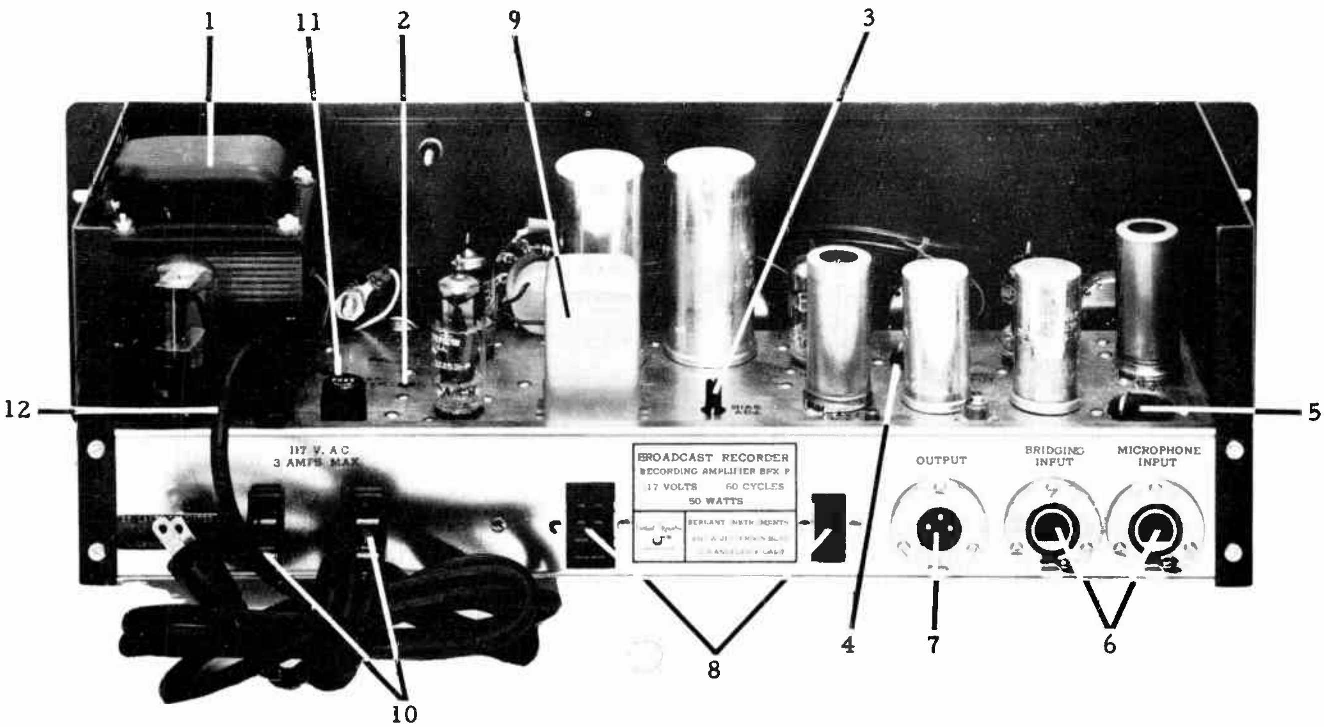
Before loading the tape, move Tape Drive Control Lever to "Edit." Dampen a clean piece of fabric, such as fine muslin, with alcohol and carefully wipe the pole pieces of the heads with the muslin wrapped across the ball of the index finger. It is not necessary to saturate the cloth. A small amount of alcohol is enough.

Occasional attention also should be paid to the capstan and pressure roller. Remove the lower head cover by grasping each end and pulling away from the panel. This casting, as well as the upper head cover, is located by two dowel pins anchored into the main plate. The covers are held in place by friction springs located inside the castings. With the cover removed, clean the capstan and the rubber pressure roller in the same manner as the heads. Replace the head cover by locating it on the two dowel pins and pushing it back in place. Make sure the Record Button is properly aligned to fit the opening in the cover.

Although slow decay characteristics are built into the circuitry to prevent magnetization of the heads, with resultant noise (hissing and crackling) and loss of high frequency response, it is wise to demagnetize the heads at the same time they are cleaned. Head demagnetizers are supplied by various manufacturers at very reasonable prices. They should be used in accordance with instructions. Always be sure the recorder is switched off when the demagnetizer is used.

X - INPUT AND OUTPUT CONNECTIONS

Two inputs are provided on the BRX-P amplifier (Fig. 3). The microphone input is a Cannon XL13 receptacle connected to an octal socket designed to permit adaptation to a wide variety of inputs by plug-in transformers and other accessories. With the socket strapped for continuity, the input is for a high impedance (1 megohm) microphone.



1. Power Transformer
2. Bias Meter Set
3. Bias Level Adjust
4. Output Transformer Socket
5. Input Transformer Socket
6. Input Cannon Receptacles
7. Output Cannon Receptacle
8. Connectors to Heads
9. Erase Oscillator Coil
10. Power Outlets
11. Fuse Post
12. Power Cord

FIG. 3 AMPLIFIER, TOP AND REAR VIEWS

For 50/250 ohm balanced and unbalanced microphones and other low level sources, refer to connection diagrams shown in Fig. 4.

The 200,000 ohm bridging input is designed for connection to standard high impedance, phono level lines, or to bridge unbalanced studio lines, or to bridge from one side to ground of balanced lines.

The output connection is by an XL14 Cannon receptacle coupled to the output tube through an octal socket and accommodating a plug-in transformer to convert the output from a cathode follower giving a 2 volt signal to a 600 ohm balanced line zero DBM signal.

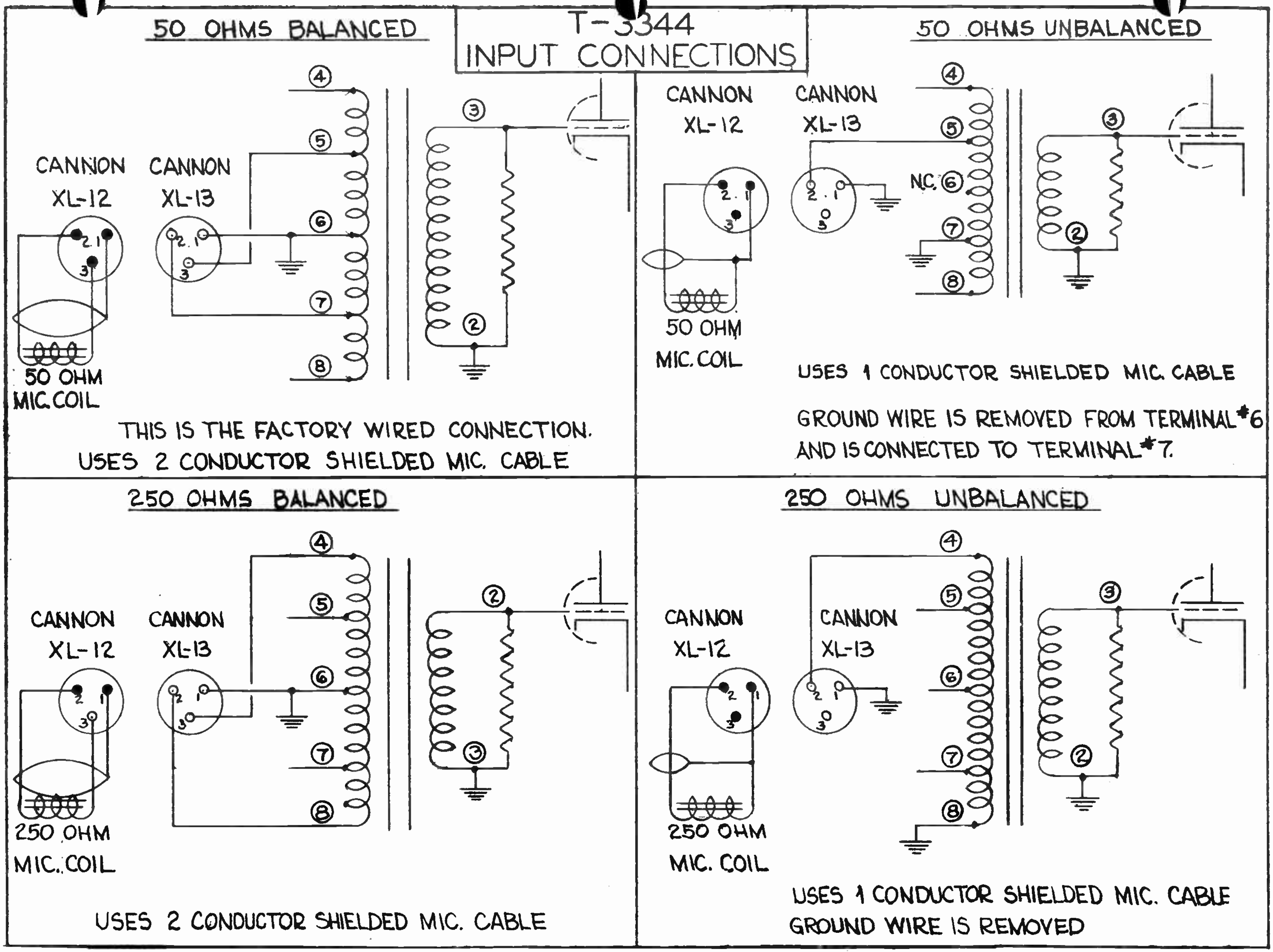


FIG. 4 INPUT CONNECTIONS

XI - METER SWITCH

The fourth knob from the left on the amplifier panel (Fig. 2) is marked "Meter." This knob switches the meter circuit to read any of three positions.

The first position, marked "Bias," reads the value of bias current being supplied the record head, as a means for rapidly determining the proper operation of erase and record circuits when all circuits are working properly. The meter should read 100 on the scale if properly set in accordance with instructions in the maintenance section of this manual.

In the second position, marked "Record," the meter reads the modulation level of the audio signal being recorded. On the scale, 100 represents the point at which a steady 1000-cycle signal enters the toe of the distortion curve, due to overload of the magnetic coating of the tape. A recording made at this point and played back at zero level output will have a total harmonic distortion content of 1 to 1.5%. An intermodulation distortion test (SMPTE) signal at the same level will give a reading below 3%.

In the third position, "Output," the meter indicates the signal level at the output of the amplifier, and at the monitor jack on the face of the amplifier panel.

XII - OUTPUT LEVEL CONTROL

The third knob from the left is marked "Output," and controls the level and origin of the signal at the output receptacle. Turning the knob to the left from the center zero position, into the area marked "Source," picks up and amplifies the signal being fed into the recorder. Turning the knob to the right from zero position into the area marked "Tape," picks up and amplifies the signal being played back from the tape.

XIII - RECORD LEVEL CONTROLS

The first knob on the left is marked "Microphone," and controls the level of the signal being recorded on the tape. The record amplifier is activated by the Record Button on the drive mechanism, and will be effective, as will the record function of the meter, only when the Record Button on the drive mechanism is depressed. To pre-set record level while tape is not in motion, hold this button down and set Microphone Level Control to the level desired, using the meter as an indicator.

The second knob on the left is marked "Line" and controls the level of the bridging input signal being recorded on the tape.

Both controls are independent and <u>may be used to mix two signals</u> on the tape.

When using the bridging input only, the Microphone Level Control should be turned to "Zero" to avoid excessive hum pick-up when a microphone is not connected.

I - BIAS LEVEL ADJUSTMENT

Recorded signal level, distortion, and frequency response are all affected by bias level. The bias level is set at the factory to give optimum results on red oxide, plastic base tape. The meter reading at "Bias" position has been adjusted to read 100 for this bias setting. Aging of components and other factors may cause the bias level to change.

Procedure for resetting bias level to restore optimum performance, or to obtain the best results from a specific brand or type of tape is as follows:

1. With the recorder off, zero the meter by the screw adjustment on the front.

2. Turn the record amplifier on and run for at least ten minutes, until all electronic components are at operating temperature.

3. Feed a 1000-cycle note into the recorder, setting a record level of 80 on the meter.

4. Switch the meter to "Output." Set output level to give any convenient reference reading on the meter.

5. Turn bias adjust control (Fig. 3) on amplifier chassis counter-clockwise, decreasing bias.

6. Slowly return bias adjustment control clockwise, as you watch the output meter. Increase bias slowly, until meter reaches maximum reading, and begins to fall. Continue increasing bias until meter indicates decrease of 1/2 to 1 DB in output of tape. Remember there is a time delay of 1/10 second between record and playback functions.

This represents the optimum setting for general recording purposes. The reason for going past maximum response is to establish a safety margin for variations in tapes and operating conditions.

Reducing the bias below optimum increases high frequency response and also distortion. Increasing the bias beyond this point decreases high frequency response and distortion.

II - BIAS METER SET

Following the bias level adjustment, the meter reading should be checked, and if necessary, reset to give a reference reading of 100 for purposes of checking bias level from time to time.

The meter reading may be reset to 100 by the screwdriver adjustment on the chassis (Fig. 3), marked "bias meter set."

III - FREQUENCY RESPONSE CHECK

In music, substantially all frequencies above 5000 cycles are overtones of fundamental notes of lower frequency. These overtones are of greater diminished amplitude than the fundamental notes. The amount of pre-equalization required in a wide range recording amplifier to correct for tape characteristics is considerable. Consequently, it is necessary to run frequency checks at very low input levels so that the full equalization can be realized within the limits of the overall gain of the amplifier.

Berlant Recorder equalization follows closely the NARTB standard, and because of the nature of power distribution in the musical spectrum as stated above, faithful reproduction will result if the following frequency check method is followed:

1. The equipment required is an audio oscillator and an audio frequency millivoltmeter capable of reading the audible spectrum. These two instruments should be checked together to determine their combined correction factor.

   The output of the audio oscillator should be free of hum and noise in order to obtain correct readings.

2. Connect the audio oscillator output to the bridging input of the amplifier. Recording a 1000-cycle signal, adjust the controls until the meter on the amplifier reads minus twenty with the Meter Switch in the "Record" position.

3. Connect the output of the amplifier into the audio voltmeter.

4. Record various frequencies such as: 50, 100, 1000, 10,000, 15,000 cycles for a period of around three to five seconds each.

5. Playback the recorded frequencies with the amplifier Output Level Control set on "Tape" at such a point as to give around .5 volts on the audio voltmeter. Correct the output readings by the amount determined in step one.

IV - HEAD ALIGNMENT PROCEDURE

If frequency response on the recorder becomes deficient, and it is not due to dirt on the heads, worn heads, or excessively high bias adjustment, misalignment of the heads may be the cause.

To align the playback head, first remove the head cover castings, then clean and demagnetize heads, capstan and pressure roller. Load the recorder with a standard alignment tape, which is available from your distributor. Run the recorder at 15 inches per second tape speed. Turn the Meter Switch to "Output" and the Output Level Control to a point on the "Tape" scale to give any convenient reference reading on the meter from the 12kc signal.

Slowly turn the adjustment screw on the playback head. If the meter reading goes down, turn the screw in the other direction. If the meter does not go beyond the reference reading during this process, the head does not need adjustment.

To align the record head:

Method A. Turn the output gain down to 0, disconnect the record head leads, and transfer the playback head leads to the record head. This head will now function as a playback head during the adjustment. Repeat the above alignment procedure for the record head. After adjustment is completed, return the leads to their original positions.

Method B. Replace the standard alignment tape with a reel of blank tape, and operate the recorder in record position while feeding in a 12 KC signal from a signal generator, at a level of minus 20 DB. Set playback level to give any convenient reference reading on the meter, and align the record head as the playback head was aligned. (Remember, there is a time lag of a fraction of a second while the tape is moving from the record to the playback head.)

Adjust the record head until the maximum response is obtained from the playback.

V - PRESSURE ROLLER ADJUSTMENT

There are two adjustments on the pressure roller mount and arm. These may need resetting after replacing a pressure roller, or to compensate for wear on it.

If the pressure roller has been replaced, the first adjustment to be made is to parallel the face of the roller to the drive capstan. Loosen the cap screw on the end of the arm, and align the roller until it is vertically parallel to the capstan. Tighten the cap screw until it is solidly seated.

Next loosen the lock screw at the center of the roller bracket and adjust for lateral displacement. The center of the pressure roller should be about 1/8" to the right of a line through the center of the capstan. The bracket must be adjusted by rotating it around the lock screw as an axis until the pressure roller will run in contact with the capstan with no skew action. Tighten set screw until it is seated solidly.

VI - TENSION ARM ADJUSTMENT

The tape tension arms (Fig. 1) have a dual function: they serve to eliminate tape slack while absorbing small reeling irregularities, and to turn off the recorder mechanism if the tape is broken or exhausted.

If the tension is too great, the cut-off switch will be actuated unnecessarily. If the tension is not great enough, the cut-off switch will not actuate.

To readjust the tension, loosen the lock nut on the screw protruding (below the panel) through the boss supported by three ribs. (Fig. 5) Turn the screw in the direction of spring actuation to increase tension, or in the opposite direction to decrease tension. Then tighten the nut to lock.

VII - BRAKE ADJUSTMENT

There is only one adjustment on the brake assembly. (Figs. 5 & 6) This is a single bracket fastened to a slider arm by two lock screws, activated by the brake cams on the function control lever shaft.

To Adjust: With the recorder off, place the Tape Drive Control Lever in "Run." Loosen the two brake adjust lock screws and move the brake adjust bracket back until the brake arms are lifted clear of the brake drums by 1/16 inch. Tighten the brake adjust lock screws until firmly seated. Return Tape Drive Control Lever to "Stop," and turn Tape Spooling Control Lever to each side. As the brake drums revolve, check to insure clearance of brake arm pads from drums.

VIII - LUBRICATION

To insure maximum trouble free operation, self-lubricating bearings have been used wherever possible. Normal maintenance lubrication is required only on the two spooling motors.

Place 5 drops of Gulfcrest A or Standard C oil in both oil holes on each motor after 500 hours of operation or at three-month intervals. After operating the recorder, remove any excess oil that is forced out of the bearings by the initial run.

The Synchronous Drive requires lubrication only once a year. Details of this procedure will be found under Section III of Repairs and Service.

IX - FUSES

The amplifier is protected by a quick change fuse mounted in a fuse extraction post on the back of the amplifier. The drive mechanism is protected by a similar unit on the top of the wiring terminal housing on the back of the recorder.

Replace fuses ONLY with fuses of the same type and size. Otherwise the equipment is not properly protected against damage.

Fuse failure is an indication of either excessive voltage, wrong type of current supply, or malfunction within the equipment, and the cause of failure should be investigated before replacement.

C. REPAIRS AND SERVICE

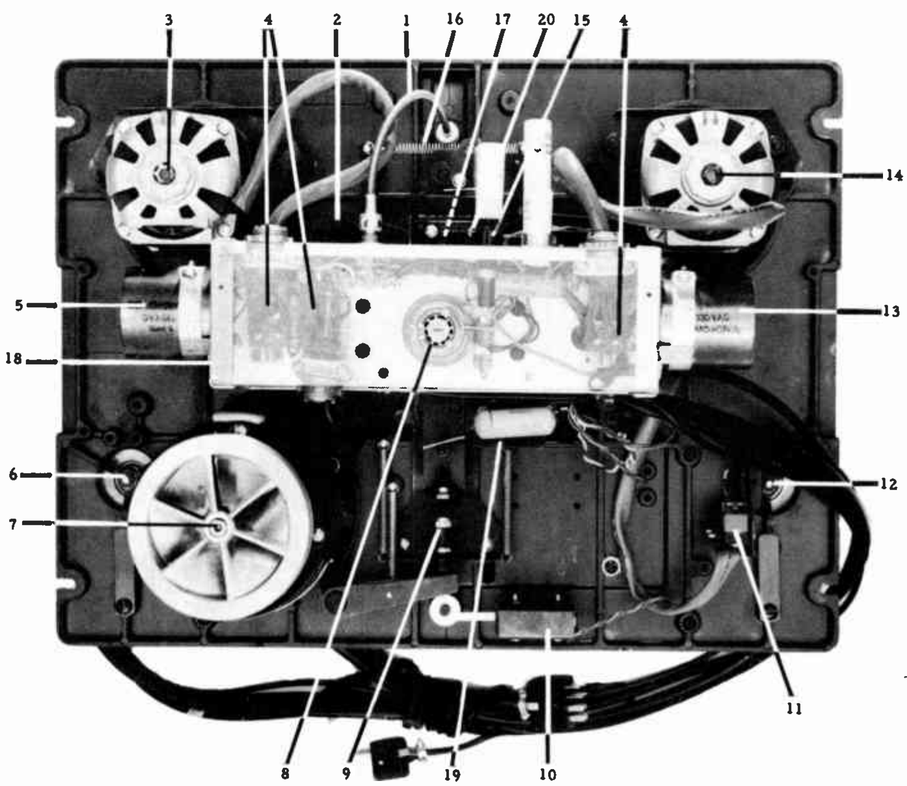
Because the Berlant Broadcast Recorder completely eliminates all clutches and/or belts in driving and spooling tape, service problems are greatly simplified.

If malfunctions are not corrected by the adjustments outlined in the section on maintenance, the following information will guide the service man in locating and repairing the defect.

I - DRIVE CONTROL CIRCUITRY

By removing the dust cover on the control chassis (Fig. 5), access is obtained to all voltage points necessary to check proper electrical functioning of the drive mechanism. The circuit diagram gives voltage readings for various conditions of operations.

If the readings in "Run" position are the same as for "Stop" position, check the operation of the microswitch, S_1. The switch should actuate before motion of the Tape Drive Control Lever to "Run" position is completed.



1. Speed Change Control Cable
2. Brake Arm
3. Take-up Motor
4. Motor Disconnect Plugs
5. Drive Motor Capacitor
6. Tape Tension Adjust Lock Nut
7. Synchronous Drive
8. Tape Control Cam Assembly
9. Pressure Roller Adjust
10. Record Switch
11. Cut-off Switch
12. Tape Tension Adjust Lock Nut
13. Spooling Motors Capacitor
14. Supply Motor
15. Fuse Post
16. Brake Tension Spring
17. Brake Adjust Tab Lock Screws
18. Junction Box Cover
19. Microswitch, S_1
20. " S_2

FIG. 5 DRIVE PANEL, REAR VIEW (Junction Box Ghosted)

II - SPOOLING MOTOR REMOVAL

With the recorder detached from the power source, remove dust cover from the control chassis and unplug the motor connector. Release the cable clamps by loosening the castellated nut. Remove the reel mount flange plate by taking out the three screws. Remove the three nuts holding the motor mounting plate, and remove the motor from the mechanism.

Do not disturb the setting of the nuts between the motor mounting plate and the main mechanism panel, or it will be necessary to readjust for reel height and alignment. If the spindle is removed from the motor shaft, it must be replaced exactly or the height of the motor mounting plate must be readjusted.

Replace all components in reverse order. Height and alignment adjustment is by the nuts between the motor plate and the main panel. When properly set, the tape will spool accurately between reel flanges, and the reel will be parallel to the surface of the main plate.

III - SYNCHRONOUS DRIVE

The Synchronous Drive (Fig. 5) is removed by unplugging the motor connector and removing the four bolts holding the drive to the underside of the main panel.

Important Note: The Synchronous Drive should be disassembled only by persons thoroughly familiar with precision assemblies, and under conditions of extreme cleanliness. Dirt introduced into the bearings can ruin them.

Lubricate the drive motor by placing 5 drops of 10 SAE motor oil in each of the two oil holes. This lubrication is to be performed only once a year.

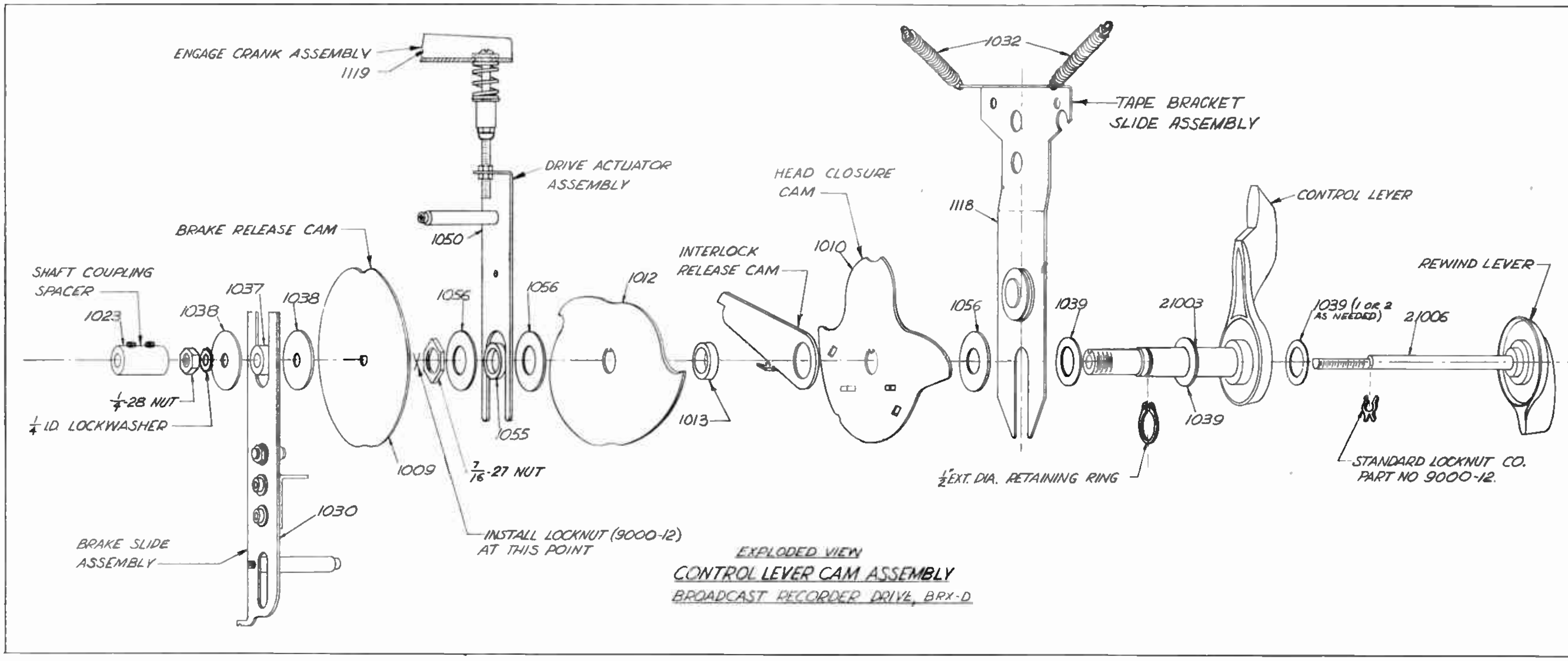


FIG. 6

IV - CONTROL CAM ASSEMBLY

To service cam assembly (Fig. 5), disconnect head leads and unfasten cut-off switch. Remove control chassis dust cover and unplug all three motor connectors. Loosen fastening on shaft coupling between rewind control lever shaft and rheostat on control chassis. Loosen lock screw of flexible shaft coupling to speed selector switch and release from shaft. Remove four screws holding chassis to mounting bracket and lift chassis clear of panel. Access to the cam assembly is now possible.

The exploded view of the cam assembly (Fig. 6) shows the proper order and relationship of cams, followers and spacers. The lock rings are released by squeezing the protruding fingers. After disassembly is completed, the control levers may be lifted out of the panel from the top. The shafts are pressed into the levers, and cannot be removed from them.

Reassemble in reverse order, and make any necessary adjustments of brake and tape pressure roller assemblies. Rheostat must be centered in run position.

V - TAPE TENSION ASSEMBLIES

Each tape tension assembly (Fig. 1) may be taken down by removing the lock nut holding the assembly to the main panel, then lifting roller and tension arm from the top of the panel. Note the location and order of spacers, washers and spring assembly. The bearings in this mechanism are dry bearings, and no lubrication should be used. Cleanliness must be observed on reassembly. Readjust tension in accordance with maintenance service instructions.

VI - HEAD MOUNT GUIDES

The head mount guides may be replaced, if worn, or rotated to present a fresh surface by loosening the lock screw on the side of each guide. The guide may be moved forward or backward by loosening the screw clamping it to the head mount. This controls the amount of wrap of the tape around the heads. Both guides must be set to keep the head shield mount parallel to the head mount. Distance from the front edge of the head mount plate to the front bottom edge of the shield mount should be about 1/16" to give proper wrap of tape on heads. Guides must be seated within the groove on head mount plate, and firmly fastened, otherwise tape will not align properly.

VII - DISCONNECT SWITCH OPERATION

Microswitch S2, operated by the brake slide assembly serves to reduce reeling motor current during the stop condition. Whenever the brake slide is operated, the switch shorts out the 250 ohm resistor in series with the reeling motors. Failure of the switch to operate properly would be indicated by poor take-up or weak rewinding.

VIII - NOTES AND COMMENTS

D. ELECTRONIC SERVICE DATA

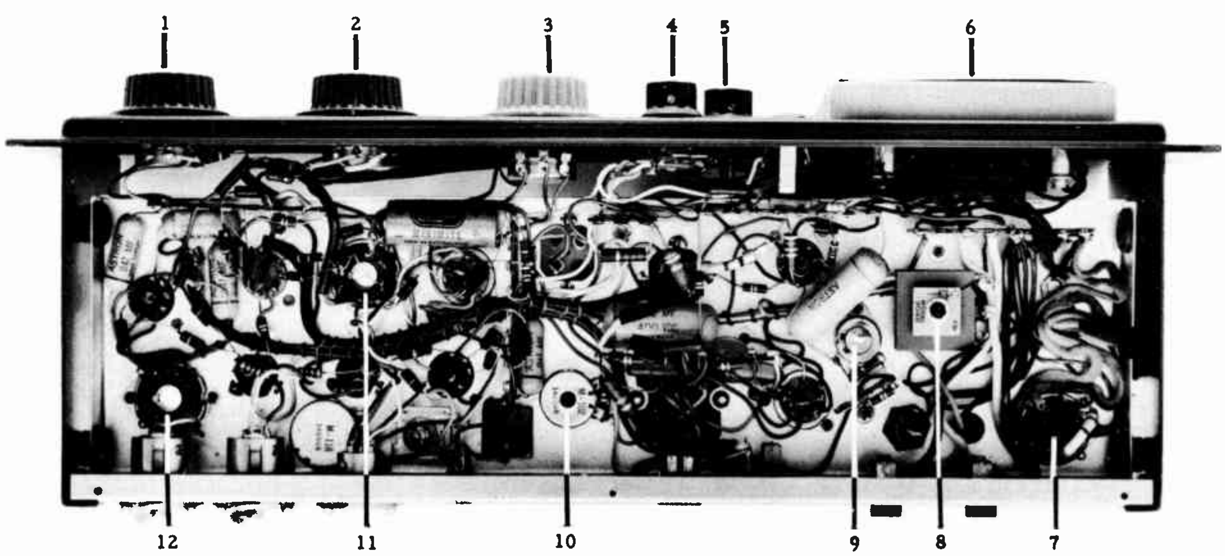
The Broadcast Recorder Amplifier BRX-P, complete with power supply, is mounted on a 5-1/4" x 19" relay rack panel and performs the following functions:

Record Amplification
Playback pre-amplification
Output amplification
Erase and bias generation
Bias level indication
Record level indication
Output level indication

(A schematic diagram of the electronic circuitry is pasted inside the dust cover of the amplifier BRX-P.)

I - POWER SUPPLY

This supply is conventional with the exception of the D.C. heater supply for the low level tubes. A full wave bridge selenium rectifier and a 22-volt winding on the power transformer furnish approximately 24 volts D.C. to the 500 MFD filter capacitor. All the low level tube heaters are in series parallel across this 24 volt supply.



1. Microphone Level Control
2. Line Level Control
3. Output Level Control
4. Meter Switch
5. Power Switch
6. Meter
7. B+ Rectifier
8. Filament Rectifier
9. Bias Meter Set
10. Bias Adjust Potentiometer
11. Output Transformer Socket
12. Input Transformer Socket

FIG. 7 AMPLIFIER, BOTTOM VIEW

II - BIAS AND ERASE OSCILLATOR

V3, a type 12BH7 dual triode, is used in this circuit as a balanced Colpitts oscillator. Bias current for the record head is taken out of a secondary winding through the bias current control. Erase voltage is taken from the two plates through coupling capacitors to the erase head. Aside from the bias current adjustment there are no adjustments on the bias oscillator.

Frequency of oscillation will vary in the vicinity of 55 KC, depending on components.

III - RECORD AMPLIFIER

This portion of the amplifier uses two dual triode tubes in cascade to raise the input signal from microphone level to a level sufficient to drive the record head. V1, - type 12AX7, is coupled to input signals through two connectors. (Both stages of V1 are connected as conventional triode amplifiers.) The first V1A connects to a 3-contact microphone input through an octal socket labeled T-3344. Coupling to various inputs is described in the Instruction Manual, X. The output of this stage is fed to the grid of the second stage, as is the 200,000 ohm unbalanced bridging input, through the Line Level Control potentiometer.

The output of V1 is used to drive a two stage feedback amplifier consisting of the two triode sections of V2. Equalization is controlled by the feedback voltage generated across the 15,000 ohm resistor in the ground return lead of the record head. The amount of voltage fed back at each frequency to the V2a cathode is determined by the reactive elements in the feedback loop. The result is a record current curve which increases with frequency from a thousand cycles up. When the recorder is being used at 7.5 inches per second a .004 mfd capacitor is connected across the first cathode of V2 to provide increased rise at 15 KC. When the speed is 15 inches per second, the .004 mfd capacitor is not used. This switching is done automatically when the speed is changed.

IV - PLAYBACK PREAMPLIFIER

The very low output of the playback head is brought up to usable level by V6, type 12AX7. This tube is connected as a two-stage feedback amplifier with bass boost determined by the feedback path. The ratio of resistance and capacitance determines the playback response curve. The gain of the amplifier is inversely proportional to frequency up to approximately two kilocycles. Beyond that point the gain is controlled by the setting of the 15 KC adjust.

The lead connecting the playback head to the amplifier is of double shielded construction. The inner shield is driven by the voltage developed across V-6A cathode resistor. The function of the driven shield is to minimize the capacity effect inherent in the cable. Without the driven shield arrangement, the playback head would self resonate in the audio band causing poor response characteristics.

V - OUTPUT AMPLIFIER

The signal from V6 is fed to one side of a center tapped 200,000 ohm potentiomater. The center tap is grounded, and the other side is bridged across the output of the record preamplifier stage, V16. The variable tap of the potentiometer acts as a fader control feeding the grid of the first stage of V4, type 12AT7, connected as a conventional voltage amplifier. The second stage of V4 is a cathode follower feeding the output receptacle through strapped octal socket, labeled T-2560. Removing the straps and plugging in the matching transformer converts the cathode output to a 600 ohm balanced zero level line output.

Capacity of a shielded line has very little effect on the output and can be run as far as several hundred feet, if needed.

VI - METER CIRCUITRY

Metering is by a V. T. V. M. circuit using V5, type 12AU7, as an extremely stable amplifier and vacuum tube voltage doubler rectifier. The first stage is operated as a conventional triode; the second stage is diode connected, with the cathode biased by the voltage drop across the cathode resistor of the first stage. Voltage doubler rectification is by a germanium diode, CK-705. The selector switch connects the grid of the VTVM to the various circuits to be metered. The record circuit is bridged at the plate of V2B, the bias signal is trapped out by an RC network consisting of two 100K resistors, a .00025 and a .00015 capacitor, to eliminate bias leakage affecting the meter. The bias circuit is bridged at the return of the record head circuit through a .001 capacitor. A 2000 ohm variable resistor permits setting the meter reading to 100 for the value of bias required by the tape, giving a standard reference point in checking bias circuit operation. The output circuit is bridged at the cathode of the cathode follower output stage V4b.

VII - COMPONENTS

Several facts should be noted about the components used in this amplifier. The resistors in the cathode and plate circuits of the first and second record and first and second playback stages are of the deposited carbon variety. These resistors are very quiet. In case one of them should ever have to be replaced, the replacement must be of the same type. Ordinary composition resistors will bring up the hiss level.

The capacitors used in the bias oscillator have been matched in production to within five per cent to preserve symmetry. The actual value of the matched pairs is not critical since the bias frequency is not critical. It is important, though, that the positive and negative halves of the bias waveform be identical.

VIII - FREQUENCY RESPONSE

Technicians unfamiliar with tape recorder techniques frequently make response tests and, due to incorrect methods, condemn the recorder as not having high frequency response even though their ears are satisfied with the music they hear. This common error is due to ignorance of the equalization scheme required to make a high fidelity magnetic tape recorder work. It is common practice to record with a rising record current versus frequency curve in order to keep hiss down to a satisfactorily low level. This is true of disc recording as well and fortunately is quite compatible with the energy content of most music.

Bearing this pre-emphasis in mind, it can be seen that a 15,000 cycle signal strong enough to saturate the tape will require a much lower level input than will a 1,000 cycle signal for the same amount of saturation. If both signals were fed in at the level required for full modulation at 1,000 cycles, the 15,000 cycle signal would be saturated at an early stage and the pre-emphasis would be nullified. The result would be apparently poor high frequency response. On the other hand, if the response check were made at a level twenty db lower, the response would be excellent.

The BRX-P amplifier incorporates two adjustments in the playback amplifier. The 5 KC adjust pot is used to set the mid-range response with respect to the low frequencies. In order to achieve a compromise between the two speeds without using complicated switching, the 5 KC adjust is set so that at 7.5 the 5 KC response is down 1.5 DB with respect to 1 KC. With this setting the 5 KC response at 15" will likely show a 1.5 to 2 DB rise. A similar compromise is made at 15 KC, using the 15 KC adjustable trimmer. If one speed is to be used predominately, the adjustments can be made to favor the desired speed.

IX - VOLTAGE POINTS

Two voltages are given for each important point on the schematic. The upper is valid if the Record Button is down, the bottom value applies otherwise.

X - NOTES AND COMMENTS

PARTS LIST

21001	Lower Head Cover
21002	Upper Head Cover
21003	Control Lever Assembly
21006	Rewind Lever Assembly
1009	Brake Release Cam
1010	Head, Closure Cam
1011	Interlock Release Cam
1012	Pressure Roller Cam
1013	Spacer, Interlock Tumbler
1014	Spring, Interlock Tumbler
1023	Shaft, Coupling Spacer
1031	Brake Slide
1032	Brake Slide Spring
1034	Brake Adjust Tab
1035	Brake Cam Pawl
1036	Brake Slide Spacer
1037	Brake Cam Spacer
1041	Brake Lever, Take-up
1043	Brake Lever, Supply
1045	Brake Arm Shaft
1046	Brake Felt Pad
1054	Pin, Micro-Switch Actuating
1055	Spacer, Actuator Slide
1059	Mounting Bracket, Control Switch
1065	Roller Assembly, 1-1/2" Dia.
1068	Pressure Roller Arm
1069	Pressure Arm Shaft
1075	Shaft, Interlock
21080	Record Button Assembly
1083	Sleeve, Record Shaft
1084	Collar, Record Shaft
1085	Spring, Record Shaft
1086	Tape Tension Roller Assembly
1089	Mounting Plate, Switch
21099	Tape Damper Shell Assembly
1094	Detent Pin, Damper
1095	Spring, Damper
1098	Retainer, Detent Pin
21102	Head Mount Bracket
21103	Tape Guide Bracket
1104	Head Clamp
1105	Head Clamp Spring
21111	Tape Engage Bracket
1112	Spring Retainer
1113	Spring
1114	Head Shield
1118	Slide, Tape Bracket
21120	Reelok
1130	Reel Motor Assembly
1131	Spindle Assembly
21137	Reel Flange
21141	Speed Change Knob
1142	Speed Change Shaft
1152	Bracket, Micro-switch
T-7812	Power Transformer
K-100	Erase and Bias Oscillator Coil
M-102	Bias Adjust Control
M-104	Record Level Controls
M-106	Fader Control
M-110	Rheostat
R-102	Meter Switch
2U-100	Meter, 4-1/2"
R-112	Speed Change Switch
R-114	Record Switch or Reeling Motor Control Switch
X-100	Speed Change Switch Flexible Shaft Coupling
BHD-2	Synchronous Drive (with plug)
RTM-1	Torque Motor, Take-up or Supply
M-130	2000 ohm Bias Meter Set
	Capacitor 2.5 mfd

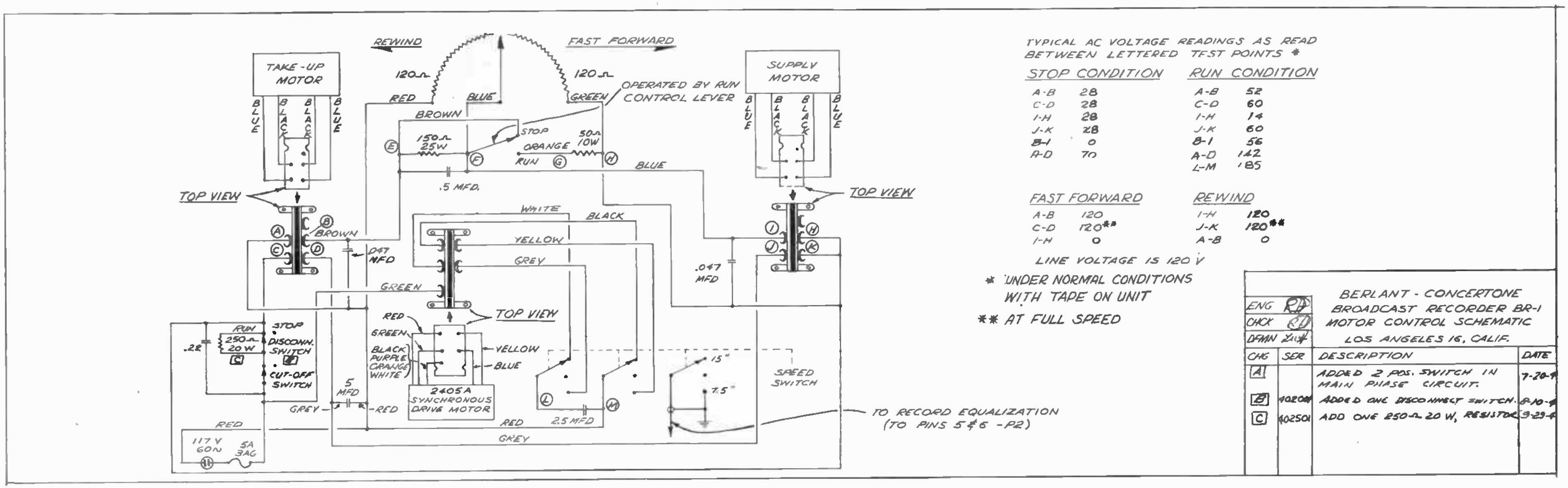


FIG. 8 SCHEMATIC, DRIVE BRX-D

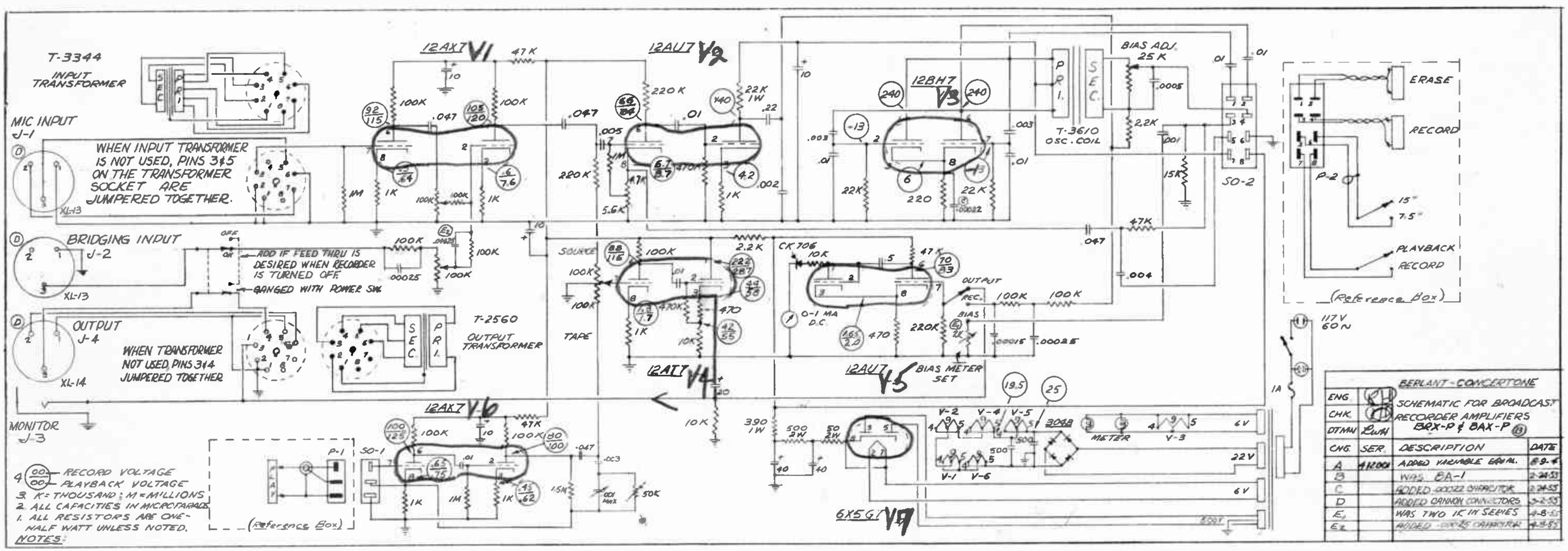


FIG. 9 SCHEMATIC, AMPLIFIER BRX-P

WARRANTY

The CONCERTONE 20/20 TAPE RECORDER is fully guaranteed against defects in material or workmanship for a period of 90 days from date of purchase.

Under this warranty, Berlant Concertone agrees to replace any part which, when examined at the factory shall prove to have been defective. This warranty does not cover tubes or any Recorder which has been tampered with or altered outside the factory, or which has been subject to misuse, accident, or abuse, or on which the serial number has been altered or removed.

Before returning any Recorder or Parts, please write us for instructions. All shipments must be prepaid.

To protect your rights under the factory warranty, you must fill out and mail the enclosed card immediately on receipt of your Concertone Recorder. This Warranty is in lieu of all others, express or implied, and does not take effect unless the Warranty Request Card supplied with each Recorder is properly filled out and returned to us.

BERLANT CONCERTONE

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