NAVSHIPS 365-2620

TECHNICAL MANUAL

RECORDER-REPRODUCER SET, SOUND

TYPE AN/UNQ-7A

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MAGNECORD DIVISION OF
MIDWESTERN INSTRUMENTS, INC.
Tulsa, Oklahoma

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GENERAL DATA

MAGNETIC TAPE RECORDER-REPRODUCER

DIMENSIONS:	20-1/2 inches wide x 17 inches deep x 24 inches high
WEIGHT:	156 lbs.
INPUT POWER REQUIREMENTS:	115 volts
	60 cps
	375 watt

SPECIFICATIONS:

TAPE SPEED-	3.75- 7.5- 15 inches per second
TAPE SIZE-	1/4 inch
FREQUENCY RESPONSE-	50 cps to 4000 cps (±3db) at 3.75 inches per second
	50 cps to 10,000 (±2db) at 7.5 inches per second
SIGNAL-TO-NOISE-RATIO-	40 db
DISTORTION-	2% Total Harmonic Distortion
RECORDING METHOD-	Dual Track

INPUTS-

Channel A mike	150 ohms	-25 dbm
Channel A bridging	200,000 ohms	15 volts
Channel A line	600 ohms	+20 dbm
Channel B (sonar):		
Bridging	30,000 ohms	.56 volts
Line	600 ohms	0 dbm

OUTPUTS-	On watt across eight ohms available on terminal boards and front panel jacks.
METERING-	Record level measured on 2 V.U. meters.

GENERAL DATA

HEADS-	One dual track record head, one dual track reproduce head; and one full track high frequency erase head.
PLAYING TIME-	60 minutes, maximum, with a 1200 foot reel of tape at 3.75 in/sec.
REMOTE CONTROL-	Record Control; Remote Control has meter to read record level.

ELECTRON TUBE COMPLEMENT

	TUBE NO.	QTY.	SCH. REF.
REPRODUCE AMPLIFIER	5751	2	V412,V418
	5879	2	V413,V419
	6C4W	2	V414,V420
	6005/6AQ5W	4	V415,V417, V422,V423
	5814A	2	V415,V421
RECORD AMPLIFIER	12AT7WA	1	V408
	5749/6BA6W	2	V404,V405
	5726/6AL5WA	1	V407
	5814A	4	V409,V501 V801,V802
	5879	2	V401,V402
	6C4	2	V406,V403
POWER SUPPLY AMPLIFIER	5R4WGA	1	V411

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SECTION I

GENERAL DESCRIPTION

1-1. GENERAL DESCRIPTION

1-2. Recorder-Reproducer Set Sound Type AN/UNQ-7, is a dual-track magnetic tape recorder and reproducer operating at tape speeds of 15, 7-1/2, or 3-3/4 ips. Electrical signals which fall within the audio frequency spectrum may be recorded on this equipment and this information either reproduced immediately, or under proper conditions, stored indefinitely.

1-3. The equipment consists of four major units; one recorder-reproducer assembly, one amplifier assembly, one cabinet assembly, and one remote control assembly.

1-4. RECORDER-REPRODUCER ASSEMBLY. The recorder-reproducer assembly (see Fig. 1-1) consists of a three-motor, three-speed, dual-track, magnetic tape transporting mechanism. Recording and reproducing can take place simultaneously, or the reproducing function can be performed subsequent to the recording process. Two information channels are provided, one for voice recording and the other for recording sonar information. Provisions are incorporated for connecting and controlling a second recorder-reproducer (see Paragraphs 3-31 and 4-25).

1-5. AMPLIFIER ASSEMBLY. The amplifier assembly (see Fig. 1-2) consists of a dual record amplifier sub-assembly, a dual reproduce

amplifier sub-assembly, and a power supply sub-assembly; also included is the control circuitry for the recorder-reproducer.

1-6. CABINET ASSEMBLY. Both the recorder-reproducer assembly and the amplifier assembly are mounted in a shock and vibration isolated cabinet (see Fig. 1-3). Slides provide easy access for checking or servicing; and shock mounting at the base and the back of the cabinet effectively isolates the units from shock and vibration normally encountered. External wiring to the equipment is connected to the terminal board in the cabinet. Internal connections are contained within the cabinet.

1-7. REMOTE CONTROL UNIT. The remote control unit (see Fig. 1-4) provides facilities for starting and stopping the recording function at some location removed from the recorder. Indicators for the standby and record mode are furnished, and an end-of-reel warning device informs the operator when the reel of tape on the recorder-reproducer is nearly exhausted.

1-8. FUNCTIONAL DESCRIPTION

1-9. Two channels are recorded simultaneously, with any previously recorded information being erased prior to the recording function. Recordings can be made at tape speeds of 15, 7-1/2, or 3-3/4 ips (inches per second); on Channel A (voice) the input signal may be derived from a microphone or line input, while Channel B (sonar) must be derived from a line input. (Impedance for the different

inputs is quoted in paragraph i-3(g) under General Data). Thus, it is possible to use both channels for recording data, or use Channel B for recording data and Channel A as a voice channel used to explain the information on the data channel.

1-10. Both channels are reproduced simultaneously, either as the recording is taking place or at any subsequent time. Each channel has two paralleled outputs, one terminated at the terminal board in the cabinet and the second terminated in a phone jack on the front panel of the amplifier assembly. Both will provide either one watt across an eight ohm load or three volts across a 600-ohm load.

1-11. The equipment automatically erases prior recordings simultaneously on both channels as a new recording is made. Erasure can also be affected without recording any new signal. The magnetic tape can thus be used repeatedly for making new recordings, which in turn may be reproduced repeatedly or stored as a permanent record.

1-12. DETAILED DESCRIPTION

1-13. CABINET

1-14. The cabinet consists of a two-compartment enclosure, and a vibration isolating base and stabilizer. Each compartment is equipped with sliding hardware which permits the recorder-reproducer assembly and the amplifier assembly to be extended from the cabinet.

Terminal boards are mounted on a tray between the compartments; and all external connections are made from these boards. Cable entrance facilities are provided through cable entrance plates. The cabinet bolts to the ship's structure at the base plate and at the stabilizer (located on the back of the cabinet toward the top).

1-15. RECORDER-REPRODUCER ASSEMBLY, RD-141-UNQ-7

1-16. The recorder-reproducer assembly is a three-motor, three-speed, dual-track mechanism consisting of tape drive components, rewind components, take-up components, head assembly, a control box, a reel-end warning mechanism, and a safety switch. These components are mounted on a cast aluminum frame. Provisions are furnished for stopping mechanical operation at the end of a reel or if tape breakage occurs, and to warn the operator at the remote control unit when operation approaches the end of a reel. Tape speed and fast winding are controlled by switches on the front panel of the recorder-reproducer.

1-17. TAPE DRIVE COMPONENTS. Tape drive components are comprised of a synchronous drive motor assembly, a capstan and capstan idler assembly, a reel idler assembly, and a tape guide assembly.

1-18. The drive motor is a hysteresis synchronous motor with three windings to provide the three tape speeds. Attached to the motor shaft is a flywheel-pulley which through a nylon belt drives the capstan. The drive motor will start, and the capstan

will rotate, whenever power is applied. Four bolts fasten the motor to a motor bracket, which in turn is fastened to the cast frame by three bolts, through vibration isolating rubber step bushings between the bracket and the frame. A bracket from the back of the motor to the recorder-reproducer frame reduces torsional vibration to the motor. Leads from the motor terminate in plug P203 which mates with receptacle J203.

1-19. The components of the capstan and capstan idler assembly are mounted on a capstan housing which is attached to the cast frame by two bolts. The capstan shaft passes through the housing, supported at its outer end by a porous bronze bearing and at its inner end by a ball bearing. A flywheel and pulley, linked through the nylon belt to the drive motor, are mounted on the inner end. Drive belt tension is maintained by a spring-loaded pivot arm on which is mounted a belt idler. The capstan idler consists of a rubber-tired idler wheel mounted on an arm which is in turn attached to the shaft of a shielded rotary solenoid. Energizing the solenoid moves the idler arm so that the wheel is forced against the capstan, providing a bearing surface for the capstan, which then drives the magnetic tape at a constant speed. Dust caps protect the idler wheel bearing and the capstan bearing.

1-20. The reel idler assembly serves to smooth out an transient variations in tape speed originating in the tape supply reel. It is attached to the cast frame by three bolts, and is

supported at both its outer and inner ends by ball bearings. A flywheel is mounted on the inner end of the shaft; damped flywheel action is obtained by silicone fluid on which the flywheel actually rides. This fluid is inserted between the flywheel and its bushing. Two set screws in the inner end of the bushing hold both the bushing and the flywheel on the idler shaft.

1-21. The tape guide positions the tape vertically with respect to the head assembly. Shims are used to provide proper guide spacing. The rotor is a ball bearing and the entire unit is attached to the front of the cast frame by one bolt.

1-22. REWIND AND TAKEUP ASSEMBLIES. The rewind and takeup assemblies are identical in construction. Each consists of an induction motor providing high torque at low speeds, a brake drum, a flange for mounting the assembly on the cast frame, and a turntable.

1-23. Each motor is attached to the flange by four screws, and the flange in turn is rigidly attached to the cast frame by three bolts. Wiring to the motors is terminated in plugs which mate with receptacles on the control box.

1-24. Most of the components of the brake drum are affixed to the cast frame and are concealed beneath the top cover. The brakes are released when the brake solenoid is energized; the brake bands are pulled from the drums by the action of the brake

actuating rods. The brake drums are stainless steel and are attached to the shafts of the take-up and rewind motors. High tension springs and low tension springs determine the braking force applied for each direction of rotation.

1-25. HEAD ASSEMBLY. This assembly consists of three heads; erase, record, and reproduce; magnetically shielded in a mu-metal housing. In the record or reproduce modes a point on the tape will pass over the erase, record, and reproduce heads in that order. The outer tracks of the record and reproduce heads are for Channel A, the inner tracks are for Channel B. The erase head is full track, erasing the full width of the tape and thus both Channel A and Channel B. All heads are connected to a terminal board. The erase and record head cables are then terminated in a single plug which mates with a receptacle on the control box; the reproduce head cables are each shielded and each terminate in a feed-through receptacle on the back frame of the recorder-reproducer. Another cable connects this receptacle to the respective reproduce amplifier. Access holes are provided in the mu-metal shield to facilitate head adjustments. Four screws at the front of the recorder-reproducer mount the head assembly on the cast frame and a fifth screw secures the terminal board bracket to a rib of the frame.

1-26. CONTROL BOX ASSEMBLY. This assembly contains the electrical components associated with control of tape motion; including the rewind, fast forward, play and time delay relays; a rectifier and filter circuit which provides 115 volts d-c to operate the

relays and solenoids; the resistors and capacitors for the three motors; the control switches and the reel end warning mechanism. The REWIND-FAST FWD switch and the TAPE SPEED switch protrude through an opening in the cast frame to the front of the recorder-reproducer. The assembly is attached to the cast frame by six screws, four of which are grounded around the switch opening; and the remaining two are located beneath the brake access cover. Access to components within the control box is attained by removing a bottom plate.

1-27. REEL- END WARNING MECHANISM. This mechanism is activated by the reel-end warning arm, which is positioned by the angle of the tape as it leaves the supply reel. It provides a warning to the operator at the remote control station that the amount of tape on the supply reel is nearly exhausted. The arm is pivot mounted at one end to the back of the cast frame; a post at the other end protrudes through a slotted hole in the cast frame to the front of the recorder-reproducer. The post is in the tape threading path, and as the end of the tape on the reel is approached, the angle of the tape positions the arm so that it activates the reel-end warning switch in the control box.

1-28. SAFETY SWITCH ASSEMBLY. If tape tension is lost for any reason, the components of the recorder-reproducer assembly which control tape motion are stopped by the action of the safety switch assembly. Contacts of the safety switch are normally closed, and

the switch is activated (contacts opened) by the action of an arm, spring loaded at a pivot mounting on one end. The other end of the arm has a shaft which protrudes through an opening to the front of the recorder-reproducer. A tape guide is attached to the shaft and tape is threaded around this guide. If tape tension is lost, the spring loaded action forces the arm against the switches, opening the switch contacts and breaking the circuits to tape motion components. The assembly contains the two sections of the safety switch and a terminal board which provides connecting points for the switch and the two solenoids for the capstan idler and the brakes.

1-29. AMPLIFIER ASSEMBLY (See Fig. 1-5).

1-30. The amplifier assembly is divided into three main sub-assemblies, the record assembly, the reproduce assembly, and the power supply assembly.

1-31. RECORD ASSEMBLY (See Fig. 1-6). This assembly consists of the two record amplifiers, the AVC circuit for the Channel B record amplifiers, the bias oscillator, and the record level indicators. A record switch on the front of the amplifier assembly places the equipment in the record mode; this switch can be operated only when the record safety lock is simultaneously pushed to the left to prevent accidental placement of the equipment in the record mode. A pilot lamp indicates when the equipment is in the record mode.

1-32. The record amplifier for Channel A (voice) will accept three different types of inputs: 150 ohm microphone, 200,000 ohm balanced bridging line, and 600-ohm balanced line, determined by the strapping of the terminal board (see Section IV, Installation Instructions). Following the input transformer there are three stages of resistance coupled audio amplification. Recording level is controlled by a potentiometer between the first and second stages. An adjustable output is taken between the second and third stages to the record level indicator. The output of the last stage is connected to the Channel A record head through the record head relay and the cabinet cabling. High frequency pre-emphasis is obtained through an LC network in the cathode circuit of the final stage. Plate voltage for the final stage is applied only when the equipment is in the record mode.

1-33. The record amplifier for Channel B (sonar) has provisions for two different types of inputs, 30,000 ohm balance bridging line and 600-ohm balanced line, controlled by the strapping of the input terminal board (see Section IV, Installation Instruction). The input transformer has a balanced secondary winding which drives a push-pull input stage. A record level control is in the grid circuits of this stage. Transformer coupling is utilized between the push-pull and output stages. Following the interstage transformer, two adjustable outputs are taken, one to the AVC circuit and one to the record level indicator.

The output of the final stage is connected through the record head relay and cabinet cabling to the record head for Channel B. High frequency pre-emphasis is obtained through a LC network in the cathode circuit of the final stage. Plate voltage for the final stage is applied only when the equipment is in the record mode.

1-34. Signal voltage for the AVC circuit is derived from the record amplifier for Channel B by a potentiometer across the secondary of the interstage coupling transformer. A AVC circuit consists of an amplifier stage, a cathode follower stage, and a rectifier (detector) stage. The rectified and filtered AVC voltage is applied to the grids of the push-pull of the record amplifier to control its gain in accordance with the amplitude of the input signal. A AVC threshold is controlled by the setting of the potentiometer in the record amplifier. This is a fast-attach, slow-release circuit. It utilizes a voltage-delay system so that the AVC does not function until the peak signal exceeds a positive bias supplied to the cathode of the detector stage. With the AVC circuit disabled, the operation of Channel B is similiar to that of Channel A, with the push-pull input stage replacing the cascaded first two stages of Channel A.

1-35. The bias oscillator provides bias and erase current to the record heads. It is a conventional push-pull Colpitts triode oscillator operating at a nominal frequency of 100kc. Its output

is connected through the record head relay and inter-cabinet cabling to the recorder-reproducer. There the signal is delivered to the erase head, and is also adjusted for each channel, mixed with the output of the record amplifiers and then delivered to the appropriate record head. Operation of the oscillator is limited to when the equipment is in the record mode as no plate voltage is supplied in other modes of operation.

1-36. REPRODUCE ASSEMBLY (See Fig. 1-7). This assembly consists of two identical reproduce amplifiers. A switch on the front of the amplifier assembly controls placing the equipment in the reproduce mode. This may be done simultaneously with the recording function.

1-37. Each reproduce amplifier consists of a six-stage, resistance-coupled, audio amplifier with a transformer-coupled, push-pull output. Input signals from the reproduce head are connected through cabinet cabling and the reproduce head relay, to the grid of the appropriate amplifier. An equalization relay, controlled by the tape speed switch on the recorder-reproducer, selects the appropriate equalization circuit for the speed involved. Four stages of amplification, a phase inverter stage, and a push-pull output stage comprise the amplifier, with negative feedback derived from a tertiary winding of the output transformer. Two parallel outputs are provided; one terminates in a phone jack on the front panel of amplifier assembly and the second at the terminal board

in the cabinet. Either may be used to deliver one watt into an eight ohm load or three volts across a 600-ohm load.

1-38. POWER SUPPLY ASSEMBLY (See Fig. 1-8). The power supply assembly contains all the major components of the power supply and supplies all the requirements of the recorder with the exception of 115 volts d-c supplied by the rectifier in the recorder-reproducer to operate solenoids and relays. A switch on the front panel of the amplifier assembly exerts primary control over the a-c input power. Fuses which prevent damage to the equipment under overload conditions are also inserted and removed at the front of the amplifier assembly. A pilot light indicates when power is applied.

1-39. A fullwave rectifier supplies plate and screen voltage for all tubes in the equipment. A-c heater power is supplied by secondary windings of the power transformer; a fullwave filtered d-c heater supply is also provided. Filtering and decoupling networks and record relays complete the components of this assembly.

1-40. REMOTE CONTROL ASSEMBLY

1-41. The Remote Control Assembly provides facilities for controlling the record function of the equipment at a location removed from the recorder-reproducer set. Neither primary power control nor control of the reproduce mode can be excerised at this point.

1-42. Two indicator lights are provided, one indicating that the recorder-reproducer is in the standby mode and the other that the unit is in the record mode. As the equipment is changed from one mode of operation to the other, the appropriate indicator will light and the other will be extinguished. Visual end-of-reel warning is provided by the record indicator flashing on and off at a rate approximating once-per-second.

1-43. A switch controls placing the equipment in the record mode from the standby mode and vice versa. This switch, through the interconnecting cabling, simply parallels the record switch on the recorder-reproducer. Thus, if either of these switches is in the record mode it is impossible to stop this mode at the other location.

SECTION II

PRINCIPLES OF OPERATION

2-1. BASIC PRINCIPLES OF MAGNETIC TAPE RECORDING

2-2. If material capable of being magnetized is placed in the proximity of a magnetic field, the modules of that material will be oriented according to the direction of the field. Any of several methods may be used to produce a magnetic field, but of most interest in magnetic recording is the field produced by a current flowing through a coil of wire. The current itself may be derived from a transducer such as a microphone which converts the mechanical energy of sound to electric current.

2-3. Magnetic recording tape consists of finely divided iron-oxide particles deposited upon a plastic backing. During the recording process this tape is moved through a magnetic field in which the magnetizing force is alternating, and the iron-oxide particles are aligned according to the instantaneous direction and magnitude of the field. (See Fig. 2-1)

2-4. The magnetic field is produced in the gap of a recording head (which is essentially an electro-magnet), over which the recording tape passes. The head consists of an incomplete ring of highly permeable material inserted in a coil of wire. The discontinuity in the ring forms the gap, and the ring itself is the core of the electro-magnet. The recording head and its gap

thus constitute a series magnetic circuit. (See Fig. 2-2)

2-5. The magnetization curve of the iron-oxide used as the recording medium is similar to that shown as the heavy line in Fig. 2-3. At points near the origin, the curve is extremely non-linear and without some corrective factor, the signal recorded on the tape would not be directly proportional to the signal applied to the head; thus, resulting in a high degree of distortion when the tape was reproduced. This distortion is greatly reduced by mixing a high frequency, constant amplitude, bias signal with the actual signal being recorded, so that operation is obtained on the linear portion of the curve. This may be compared to applying a d-c bias to a tube, to force it to work on the linear portion of its curve. The bias signal is generally selected to be at least five times the highest frequency to be recorded so that no beating will occur between the bias frequency and the harmonics of the recorded signal.

2-6. While the tape is in the recording gap, the bias causes the magnetization characteristics of the iron-oxide to follow the dashed line loops shown in Fig. 2-3, known as the "minor hysteresis loops". As the tape leaves the gap, the influence of the magnetic field created by the bias is reduced to zero and the tape assumes a permanent state of magnetization (known as "remanent induction") determined by the gap flux at that time.

2-7. After the recording process, there exists on the tape a flux pattern which is proportional in magnitude and direction to the signal recorded. If the tape is then moved past a reproduce head, which is similar in construction to the record head, the magnetic flux on the moving tape will induce a voltage in the coil of the reproduce head. This induced voltage is proportional to the number of turns of wire on the head and the rate of change of flux. This is expressed by the equation-

$$E = N \left(do/dt\right)$$

where

E= induced voltage

N= number of turns of wire

do/dt= rate of change of flux

2-8. It is desirable that the gap in the reproduce head be as small as possible so it will intercept less than one wave length of the signal on the tape at the highest frequency to be reproduced. However, as the gap is made smaller the induced voltage decreases, so there is practical limitation in decreasing the gap and still maintaining an adequate signal-to-noise ratio.

2-9. The voltage induced in the reproduce head during reproduction is computed by the equation-

$$E = Bm \ V \sin \lambda$$

where

E= induced voltage

Bm= maximum flux density of the recording material

V= velocity of tape over the head

w= width of the gap

λ = wave length of the signal on the tape

From this equation it can be seen that the voltage across the coil increases directly as the velocity and wavelength (frequency) increase. If the tape velocity and gap width are assumed to be constant, the output voltage from the head is directly proportional to the frequency as long as the wavelength on the tape is large compared to the gap width. This results in an output vs frequency characteristic such as is shown in curve A of Fig. 2-4. The voltage does not continue to rise indefinitely. As electrical losses in the core material increase and as the wavelength on the tape approaches the same dimensions as the reproduce head gap, the actual output resembles curve B of Fig. 2-4.

2-10. In order to provide an over-all frequency response that is flat(see Fig. 2-5), an equalization circuit consisting of a series resistance and capacitance is inserted in one of the early stages of the reproduce amplifier. This equalizing circuit has a high frequency droop characteristic (curve B, Fig. 2-5) which is the inverse of the reproduce head characteristic (curve

a, Fig. 2-5). In order to extend the high frequency response, additional equalization is included in the record amplifier in the form of a high frequency boost circuit designed to compensate for the droop in record and reproduce head characteristics caused by core losses, self-demagnetization of the tape at the short wave lengths, and the wavelength approaching the gap dimensions.

2-11. Disregarding the response of the associated amplifiers, the physical aspects of maintaining constant tape speed and good head-to-tape contact, and core losses in the head, all of which can be placed at a high performance level by good engineering design, there are certain inherent properties which define the frequency limits in recording and reproducing information on a specific magnetic tape recorder-reproducer. While these properties can be varied to meet differing requirements, the overall result represents a compromise arrangement in which frequency response, signal-to-noise, and distortion are interrelated. In this respect the high frequency response is primarily limited by the dimension of the reproduce head gap, and the frequency at which the head resonants with the capacity in the circuit.

2-12. During the recording process the tape assumes a permanent state of magnetization as it leaves the head gap, thus the record head gap width is relatively uncritical. However, in the reproduce mode the magnetic flux on the moving tape must induce a voltage differential across the reproduce head coil if

a current is to flow in that coil. This induced voltage is attained as the flux travels through each branch of the head core, forced into that path by the high reluctance of the head gap. Therefore, an instantaneous difference in the magnitude of the moving flux must exist across the head gap to cause the flux to travel through the core and magnetically induce a voltage difference in the head winding.

2-13. When the frequency-recorded rises to a degree where the reproduce head gap intercepts a complete wavelength of the signal, (as it appears on the tape) there can be no difference in flux magnitude across the gap, and head output will reduce to zero. This cancellation effect will occur at multiples of the represented frequency, and for all practical purposes the output is useless.

2-14. There are two means of counter-acting the "gap effect". Either the reproduce head gap width can be reduced or the record reproduce tape speed can be increased. There are limitations in reducing the gap width and retaining adequate signal level and realistic manufacturing tolerances. As these limitations are reached, any further extension of high frequency requirements must be accomplished by corresponding increases in record-reproduce tape speed. (In instrumentation applications it is also possible to record at a high tape speed and reproduce at a low speed, thus providing a signal expansion characteristic. For example; a 10kc signal recorded at 7-1/2 ips will reproduce as a 5kc signal, if

the reproduce tape speed is 3-3/4 ips. This procedure of course, cannot be used in standard audio applications where music or voice is recorded). Increasing the record-reproduce tape speed lengthens the wavelength of the signal as it appears on the tape, with the result that higher frequency wavelengths do not approach the gap dimension. (It also decreases the "self-demagnetizing" effect which occurs as the opposite poles of individual magnetic fields on the tape come closer and closer together).

2-15. The resonant frequency of the inductance of the head coil and the capacitance, either actual or distributed, of its circuit must normally be either outside the pass band of the system (so the drop in output following the point of resonance will not adversely effect the frequency response), or so placed at the extreme upper limit, so that the increased output at the moment of resonance actually provides an extended response. When good engineering design has reduced circuit capacitance to an irreducible minimum, the only means of placing head resonance at a higher frequency is to reduce the inductance of the head coil by reducing the number of turns of wire. This adversely affects the output over the entire frequency range, and will particularly influence the low frequency limit. Low frequency response is primarily determined by the relationship of the required signal-to-noise, the characteristic curve of the reproduce head, the distortion which can be tolerated, and the bandwidth which must be recorded.

2-16. As previously explained (see Paragraph 2-9), the output of a reproduce head rises directly with frequency at an approximate rate of 6db per octave. Stated conversely, the reproduce head output drops directly with frequency at an approximate rate of 6db per octave. The low frequency limit is determined by how far this decreasing output can be tolerated while maintaining an adequate signal-to-noise ratio. Thus, the noise generated by the associated electronic assemblies will have a definite effect on low frequency response. Increasing the record level to offset this decreasing output will eventually result in an increase in distortion.

2-17. Bandwidth is a determining factor in low frequency response because the 6db per octave dropoff in reproduce head output normally starts at the highest frequency which must be reproduced, and is constant regardless of tape speed. Thus, as the upper frequency requirement is extended, the lower frequency limit, dictated by the required signal-to-noise ratio, rises inexorably with it, octave for octave. A general rule is that the maximum bandwidth which can be effectively reproduced by any magnetic tape device is approximately ten octaves.

2-18. It should now be apparent that compromises are necessary in designing a magnetic tape recorder for a given purpose. If a high frequency requirement is imposed, then low frequency, signal-to-noise, or distortion must be limited (or perhaps a

modulation-demodulating system employed which will effectively compress the bandpass requirements). Conversely, a low frequency requisite limits the high frequency response which can be obtained. The AN/UNQ-7 has been designed to meet certain performance parameters. The alignment procedures quoted in this instruction book mirror those parameters and should be rigidly followed if the inter-relationship between the frequency response, noise, and distortion is to be maintained for optimum performance of the equipment.

2-19. RECORD AMPLIFIER CHANNEL A (See Fig. 2-6).

2-20. INPUTS. This amplifier will accept three different types of inputs; 150 ohm microphone, 200,000 ohm balanced bridging line, or 600 ohm balanced line. Input connections depend upon which type is desired, and are detailed in Section 4, Installation. The microphone connects directly to channel A Record Amplifier input transformer T401. Resistors R108, R109, and R107 (in the cabinet wiring) provide a 200,000 ohm bridging input impedance and also attenuate the signal to approximately the same amplitude as would be derived from the microphone. Similarly, resistors R106, R104, and R105 provide the matching impedance and signal attenuation for the 600 ohm balanced line.

2-21. THEORY OF OPERATION. The secondary of input transformer

T401 is connected, through RECORD LEVEL control R406, to the grid of input amplifier V401; a high gain, low noise, pentode vacuum tube which is connected as a triode amplifier. The amplified signal at the plate of this stage is coupled to the grid of V402 through capacitor C403 and resistor R403. After further amplification in V402, the signal is applied to the grid of the record output stage V403, through capacitor C405, and resistors R412, and R413. The output stage directly drives the record head through capacitor C408, and record head relay K401. In the cathode circuit of V403, resistor R416 provides current feedback to furnish a constant current versus frequency characteristic in the amplifier output. Connected across this resistor is a series resonant circuit (consisting of C407 and L401) which is resonant at approximately 11kc. As the signal frequency approaches this resonant condition, resistor R416 is shunted by the decreasing impedance of the resonant circuit resulting in a higher signal amplitude at the plate of V403. High frequency pre-emphasis (described in paragraph 2-10)is thus accomplished. The signal which is fed to the Record Level Indicators is picked up at record level calibration potentiometers R411 and R521, between V402 and V403. High frequency record bias, derived from the bias oscillator across capacitor C421, is adjusted in amplitude in the tape transport assembly and mixed with the signal to be recorded.

2-22. RECORD AMPLIFIER CHANNEL B (See Fig. 2-7).

2-23. INPUTS. This amplifier has provisions for two inputs; 30,000 ohm unbalanced bridging or 600 ohm unbalanced line. Input connections depend upon which type is desired and are detailed in Section IV, Installation. The unbalanced bridging input is connected to the grid of the pre-amplifier tube V501-A through the cabinet wiring. The unbalanced 600 ohm line is connected across matching resistor R101, and to the grid of pre-amplifier tube V501-A, through the cabinet wiring.

2-24. THEORY OF OPERATION. The input signal is applied to the primary of transformer T402, through the pre-amplifier V501-A and V501-B. The signal at the balanced secondary winding of transformer T402 is applied through the dual RECORD LEVEL control (R418A and B), to the grids of push-pull amplifier input stage V404 and V405, two pentode vacuum tubes. The amplified signal at the plate of this stage is coupled through interstage coupling transformer R403, capacitor C411 and resistors R428 and R429, to the grid of the record output stage. Resistors R425 and the series combination of capacitor C410 and R424, in the plate circuits of the push-pull input stage, provide low frequency compensation which extends the low frequency recording capabilities of this amplifier; at the upper and middle audio frequencies the impedance of C410 is negligible and the primary of the interstage coupling transformer is shunted by the parallel resistance of R424 and R425. However, at the lower frequencies, the impedance of C410 rises and the total shunting impedance across T403 becomes greater. Thus, signal

voltage across the primary will rise. The amplitude and rate of this rise has been designed to compensate for the low frequency roll-off that would be encountered if the compensation network were not present. The output signal is taken through capacitor C413 and record head relay K401, mixed with the high frequency record bias derived from the bias oscillator, adjusted in the tape transport assembly, and delivered to the record head. Three signals, two to be delivered to the Record Level Indicators, and one to be delivered to the a.v.c. circuit, are adjusted at potentiometers R427, R522, and R426 respectively. These potentiometers are connected across the secondary winding of interstage coupling transformer T403. The series resonant circuit consisting of C412 and L402 provides high frequency pre-emphasis exactly as did C407 and L401 in the Channel A record amplifier.

2-25. A.V.C. CIRCUIT (See Fig. 2-8).

2-26. Signal voltage for operation of the automatic volume control circuit is derived from potentiometer R426, connected across the secondary of interstage coupling transformer T403, in the Channel B record amplifier. This adjustable voltage is amplified by stage V408B and delivered to the grid of a cathode follower stage, V408A. The cathode follower stage supplies signal voltage to the a.v.c. detector stage V407, a dual rectifier with its sections connected in parallel. The rectified a.v.c. voltage developed across R433 is filtered by the action of C414.

This voltage is applied to the grids of the push-pull input stage of the Channel B record amplifier, to limit its gain in accordance with the amplitude of the input signal. (This a.v.c. action explains the use of the push-pull stage for the Channel B record amplifier). If a single-ended stage were used, its gain would necessarily be limited since the a.v.c. voltage would be amplified around the loop and fed back to the input. Using the push-pull circuit, the a.v.c. voltage is fed, in phase, to both grids and cancels out in the output, allowing higher gains to be utilized and improving a.v.c. action without danager of instability. Switch S401 is an a.v.c. ON-OFF switch. In its OFF position, the grids of the push-pull input stage of the record amplifier are returned to ground through the dual RECORD LEVEL control, the a.v.c. voltage is shorted to ground, and thus the a.v.c. does not operate. The a.v.c. circuit utilizes a voltage-delay system so that the a.v.c. action does not function until the signal reaches a certain pre-adjusted amplitude. This is accomplished by positively biasing the cathode of detector stage V407 so that it will not conduct, and consequently cannot develop a.v.c. voltage, until the peak signal exceeds the bias (delay) voltage. The bias is derived from the voltage divider network, consisting of R436 and R435, connected from ground to the plate supply voltage. The signal amplitude at which the circuit would operate (threshold) could be controlled by varying the delay voltage, but in this instance

it is selected by the setting of R426, which actually controls the signal amplitude fed to the a.v.c. circuit. Attach time (approximately 3 milli-seconds) is controlled by the time constant of capacitor C414 in conjunction with the series resistance offered by diode V407 and resistor R434; release time (approximately 0.1 seconds) is controlled by the time constant of C414, and resistor R433. J401 provides a test point for measuring a.v.c. voltage during the alignment procedure. (See Section V, Maintenance.)

2-27. BIAS OSCILLATOR (See Fig. 2-9).

2-28. The bias oscillator provides both the high frequency record bias and the erase current. It is a conventional Colpitts push-pull triode oscillator, operating at a nominal frequency of 70kc, the exact frequency not being critical. It consists of a dual triode, type 5814A vacuum tube, V409. Any signal at the grid of V409A is amplified in the plate circuit, coupled to the grid of V409B, and appears at the plate of V409B. It is then coupled back to the grid of V409A, in phase with the original signal, producing positive feedback and oscillation. The energy from the oscillator is taken from the secondary winding of transformer T404, the primary of which is the oscillator tank coil, through C421, and the record head relay K401, and then directly to the erase head. Record bias current is adjusted and delivered to the record heads through capacitor C201, and potentiometer R201 (Channel A), and capacitor C202, and potentiometer R202 (Channel B),

located on the tape transport assembly. Plate voltage is applied only when the equipment is in the record mode. Noise balance control R443, common to both grids of the dual oscillator tube, is adjusted to eliminate any asymmetry in the oscillator waveform, which would cause a d-c component in the record head and tend to magnetize the head. (See Section V, Maintenance.)

2-29. RECORD LEVEL INDICATOR (See Fig. 2-10).

2-30. Signal voltage for the record level indicators is derived from potentiometers R411 (Channel A, Remote), R521 (Channel A, Local), R427, (Channel B, Remote), and R522 (Channel B, Local); connected in the grid circuits of the final stage of each record amplifier, before high frequency pre-emphasis is applied. These potentiometers are used for calibration of the record level indicators. The signals from these potentiometers are applied to the grids of the Record Level Indicator Amplifier V801 and V802. The amplifiers serve as impedance matching devices and provide sufficient signal to operate the VU meters.

2-31. REPRODUCE AMPLIFIERS-CHANNELS A AND B (See Fig. 2-11).

2-32. The two amplifiers are identical in construction and performance. In the following discussion, schematic reference symbols, not in parenthesis, refer to components in the Channel A amplifiers, while those inside parenthesis refer to the corresponding component in Channel B.

2-33. THEORY OF OPERATION. The reproduce head leads enter the amplifier assembly at J407 (J409), and are delivered to contacts of reproduce relay K405. These relay contacts connect the reproduce head to the triode amplifier input stage of the reproduce amplifier V412A, (V418A), which is composed of one-half of a dual triode vacuum tube. A reproduce equalization circuit (see paragraph 2-10) is included in the plate circuit of this stage. This is a fixed equalization consisting of capacitor C435 (C448) and either R463 or R465 or R466), selected by the contacts of equalization relay K404 which is energized when the 3.75 - 7.5 - 15 switch on the front panel of the tape transport assembly is placed in its 3.75 position. Equalization for 7.5 in/sec and 15 in/sec tape speeds is the same.

2-34. The input stage is followed by a second triode amplifier stage V412B (V418B) consisting of the second half of the dual triode vacuum tube, a pentode amplifier stage V413 (V419), the REPRODUCE LEVEL control R480 (R504), a triode amplifier V414, (V420), phase inverter stage V415A and B (V421A and B), push-pull output stage V416 and V417 (V422 and V423), and output transformer T406 (T407). All stages are conventional, resistance coupled circuits. The output stage consists of two triode connected tetrode vacuum tubes which, under the normal output of 1 watt across an eight ohm load, operate in class AB1. Approximately 10db of negative feedback is obtained from a tertiary winding on output transformer T406 (T407), which is connected

through resistor R484 (R508) back to the cathode circuit of V414 (V420). The cathodes of phase inverter stage V415 (V421) are not grounded directly, but are carried through the contacts of REPRODUCE switch S403 to ground. Thus, when this switch is in its neutral (middle) position, the reproduce amplifier is disabled, this prevents reproduction of any material, when the tape is being transported in the fast forward or rewind mode. Plate voltages are applied to all stages whenever the POWER switch is in its OFF position.

2-35. OUTPUTS. Output transformer T406 (T407) is connected to two parallel outputs; one terminated in a two-circuit phone plug on the front of the amplifier assembly, and the other on the terminal boards in the cabinet. Either of these paralleled outputs will deliver one watt into an eight ohm load or three volts across 600 ohms (or any other impedance between 8 ohms and infinity).

2-36. POWER SUPPLY (See Fig. 2-12).

2-37. The power supply furnishes the complete power requirements of the entire equipment, with the exception of 115 volts d-c for operation of the relays and solenoids in the tape transport assembly, (which is supplied by rectifier CR201 in the control box on the tape transport assembly).

2-38. A-c power is brought into the equipment at terminals 32 and

33 of TB104 (see Section IV, Installation). From these terminals it is routed through filter FL101 to connectors 1 and 9 of plug P405, where it enters the amplifier assembly. Power switch S402 is inserted in both sides of the line and the power path continues from this switch through fuses F405 and F406 to the primary of power transformer T405.

2-39. Secondary winding 9 and 10 supply five volts a-c filament power to rectifier V411. The filament of V411 is also operated at high potential and is provided with high voltage insulation.

2-40. Secondary winding 3, 4 and 5, in conjunction with fullwave selenium rectifier CR401, provides d-c heater voltages to tubes V401, V404, V405, V412, V413, V418, and V419. This heater voltage is filtered by C431, and R457.

2-41. Secondary winding 11 and 12 provides a-c power to the indicator lights and to the heaters of tubes V414, V402, V403, V406, V407, V408, V409, V415, V416, V417, V420, V421, V422, V423, V501, V501, V801, and V802.

2-42. Secondary winding 6, 7, and 8 is the high voltage winding for fullwave rectifier V411. V411 supplies plate voltage for the tubes in the amplifiers filtered by C434, L403, and C432C.

2-43. Additional resistor-capacitor filter sections are provided as decoupling networks for various circuits in the amplifiers.

R447 and C423B decouple final stage of record amplifier V403.

R448 and C423A decouple final stage of record amplifier V406.

R455 and C428C decouple A.V.C. cathode follower V408A.

R456 and C428A decouple push-pull record amplifier stage V404 and V405.

R453 and C429A decouple reproduce amplifier Channel A (except last stage).

R454 and C429B decouple reproduce amplifier Channel B (except last stage).

2-44. Resistor R449 and capacitor C424 are connected across the contacts of record relay K403, which supply plate voltage to the bias oscillator. This reduces arcing of the contacts as they make and break.

2-45. CONTROL CIRCUITS

2-46. GENERAL. Schematic reference numbers are assigned to components according to the chassis on which they are located. Components in the 1 to 10 series are located on the remote control. Those in the 200 series are in the tape transport assembly. Those in the 800, 400, and 500 series are in the amplifier assembly. Certain components in this system, and certain contacts of switches and relays, are provided to control the operation and switching of an auxiliary tape transport

assembly. Since they will not normally be used, these components and contacts are not discussed in the following explanations of control circuitry.

2-47. POWER CONTROL CIRCUIT. When POWER switch S402 is placed in its ON position, a-c power is applied through fuses F405 and F406 to power transformer T405. It also is routed through fuses F401 and F402, (and the tape speed selector switch S202) to the capstan drive motor, which will start, and to CF201 on the tape transport assembly, which provides d-c voltage for the control of relays and solenoids.

-NOTE-

If an auxiliary power source, rather than the regular ships line, is used to supply power to the drive motor an external switch discussed in Section 3, will be used to control drive motor operation.

2-48. RECORD CONTROL CIRCUIT. When RECORD switch S404 is placed in its 1 position, and tape is properly threaded so that safety switch S205 is closed, d-c power obtained from rectifier CR201 is routed through R210, S205, normally closed contact set 8-9 of relay K202, normally closed contact set 8-9, of relay K203, normally closed contact set 4-5, of relay K201, switch S404, to record relay K402, which is then energized.

2-49. Contact set 4-12, of record relay K402 makes, completing the circuit through play-relay K204, and through the capstan idler solenoid L201; the idler forces the tape against the capstan and tape motion starts. Contact set 5-6 makes, applying a-c power to the RECORD indicator in the remote control and contact set 1-11 breaks to extinguish the STANDBY indicator in the remote control. Contact sets 10-14 and 8-9 make, applying B+ power to the final stages of the record amplifiers and to the bias oscillator. Contact set 7-13 makes to light the RECORD 1 indicator.

2-50. Contact set 7-8 of play-relay K204 makes, energizing brake solenoid L202, which pulls the brakes from contact with the brake drums, contacts 8-9 break, opening the circuit to the take-up relay, rewind relay, and time delay-relay. Contact set 5-6 makes, completing the circuit to the take-up and rewind motors through resistors R204, R206, and normally closed contact sets 4-5 of relays K202, and K203.

2-51. When reel end warning switch S203 is actuated by the angle of the tape as it leaves the supply reel, the flasher switch motor is energized through contact set 5-6 of energized play-relay K204, and contact set 1-2 of S203. The motor controls a switch contact, placing it first in one position then reversing it, so that the circuit to the record indicator on the remote control is completed, then broken, then completed again, etc.

Thus, this indicator will flash on and off. A lead from the flasher switch to contact 3 of the reel end warning switch is provided to ensure that the flasher motor does not stop with its switch in the position which breaks the circuit to the RECORD indicator on the remote control.

2-52. REPRODUCE CONTROL CIRCUIT. When the REPRODUCE switch is placed in its 1 position, switch contacts 7-8 make, and complete a d-c circuit to play-relay K204, and to capstan idler solenoid L201, through normally closed contact sets 8-9 of relays K202 and K203. The capstan idler forces the tape against the capstan and tape motion is started. Contacts of play-relay K204 function exactly as described in paragraph 2-50.

2-53. Switch contacts 1-3 of the REPRODUCE switch break, extinguishing the STANDBY indicator in the remote control. When the 3.75 - 7.5 - 15 switch is in its 3.75 position, switch contacts 10-11 will complete a circuit through the reproduce amplifier equalization relay. In the de-energized position, the contact sets of this relay select the 7.5 ips equalization circuit; while in the energized position, they select the 3.75 equalization circuit. Switch contacts 4-5 provide the ground return for the cathodes of the phase inverter stage of the reproduce amplifier.

2-54. FAST FORWARD CONTROL CIRCUIT. When REWIND-FAST FWD switch S201 is placed in its FAST FWD position, contact set 7-9 breaks

to extinguish the STANDBY light on the remote control. Contact set 1-2 makes, energizing take-up relay K202; contact set 4-5 makes, energizing time delay relay K201 and allowing capacitors C204A and C204B to charge.

2-55. Contact set 8-9 of take-up relay K202 breaks, opening the circuit to the record and play relays and to the capstan idler solenoid; contact set 8-7 makes, energizing brake solenoid L202, which pulls the brakes from contact with their drums. Contact set 4-5 breaks and contact set 5-6 makes; this places take-up motor B201 directly across the a-c line, and rewind motor B202 also across the a-c line, but in series with resistor R209. B201 will operate at full torque and B202 at reduced torque.

2-56. Contact set 4-5 of time delay relay K201, in series with the record and play relays, and with the capstan idler solenoid, breaks so relay K201 will be held energized (by the discharge of capacitors C204A and C204B) for a period of approximately three seconds after the REWIND-FAST FWD switch is returned to its neutral position. Thus, if either the RECORD or REPRODUCE switches are placed in other than their neutral positions, while the equipment is in the fast winding mode, and the REWIND-FAST FWD switch is then returned to its NEUTRAL position, there will be a delay period, allowing the fast moving tape to stop before the capstan idler forces it against the capstan; tape breakage is thus prevented when this operation procedure is followed.

2-57. REWIND CONTROL CIRCUIT. When the REWIND-FAST FWD switch is placed in its REWIND position, contact set 10-12 breaks and the STANDBY indicator on the remote control is extinguished. Contact set 13-14 makes, energizing rewind relay K203, and contact set 16-17 makes, energizing time delay-relay K201.

2-58. Contact set 8-9 of rewind relay K203 breaks, opening the circuit to the record and play relays and to the capstan idler solenoid. Contact set 8-7 makes, energizing brake solenoid L202, which pulls the brakes from contact with the brake drums. Contact set 4-5 breaks and contact set 5-6 makes, placing the rewind motor directly across the a-c line, and the take-up motor also across the a-c line, but in series with resistor R209. The rewind motor will thus operate at full torque and the take-up motor at reduced speed.

2-59. Contact set 4-5 of time delay-relay K201 provides exactly the same delaying action described in paragraph 2-56.

2-60. TAPE DRIVE SYSTEM (See Fig. 2-13).

2-61. OPERATION. When either the RECORD or REPRODUCE switch is in its 1 position, the capstan idler moves against the capstan, thus providing a bearing surface as it presses the tape against the capstan. Tape speed is governed by the speed of the capstan, and proper tape tension is maintained by the rewind and take-up motors as they act on their respective turntables.

The capstan is coupled to the drive motor by a nylon belt, which passes over the drive motor pulley, the capstan pulley, and a belt idler on a spring-loaded pivot arm which keeps the belt under proper tension.

2-62. The rewind and take-up motors are so connected that when power is applied, their forces are in opposite directions; clockwise for the rewind motor and counterclockwise for the take-up motor. In the record or reproduce mode, series resistance (R206) for rewind, (R204) for take-up, are placed in the circuit of each motor; these resistances reduce the normal torque of the motors and are chosen so that optimum tape tension is obtained at each reel. The reels of tape are isolated from each other by the capstan and capstan idler. The capstan pulls the tape from the supply reel, overcoming the opposing torque of the rewind motor, which provides hold-back tension. At the same time the capstan is feeding tape to the take-up reel; since the take-up tends to exceed the rate at which the capstan feeds tape, the take-up reel also supplies tape tension. A tape loop will be thrown whenever any malfunction of the equipment allows the feed rate to exceed the take-up rate; if this loop is sufficiently large (or if tape breakage occurs), the safety switch arm will be released, actuating the safety switch and stopping the equipment. The primary function of this arm is to actuate the safety switch, and it is not considered part of the tape tension system.

2-63. In the fast forward mode of tape travel, series resistor R204 is removed from the take-up motor circuit, and that motor operates at full torque. As series resistance R209 is placed in the rewind motor circuit, that motor operates at reduced torque and the tape will be pulled from the supply reel (on the rewind turntable) to the take-up reel (on the take-up turntable), being held under tension by the opposing torque of the rewind motor.

2-64. In the rewind mode of tape travel, the operation described in paragraph 2-63, is reversed. Now resistor R209 is placed in the take-up motor circuit. The rewind motor will thus operate at full torque, the take-up motor at reduced torque, and tape will be pulled from the take-up reel to the supply reel, being held under tension by the opposing torque of the take-up motor.

2-65. The tape guide positions the tape vertically with respect to the head assembly. The reel idler smooths out transient varia-- tions in tape speed, such as occur when random or periodic variations in the torque of the rewind motor occur, or when vibrations are induced in the supply reel by external forces.

2-66. BRAKE OPERATION (See Fig. 2-14).

2-67. Whenever the equipment is being operated in any mode of tape travel, correct tape tension is determined by the power applied to the rewind and take-up motors. However, when power is removed from these motors, their opposing torques on the tape

are removed, and maintenance of tape tension becomes a function of brake operation. To avoid throwing tape loops as the tape comes to a stop, it is necessary that the braking force on the trailing turntable (the turntable from which tape is being pulled) always be greater than that which is applied to the leading turntable, (the turntable which is taking up the tape). However, this braking differentail must not be so great that the tape is in danger of being deformed or broken.

2-68. Operation of the brakes is exactly the same for each turntable, however, one is a mirror image of the other, and the following discussion details the operation at the rewind turntable. It must be borne in mind that braking force at the take-up turntable when the tape is being brought to a stop, will be governed by the opposite spring to that named in this discussion.

2-69. When the equipment is being operated in any mode, the brake bands are held from contact with the brake drums by the action of the brake solenoids as shown in Fig. 2-14.

2-70. STOPPING FROM THE RECORD, REPRODUCE-OR FAST FORWARD MODES. With the rewind turntable rotating in a counterclockwise rotation when power is removed, the brake solenoid is de-activated, allowing the brake to move into contact with its brake drum. The brake will move in a counterclockwise rotation, because of the friction developed between the rotating brake drum and the brake, until it reaches the limit of its travel, determined by the stop

nut and spacer on the brake release rod as it contacts the brake solenoid arm at point B in Fig. 2-14. The end of the brake band which is attached to the brake release rod is thus held in a fixed position, and the braking tension will be determined by the high tension spring. The friction of the brake band on the rotating brake drum is in an opposing direction to the force applied by the spring; hence as the turntable is brought to a stop, the brake is self de-energized.

2-71. STOPPING FROM THE REWIND MODE. With the rewind turntable rotating in a clockwise rotation when power is removed, the brake solenoid is de-activated, allowing the brake to move into contact with its brake drum. Because of the friction developed between the moving brake drum and the brake, the brake band will move in a clockwise direction until it reaches the end of its travel, as the loop in the brake band contacts the fixed pin at point a in Fig. 2-14. Thus, the end of the brake band opposite to that in paragraph 2-70 is held in a fixed position, and the braking tension will be determined by the low tension spring. Brake action is again self de-energizing.

2-72. DETERMINATION OF BRAKING FORCE. Bracking force is determined by the co-efficient of friction between the brake lining and the brake drum (which is the same regardless of the direction of rotation), and the tension on the brake band (determined by either the high tension or low tension spring). Only the spring tension

is dependent on the direction of rotation, which determines which spring shall apply the tension, and a difference in braking force is thus developed between the turntables (the direction of rotation of the turntables is always the same, but as explained in paragraph 2-68, the braking action is a mirror image and the operation of the springs will be reversed for the same direction of rotation). Thus, the high tension spring will always be acting on the trailing turntable).

SECTION III

OPERATING INSTRUCTIONS

3-1. OPERATING CONTROLS AND INDICATORS

3-2. Operation controls and indicator for the Recorder-Reproducer Set are shown in Fig. 3-1, 3-2, and 3-3. Their designations and purposes are shown in Table 3-1.

3-3. Two headphone jacks, one for Channel A and one for Channel B, are provided on the front panel of the amplifier assembly. High impedance headphones (or 600 ohm headphones) may be plugged into these jacks to provide monitoring of the reproduce output of either channel.

3-4. Main power line fuses for the recorder-reproducer assembly and the amplifier assembly are available on the front panel of the amplifier assembly.

3-5. Several controls and indicators; the record switch, the reproduce switch, and the record indicating light, have positions or indications designated 1 and AUX. The AUX position and the AUX indicator will not normally be activated, but are provided for use if an auxiliary recorder-reproducer is added to the system. Similarly, fusing facilities for an auxiliary recorder-reproducer are provided on the amplifier assembly. (See Paragraph 3-31).

3-6. TAPE THREADING (See Fig. 3-4).

3-7. The reels are held in place on the turntables by reel hold-down knobs which screw down on the turntable spindle. Clockwise rotation of the hold-down knobs tightens the reel on the turntable; excessive pressure is not required. To mount a reel, hold it with one hand to prevent it from rotating and install the knob with the other hand. The hold-down knobs must be completely removed from the spindle; counter-clockwise rotation of the knob will loosen it; when reels are to be mounted or removed.

3-8. The system is designed to provide optimum performance using reels having a 2-1/4 inch hub diameter. If reels with hubs of smaller diameter are used there is a possibility of the holdback tension on the tape increasing to a point where a slippage occurs between the tape and the capstan; also the reel-end warning mechanism will operate sooner than normal. It is also recommended that reels of the same size always be used on the two turntables; if not, the loads on the turntable will be unequal and the operation of the braking system will be affected.

3-9. Install a full reel of magnetic tape on the left hand (supply or rewind) turntable and an empty reel on the right hand (take-up) turntable. The tape threading path between the reels is illustrated in Fig. 3-4, and is also shown on the head cover

of the recorder-reproducer assembly. Hold the tape by one finger on the hub of the take-up reel and rotate the reel several revolutions in a counter-clockwise direction to anchor the tape on that reel. Continue turning the take-up reel until tape tension holds the safety arm in the upper portion of its clearance slot.

3-10. When using a new, factory wound reel of tape for the first time, it is recommended that it be inspected by running it in the fast forward mode on the recorder-reproducer. New tapes are often looped to the hubs of the reels so that the end of the tape will not come free from the reel. If this occurs, tape motion will cease, but the safety arm will not de-activate the equipment; the capstan idler will remain engaged to the rotating capstan and a flat spot may be worn on the capstan idler tire.

3-11. RECORDING AT THE EQUIPMENT

Step 1. Thread a reel of blank tape (or tape recorded with information which is not to be saved) on the recorder-reproducer. Any previously recorded information will be erased during the recording process.

Step 2. Place POWER switch in its OFF position. The power indicator will light and the capstan will start. Allow a 20 second warm-up period.

Step 3. Select the tape speed at which it is desired to record by placing the speed switch in its appropriate position.

Step 4. With a signal corresponding to that which will normally be recorded connected to the inputs of either or both channels, place the CHANNEL SELECTOR switch in either its A or B position to select the appropriate channel on which the record level is to be set.

Step 5. Observe the amplitude of the reading on the face of the meter, and if necessary adjust the appropriate RECORD LEVEL control until the signal peaks at zero db.

Step 6. Reverse the position of the CHANNEL SELECTOR switch and repeat Step 5 for the other channel.

Step 7. The equipment is now ready to record simultaneously on both channels at normal operating level. To start the recording process, hold the record safety interlock to the left and place the RECORD switch in its 1 position. The tape will start in motion and record indicator 1 will light. Reset the RECORD LEVEL control (s) if necessary.

Step 8. The recording function may be stopped at any time simply by returning the RECORD switch to its neutral (middle) position); no manipulation of the record safety interlock is necessary. Thus, the recording function can be started or stopped whenever desired through the run of a reel, with the equipment returning to the standby condition whenever the RECORD switch is in neutral position. Tape motion components will be automatically de-activated at the end of a reel.

3-12. OPERATION OF THE REMOTE CONTROL

3-13. The remote control assembly provides the remote control operator with facilities for placing the equipment in the record mode from the standby condition. An understanding of the function of the indicating lights on the remote control is essential for proper operation at the remote control location.

3-14. The STANDBY light indicates that power is applied and that tape is properly threaded on the equipment. It does not indicate that proper tape speed is selected or that the recording levels have been adjusted. It will not light when power is not applied, when tape is not properly threaded, or if the equipment is being used to reproduce a previously recorded tape.

3-15. The RECORD light indicates that the equipment has been placed in the record mode either at the remote control unit or at the equipment. Approximately 5 minutes before the end of a reel of tape, this light will start flashing on and off to provide an end-of-reel warning. This action will occur only when the end of the reel is approached with the equipment in the record mode. This light will be extinguished and the STANDBY light will come on when the equipment is returned to the standby condition.

3-16. The STANDBY RECORD switch on the remote control simply parallels the RECORD switch on the equipment. Thus, if either switch is in the recording position, it is impossible to stop the record mode at the other location.

-CAUTION-

It is possible to place the equipment in the record mode when a previously recorded tape is being reproduced, therefore, the standby-record switch on the remote control should only be moved from its STANDBY position when the STANDBY indicator is lighted. A previously recorded tape will be erased if run with the equipment in the record mode.

3-17. RECORDING AT THE REMOTE CONTROL

Step 1. Complete Steps 1 through 6, Paragraph 3-11, at the equipment. The STANDBY indicator on the remote control will be lighted.

Step 2. To place the equipment in the record mode simply place the STANDBY-RECORD switch in its RECORD position. The RECORD indicator will light and the STANDBY indicator will be extinguished. The RECORD indicator will start flashing on and off approximately five minutes before the end of the reel of tape.

Step 3. To return to the standby condition simply return the STANDBY RECORD switch to its STANDBY position. The STANDBY indicator will light and the RECORD indicator will be extinguished. Tape motion components will be automatically de-activated when the end of the reel is reached. The operator can control the record and standby functions at will during the run of a reel.

3-18. REPRODUCING

Step 1. Thread a previously recorded tape on the recorder-reproducer.

-CAUTION-

The remote operation has immediate control over the recording function. Important previously recorded tapes should not be installed on the recorder-reproducer when it is likely that the remote operator will start recording. Previously recorded tapes are erased and re-recorded during the recording process.

Step 2. Place the POWER switch in its OFF position. The power indicator will light and the capstan will start. Allow a 30-second warm-up period.

Step 3. Select the tape speed at which the recording was made by placing the speed switch in its appropriate position.

Step 4. Place the REPRODUCE switch in its 1 position. Tape motion will start and the reproducing function will be in process on both channels simultaneously.

Step 5. Adjust the REPRODUCE LEVEL control for each channel until the desired output level is achieved at the headphones, speakers, or other equipment.

Step 6. To stop the reproduce function simply return the REPRODUCE switch to its neutral (middle) position. Thus, this function may be started and stopped at will during the reproducing of a reel, with the equipment returning to the standby condition whenever the REPRODUCE switch is in its neutral position. Tape

motion components will be automatically de-activated at the end of a reel.

3-19. SIMULTANEOUSLY RECORDING AND REPRODUCING (Monitoring)

Step 1. Place the equipment in the record mode by following Steps 1 through 7 in Paragraph 3-11.

Step 2. Place the REPRODUCE switch in its 1 position. The information being recorded on both tracks of the tape will now be reproduced through the action of the reproduce head. (The tape passes over the erase, record, and reproduce heads in that order).

Step 3. Adjust the REPRODUCE LEVEL controls for the desired output level on both channels.

-NOTE-

Acoustical feedback may result when recording from a microphone and simultaneously reproducing from a loudspeaker at the same location. Proper placement of the microphone and loudspeaker and appropriate adjustment of the reproduce level control, so that little or none of the loudspeaker output is fed back into the microphone, will prevent this condition. Also, because of the placement of record and reproduce head, and the consequent tape travel item between them, a slight time delay will be noticed between the introduction of the input signal and the acoustical output of that same signal at the loudspeaker.

Step 4. To stop either the record or reproduce function return the appropriate switch to its neutral (middle) position. To stop both the record and reprodudce functions and tape motion, return both the RECORD and REPRODUCE switches to their neutral positions. Tape motion components will be automatically de-activated at the end of a reel.

3-20. REWIND AND FAST FORWARD OPERATION

3-21. NORMAL. Tape threaded on the recorder-reproducer and not already in motion, can be moved rapidly in either the forward (FAST FWD) or reverse (REWIND) directions by placing the REWIND-FAST FWD switch to the appropriate position. Tape motion can be stopped by returning this switch to the neutral (middle) position. Tape motion components will be automatically de-activated at the end of a reel; place the REWIND-FAST FWD switch in its neutral position before re-threading the tape.

3-22. WITH THE TAPE IN MOTION. If the tape is already in motion in the record or reproduce mode when the REWIND-FAST FWD switch is placed in other than the neutral (middle) position, normal operation will continue until such time as the RECORD and/or REPRODUCE switches are returned to their neutral positions. Tape motions will then immediately go into the fast winding mode dictated by the position of the REWIND-FAST FWD switch.

3-23. FROM REWIND OR FAST FORWARD TO RECORD OR REPRODUCE. If either the RECORD or REPRODUCE switches are placed in their 1 position while the tape is in motion in the rewind or fast

forward mode, the rewind or fast forward operation will continue until the REWIND FAST FWD switch is returned to its neutral (middle) position. At that time the tape will come to a stop; after a delay of approximately three seconds it will start in response to the setting of the RECORD switch or the REPRODUCE switch. The delay is introduced to prevent the tape breaking or stretching; possible if the capstan idler is allowed to engage the capstan with the tape in rapid motion.

3-24. SHUTTLING. Cueing and editing may be done at fast speed by changing the REWIND-FAST FWD switch back and forth between the REWIND and FAST FWD positions. It is not necessary to allow the tape to slow down or come to a stop. No damage to tape or equipment will result from such operation. During the tape shuttling process, the REPRODUCE switch may be placed in its 1 position to provide aural monitoring; however, do not allow the REWIND-FAST FWD switch to pause in its neutral position for more than the three second delay period for the equipment will automatically enter the reproduce mode.

3-25. ERASING MAGNETIC TAPE

3-26. WITH THE RECORDER-REPRODUCER. Erasure of a previously recorded tape without recording new information may be accomplished by installing the tape on the recorder-reproducer, turning both RECORD LEVEL controls to their full counter-

clockwise position and running the tape in the record mode at a tape speed of 15 ips.

3-27. WITH BULK DEGAUSSERS: Bulk degaussers will completely and quickly erase entire reels of tape. Follow the instructions provided with the degausser.

3-28. SPLICING MAGNETIC TAPE

3-29. In editing by cutting and splicing the tape, or if the tape is broken, proper splicing techniques will result in strong splices that will neither loosen or fray as they are used and which will cause minimum transients as they pass the heads. The use of splicing tape specifically designed for this purpose is recommended; the ordinary type of pressure sensitive tape may tend to creep, or may "bleed" around the splice and seriously comtaminate the tape and the surface over which it passes.

3-30. SPLICING PROCEDURE (See Fig. 3-6).

Step 1. Over lamp the ends of the tape and cut through both layers at an angle of approximately 45° (not critical).

Step 2. Lay the ends of the tape to be spliced on a flat surface with the uncoated (shiny) side up and butt the ends together.

Step 3. Center a piece of splicing tape over the butted ends, parallel to the splicing cut; the width of the splicing tape should not exceed 3/4 inch. Press the tape in position and

firmly rub it with some smooth object to press out all air bubbles.

Step 4. Carefully trim the splicing tape to the same width as the recording tape (or cut slightly into the edge of the recording tape), be sure no adhesive is left exposed.

3-31. OPERATING WITH TWO RECORDER-REPRODUCERS

3-32. With the auxiliary recorder-reproducer connected as described in paragraph 4-25, it is possible by proper manipulation of the amplifier controls, to record on one recorder-reproducer while reproducing on the other; or to operate either independently (such as for a record-monitor operation). Proper placement of the controls for the operating functions possible are shown in Fig. 3-7.

3-33. Note that it is impossible to enter the record (or reproduce) made simultaneously on both recorder-reproducers. Tape speeds may be individually selected, and tape may be placed in the fast forward or rewind operation on either recorder-reproducer while the other is operating in the record or reproduce mode.

SECTION IV

INSTALLATION INSTRUCTIONS

4-1. MOUNTING

4-2. Space requirements for the recorder-reproducer set, together with the layout of the holes for the mounting bolts, are shown in Fig. 4-1. Drill eight 13/32-inch holes corresponding to those in the mounting base, and use 3/8-inch bolts and nuts to secure the base to the ship's structure. Drill four 11/32-inch holes, corresponding to those in the stabilizer, and use 5/16-inch bolts and nuts to secure the stabilizer to the ship's structure.

4-4. Space requirements for the remote control and the layout of the mounting holes are shown in Fig. 4-2. Drill three 13/64-inch holes in the desk or table on which the remote control is to be mounted and use No. 8-32 bolts and nuts to secure the unit. Note that the cover must be removed by removing two screws on the front of the unit (at the lower edge) and two screws on the back of the unit (also at the lower edge); captive nuts are mounted on the inside of the cover for these screws. The cover will then lift off; it will not be free as connecting wires from the terminal board to the lights and switch will remain connected.

4-5. There is no practical limitation as to the distance that the remote control unit may be removed from the recorder-reproducer proper. For example; if the recommended wire size (No. 22) is used the remote control may be placed up to 2,000 feet away from

the recorder-reproducer. Further separation will necessitate larger wire sizes.

4-6. VENTILATION

4-7. Adequate circulation of ventilating air is assured by the design of the cabinet and no special precautions are necessary. However, do not mount the equipment near sources of corrosive vapors or fumes, or in areas where the temperature of the ambient air available for ventilation is excessively high.

4-8. SWAY SPACE

4-9. Allow sufficient sway space, as shown in Fig. 4-1, to ensure that nothing interferes with the action of the shock mounts. Never place foreign objects in the space between the cabinet and the base; this space must be left clear for shock mount action.

4-10. INTERCONNECTING-GENERAL

4-11. Access to the interconnecting terminal boards which are located on a tray between the compartments of the cabinet is obtained either by simply sliding the recorder-reproducer from the cabinet to its fully extended position, or by completely removing the recorder-reproducer from the cabinet (see Fig. 4-3). Then remove the safety cover which encloses the terminal boards.

4-12. Cable access plates are provided on the top and back of

the recorder-reproducer and on the back of the remote control. Holes must be drilled in these access plates for rubber grommets or other entrance fittings to accommodate the remote control power, and signal input and output cables. Cable clamps are provided to guide the cables after they enter the recorder-reproducer.

4-13. Use flexible cable at the entrance to recorder-reproducer set and leave sufficient slack in the cable so that it will not restrict the normal movement of the equipment under conditions of vibration.

4-14. CONNECTING REMOTE CONTROL

4-15. The remote control is connected as shown in Fig. 4-4. No interconnecting cable is provided. Use a five-conductor shielded cable; if 2,000 feet of cable (or less) is required it is recommended that each of the five conductors be of 22 gage stranded wire. This will limit the voltage drop across the resistance in the wires to less than five volts for each circuit. Use appropriately larger wire sizes if more than 2,000 feet of cabling is required. Maximum current through any conductor is less than 75 milliamps. Terminal lugs (No. 6) should be affixed to the end of each conductor, and the cables should be connected to the terminal boards in the recorder-reproducer and the remote control.

4-16. CONNECTING SIGNAL INPUT LEADS

4-17. Signal input cables will be connected dependent upon which of the optional inputs will be used; no cables are furnished. Connections for each of the various inputs are detailed in Table 4-1 and Fig. 4-5. Use shielded, 2 conductor, cable; limitations as to cable length are governed by the signal originating equipment, and the recommendation of the manufacture of these devices should be followed. Affix No. 6 terminal lugs to the conductors and to the shield for connection to the terminal boards in the recorder-reproducer.

4-18. Note that all inputs are normally balanced. An unbalanced (one side grounded) input will have a slight effect on high frequency response.

4-19. CONNECTING SIGNAL OUTPUT LEADS

4-20. One signal output for each reproduce channel is terminated in a phone jack on the front of the recorder-reproducer. These furnish convenient plug-in facilities for phone plugs from earphones or other equipment. This output is internally connected in parallel with the one described in paragraph 4-21.

4-21. The second signal output for each stage is terminated at the terminal boards. Connections to a speaker or other equipment are detailed in Table 4-2 and Fig. 4-5. Use shielded two-conductor cable. This output is internally connected in parallel with the one described in paragraph 4-20.

4-22. CONNECTING POWER INPUT CABLES

4-23. The ship's 115-volt, 60 cps, single phase, a-c line is connected to terminals 32 and 33 on TB104.

4-24. The capstan drive motor in the recorder-reproducer is a synchronous a-c motor. Tape speed, controlled by the capstan is thus a function of supply line frequency, and it may be desirable in some instances to obtain drive motor power from a source which is more stable than the ship's a-c line. This may be accomplished by removing the factory-installed jumper wire across terminals 34 and 35 on TB104, and connecting the auxiliary power source to terminals 34 and 33. Note that these connections are only to the drive motor, and that the ship's line must also be connected as explained in Paragraph 4-23; also, that fusing (1/2-ampere) and facilities for switching the capstan drive motor on and off must be provided in the auxiliary power source line.

-CAUTION-

If the normal ship's AC line and the auxiliary power source have a common neutral (normally grounded) line, polarity must be observed when making the connections described in paragraph 4-24, or a shorted power source may result. Connect the "hot" side of the normal line to terminal 32, the "hot" side of the auxiliary power source to terminal 34, and both neutral lines to terminal 33.

4-25. CONNECTION OF AUXILIARY RECORDER-REPRODUCER

4-26. Three receptacles are provided (on the shelf in the cabinet) to facilitate connecting an auxiliary recorder-reproducer. It will be necessary to drill a hole in the cable access plate to permit interconnecting cables to leave the cabinet.

4-27. The auxiliary recorder-reproducer will be identical to the RD-141/UNQ-7 assembly provided with the standard equipment.

4-28. LOCATION OF AUXILIARY RECORDER-REPRODUCER

4-29. The distributed capacity inherent in the reproduce head cables will result in the resonant frequency of the heads being reduced, so that the high frequency end of the response curve is affected . Fig. 4-6 indicates the high frequency response which can be expected for different lengths of cables running from the auxiliary recorder-reproducer to the receptacles inside the cabinet; the curve is based on using a typical cable, with a capacitance of 12 micro-microfarads per foot.

4-30. FABRICATING INTERCONNECTING CABLES

4-31. The following connectors are required to fabricate the three cables necessary to connect the auxiliary recorder-reproducer.

Type	Qty.
AN3106B-10S1-3S	2
AN3106B-10SL-4S	2
AN3106N-22-14S	1
AN3106B-22-14P	1

4-32. Cable requirements are:

(a) A 15 conductor, nine single conductors plus three shielded, twisted pairs, each conductor, type MWC22 (7)-cable for control circuits, and record and erase head connections.

(b) Two coax cables for the reproduce head connections. Capacitance of this coax should be as low as possible (Example: Sequoia Wire Co., No. 77005).

4-33. Connections for each cable are shown in Fig. 4-7. Note that the connectors which mate with the receptacles inside the cabinet will probably have to be installed after the cables are inserted through the hole in the cable access plate.

4-34. CONNECTING THE AUXILIARY RECORDER-REPRODUCER

4-35. After the cables are fabricated, connect J101, J102, and J103, (on the shelf inside the cabinet assembly) to J205, J204, and J202 respectively, on the auxiliary recorder-reproducer. It is impossible to connect any cable to the wrong connector.

SECTION V

MAINTENANCE

5-1. PREVENTIVE MAINTENANCE

5-2. GENERAL

5-3. Preventive maintenance consists primarily of periodic cleaning and lubrication of recorder-reproducer components, demagnetization of the record and reproduce heads, and visual inspection of the electronic components. Exercise care to see that oil does not reach the capstan idler tire and avoid, insofar as possible, touching the tire with the fingers.

5-4. CLEANING

5-5. Extreme cleanliness is required of all components in the tape threading path if optimum performance is to be achieved. Most tape manufacturers lubricate their tapes, and this lubricant (plus some oxide from the tape) will form a coating on the surfaces which contact the tape. If this coating is not removed, an increase in flutter, loss of positive capstan drive, and deteriorated frequency response will result.

-CAUTION-

Use only the specified cleaning agents.
Other solvents may damage the head assembly
or the rubber wheel on the capstan idler.

5-6. DAILY. Clean the capstan and tape guides, using denatured alcohol (or pure naphtha) applied with a soft, lintless cloth.

5-7. DAILY. Clean the head faces with a mixture of Xylene and 0.1% Aerosol, or pure naphtha. Head faces can be most easily cleaned by using a cotton swab on a wooden stick (such as Q-tips used for medical applications). Do NOT wrap cotton around any device which could scratch the head faces (See Fig. 5-1.)

5-8. WEEKLY. Clean the capstan idler wheel with denatured alcohol (or pure naphtha) applied with a soft, lintless cloth.

5-9. WEEKLY. Extend the tape transport and the amplifier assemblies in turn from the cabinet and remove any accumulation of dirt or dust.

5-10. LUBRICATION

5-11. UPPER CAPSTAN BEARING. The upper capstan bearing should be lubricated once each 2,000 hour operating period or once each year (which ever occurs first). Use lubricating Oil MIL-L-17331.

Step 1. Place the POWER switch in the off position.

Step 2. Extend the tape transport from the cabinet and revolve it so that the controls are upward.

Step 3. Remove the capstan idler by prying off the cap and removing the retaining ring which holds it to the shaft. Do

not lose the spacer which is underneath the idler. Use a clean cloth to avoid direct contact between the fingers and the rubber tires.

Step 4. Remove the dust cap from the capstan shaft by prying it up with a screw driver or the fingers; the upper capstan bearing is now exposed.

Step 5. Apply the recommended lubricant to the bearing, using as much as it will accept. Carefully wipe off any excess oil.

Step 6. Re-assemble the components reversing Steps 3 and 4. Be sure no oil is transferred to the rubber tire of the capstan idler in the re-assembly process.

Step 7. Revolve the assembly to its normal position and return it to its normal position in the cabinet.

5-12. REEL IDLER BUSHING. Damping action is obtained by having the reel idler flywheel coupled to the idler bushing by a film of silicone fluid. It is necessary to lubricate this component only if the damping action is lost and the flywheel spins on the shaft without any apparent coupling. Use Dow-Corning Silicone Fluid Type 200, with a viscosity of 25,000 centistokes.

Step 1. Place the POWER switch in the OFF position.

Step 2. Extend the tape transport from the cabinet.

Step 3. Remove the reel idler bushing and flywheel by loosening the two set screws which hold the bushing in place on the shaft, and pulling both the bushing and flywheel off the shaft.

Step 4. Separate the bushing and the flywheel and smear the silicone fluid liberally on the outside of the bushing.

Step 5. Re-assemble the flywheel on the bushing; wipe off reel idler shaft.

Step 6. Return the tape transport to its normal position in the cabinet.

5-13. REEL END WARNING ARM BEARING. The reel end warning arm mechanism action is damped by silicone fluid. Lubrication is necessary only if the damping action is lost, and the mechanism "chatters" during the fast winding modes of tape motion. Use the same silicone fluid recommmended in paragraph 5-12.

Step 1. Remove the brake access cover by removing the three screws which hold each turntable in position, removing the capstan idler wheel, and loosening the five cam lock fasteners which hold the cover.

Step 2. Remove the one screw on which the reel end warning arm is pivoted, the arm will come free from the cast frame. Do not lose the spacing shim underneath the arm.

Step 3. Separate the bushing from the arm.

Step 4. Smear the silicone fluid liberally on the bushing. Re-assemble the bushing and the arm and wipe off any excess fluid.

Step 5. Place the spacing shim in position and re-install the assembly on the cast frame.

Step 6. Re-install the brake access plate, the capstan idler wheel, and both turntables.

5-14. DEMAGNETIZATION OF HEADS

5-15. The record and reproduce heads may occasionally acquire a degree of permanent magnetization through a fault in the amplifiers, improper use of the equipment, or a contact with a magnetized object. Magnetized heads will generally result in an increase of five to ten decibels in noise level, distortion of any signal recorded, and a gradual erasure of high frequencies on recorded tapes.

5-16. PREVENTING HEAD MAGNETIZATION. Several precautionary measures will aid in preventing magnetization of the heads.

Precaution 1. Do not remove any tube from the record amplifier while recording.

Precaution 2. Do not connect or disconnect input cables or head cables while recording.

Precaution 3. Do not saturate the record amplifier with abnormally high input signals while recording (See General Data).

Precaution 4. Do not test the continuity of the heads with an ohm meter.

5-17. DEMAGNETIZING THE HEADS. (See Fig. 5-2). The following procedure is based upon using the DeGausser furnished.

Step 1. Place a piece of masking tape, transparent tape, etc., over the tips of the demagnetizer.

Step 2. Remove any magnetic tape from the recorder-reproducer. Place the POWER switch in its OFF position.

Step 3. Remove the head cover and the shield over the head assembly.

Step 4. Plug the demagnetizer in any 115 volt a-c power source.

Step 5. Bring the tips of the demagnetizer into contact with the record head stack with the tips straddling the head gaps in the center of the stack. Run the tips slowly up and down the stack several times; then withdraw the magnetizer very slowly. Slow withdrawl is required if thorough de-magnetization is to be achieved.

Step 6. Repeat Step 5 at the reproduce head stack. (It is not necessary to de-magnetize the erase head).

Step 7. Disconnect the demagnetizer from the power source only after it has been removed well away from the heads.

Step 8. Replace the head shield and cover.

5-18. VISUAL INSPECTION

5-19. Once each week make a thorough visual inspection of the complete system. Check for dust or dirt, potting material leaking from capacitors or transformers, loose connections, loose mounting nuts or screws, deterioration of wiring of components, corroded connections, defective plugs or receptacles, etc. Remove any articles placed in the space between the shock mounts and the cabinet or which limit the normal movement of the equipment under

conditions of shock or vibration. Check that the wiring to the equipment has not been worn or frayed by the normal movement of the equipment. Corrective measures appropriate to the conditions found through the visual inspection should be initiated.

5-20. CORRECTIVE MAINTENANCE

5-21. GENERAL

5-22 This section is intended as a guide in locating and correcting electrical or mechanical faults which may be encountered in maintaining the equipment. Only qualified personnel should be allowed to perform the servicing procedures.

5-23. LOCALIZING SOURCE OF TROUBLE

5-24. If a tape recorded on the AN/UNQ-7 does NOT reproduce properly, the trouble could be in either the record or reproduce circuits. Isolating the malfunctioning circuit may be easily accomplished by reproducing a standard alignment tape. If the reproduction is normal, the trouble is in components associated with the record circuit. If the same trouble is in components associated with the reproduce circuit.

5-25. Another method of determining whether the record or the reproduce circuit is at fault is to simultaneously record the same signal on both channels. Rewind the tape and reproduce it, observing the output of both channels. Then, without

rewinding the tape, transpose the reels, placing the supply reel on the take-up turntable, and the take-up reel on the supply turntable; this will orient the reels so that the signal recorded on one channel will be reproduced on the other channel. Reproduce the tape, comparing the output of each channel with the results noted on the previous run. If the same channel exhibits the fault, the trouble is in the reproduce circuit, if the trouble now appears at the output of the other channel the fault is in the record circuit.

5-26. Once the offending circuit is identified, the fault may be further isolated by following the alignment procedures. It may be found that proper alignment will rectify the fault.

5-27. Test circuits for use with the record amplifier and the reproduce amplifier are shown in Fig. 5-3. This circuit should be used whenever it is suspected that a defective head is causing the trouble; as the amplifier portion is checked without the head when the indicated circuit is used, it can be quickly established if the head is defective.

5-28. REMOVING UNITS FROM THE CABINET

5-29. As both the recorder-reproducer assembly and the amplifier assembly can be extended from the cabinet and rotated so that test points and components are easily available, it should NOT be necessary to remove these assemblies completely in ordinary

servicing. However, when connecting the equipment or when major overhaul procedures dictate that the equipment be removed from the ship, it will be most convenient to remove the assemblies from the cabinet (See Fig. 5-4).

Step 1. Extend the assembly from the cabinet.

Step 2. Disconnect the interconnecting cables.

Step 3. Loosen the elastic stop nuts on the slide mounting latches and flip the cap of the latch up and over, so that the pivot pin on the assembly is free.

Step 4. Lift the assembly off the slides.

-NOTE-

When replacing the assembly, reverse the above procedure. Before tightening the elastic stop nuts on the mounting latches, press the slide and the assembly together to ensure that the assembly will slide easily and smoothly in and out of the cabinet.

5-30. ELECTRONIC ALIGNMENT-GENERAL

5-31. GENERAL. The AN/UNQ-7 is completely aligned at the factory prior to shipment. Unless damaged in transit, no adjustments should be necessary when it is received; the performance checks described at the rear of this Section will determine whether re-alignment is necessary at any time. A recorder out of align-

ment may be characterized by poor frequency response, high noise and distortion, low output, or any combination of these faults.

5-32. EQUIPMENT REQUIREMENTS. The following list details the minimum equipment required for the alignment procedures:

a) Audio Oscillator-Hewlett-Packard, Model 200AB or equivalent.

b) A-c vacuum tube voltmeter-Hewlett-Packard, Model 400D or equivalent.

c) D-c vacuum tube voltmeter-Hewlett-Packard, Model 410B or equivalent.

d) Standard alignment tape.

e) Head demagnetizer.

f) Head phones-600 ohms impedance or higher.

g) Load resistor- 8 ohm non-inductive of at least 2 watt capacity.

5-33. DEMAGNETIZING HEAD. It is advisable to demagnetize the record and reproduce head (see paragraph 5-17) before proceeding with the alignment. Magnetized heads may partially erase the higher frequencies on the standard alignment tape and make it useless as a standard.

-NOTE-

In the following discussion of alignment procedures, it is assumed that the procedure will be completely carried out for the re-

reproduce and record circuits in the same sequence as that of the discussion. Unless otherwise indicated, the equipment set up remains the same throughout the procedure. If certain adjustments or settings cannot be made, it is an indication that a fault exists. It is impossible, because of component and circuit interaction, to state in this manual that a certain component or circuit is defective. It is suggested that all tubes be tested, if that does not correct the fault, voltage and resistance readings should be used to locate the malfunctioning component.

5-34. ELECTRONIC ALIGNMENT-REPRODUCE CIRCUIT

5-35. PROCEDURE. The complete procedure in aligning the reproduce circuit consists of aligning the reproduce head, setting the reproduce level, and checking the reproduce frequency response. The reproduce amplifiers for the two channels are identical and the same procedure is applicable to either channel.

5-36. REPRODUCE HEAD ALIGNMENT

Step 1. Remove the loudspeaker (or other equipment) from the output of the reproduce amplifier.

Step 2. Substitute the eight ohm resistive load for the equipment removed in Step 1. Connect the a-c vtvm across this load.

Step 3. Remove the head cover and shield which cover the head assembly.

Step 4. Thread the standard alignment tape on the recorder-reproducer assembly.

-CAUTION-

Never place the equipment in the record mode when the standard tape is threaded or it will be erased. Note that recording can be controlled at the remote location.

Step 5. The first tone reproduced from the tape will be 10kc, which is used for the reproduce head alignment. Adjust the alignment screw (see Fig. 5-5) for a maximum indication on the vtvm, if necessary reducing the setting of the REPRODUCE LEVEL control. If the head is badly out of adjustment, which should occur only if unqualified personnel without proper equipment have attempted this procedure, several minor peaks will be observed on each side of the maximum, however, the proper settings will produce a maximum peak 15 to 20 db higher than any of the minor peaks.

-NOTE-

The reproduce heads are constructed as a single unit, and the above procedure will serve to align the heads for both channels. The procedures which follow must be performed for each channel: It is recommended that the reproduce and record circuits for one channel be completely aligned and the procedure then repeated for the other channel.

5-37. REPRODUCE LEVEL SETTING. The second tone on the tape is 500 cps recorded at standard operating level. Adjust the standard operating level. Adjust the appropriate REPRODUCE LEVEL control for an indication of +10db (2.41) volts on the vtvm.

-NOTE-

This setting must be maintained until the record level indicator is calibrated.

5-38. REPRODUCE FREQUENCY RESPONSE CHECK. Following the second tone on the standard tape is a series of tones from 50 cps to 10kc. Observe the vtvm indication, as each tone is reproduced, the response should be within +2db of the +10db reference level previously set (see paragraph 4-37). Rewind and remove the standard alignment tape.

5-39. ELECTRONIC ALIGNMENT-RECORD CIRCUIT

5-40. PROCEDURE. The complete procedure for aligning the record circuit consists of adjusting the record bias, aligning the record head, adjusting the a.v.c. circuit for Channel B, and calibration of the record level indicator. The REPRODUCE LEVEL control must be set as indicated in paragraph 5-37.

5-41. RECORD BIAS ADJUSTMENT. The bias potentiometer adjustment (see Fig. 5-6) is made at the top of the recorder-reproducer assembly chassis, so that assembly should be extended from the cabinet.

Step 1. Thread a tape (either blank or one recorded with unimportant data) on the recorder-reproducer.

Step 2. Connect the audio oscillator to the input of the record amplifier, using the correct connections and level for the type of input desired (see paragraph 4-16). Set the oscillator output to 500 cps.

Step 3. Start the tape in motion at 7.5 ips in the simultaneous record and reproduce mode.

Step 4. Adjust the appropriate RECORD LEVEL control for +10db (2.41 volts rms) indication on the vtvm.

Step 5. Adjust the appropriate bias potentiometer (R201) for Channel A or (R202) for Channel B for a maximum indication of the VTVM, re-adjusting the RECORD LEVEL control if necessary.

-NOTE-

The AVC switch must be in its OFF position when adjusting the bias on Channel B.

5-42. RECORD HEAD ALIGNMENT. With the equipment still operating as in paragraph 5-41, set the audio oscillator frequency to 10kc and adjust the record head alignment screw (see Fig. 5-5) for a maximum output as indicated on the VTVM. If several peaks are noted, choose the one of greatest amplitude.

5-43. A.V.C. ALIGNMENT. Channel B, all adjustments, controls, and test points for the AVC circuit are located on the top of the amplifier assembly. This assembly should be extended from the cabinet. (See Fig. 5-7).

Step 1. Connect the negative lead of the dc vtvm to test jack J402; connect the positive lead to chassis ground.

Step 2. Place AVC switch S401 in its ON position.

Step 3. Turn the AVC THREASHOLD control full counter-clockwise.

Step 4. Set the audio oscillator frequency to 500 cps.

Step 5. Start the tape in motion at 7.5 ips in the simultaneous record and reproduce mode.

Step 6. If necessary adjust the RECORD LEVEL control for +10db (2.41 volts rms) as indicated on the a-c vtvm across the eight ohm output load.

Step 7. Disconnect the a-c vtvm from the output and connect

it directly across the audio oscillator,noting the output of the oscillator. Increase the audio oscillator output by 3db.

Step 8. Observing the indication of the d-c vtvm (connected to the test jack), adjust AVC THRESHOLD control R426 for a reading of 0.5 volts.

5-44. RECORD LEVEL INDICATOR CALIBRATION. The potentiometer for adjusting the Record Level Indicator are located on the Record Amplifier Chassis and are R521 for channel A local, R411 for channel A remote, R522 for channel B local, and R427 for channel B remote. To calibrate the indicators proceed with the following steps:

Step 1. Set the frequency of the audio oscillator to 500 cps at the proper level (see General Data) for the input being used. The reproduce level must still be set to produce +10db (2.41 volts rms) from the Standard Level tape.

Step 2. Start the tape in motion at 7.5 in/sec in the simultaneous record and reproduce mode.

Step 3. Adjust the appropriate RECORD LEVEL control for an indication of +10db (2.41 volts rms) on the VTVM.

Step 4. Adjust the appropriate local record level indicator potentiometer for a reading of zero VU on the record level indicator.

Step 5. Adjust the appropriate remote record level indicator potentiometers for a reading of zero VU on the remote meter. A selector switch is provided on the remote control box to allow

either channel A or channel B record level to be read.

5-45. NOISE BALANCE ADJUSTMENT. The most accurate method of adjusting the noise balance control requires the use of an harmonic wave analyzer (Hewlett-Packard, Model 300C or equivalent). With the REPRODUCE LEVEL control full clockwise, and the tape in motion at 7.5 ips in the simultaneous record and reproduce mode, adjust the NOISE BALANCE control for a minimum of "popping" noise heard in the headset.

5-46. RECORD AND REPRODUCE EQUALIZATION CHECK. Both the record and reproduce circuits employ fixed equalization, with no adjustments provided. The equalization of either circuit may be easily checked by using the circuits shown in Fig. 5-3, when standard trouble shooting techniques indicate trouble in the equalization. Circuit constants in both record and reproduce amplifiers should result in response curves indicated on Fig. 5-8 and Fig. 5-9.

5-47. If a faulty record or reproduce head is suspected, a run-through of the appropriate equalization check should quickly isolate the trouble either to the head, which is not used when making the equalization check, or to the amplifier.

5-48. MECHANICAL ADJUSTMENT (See Fig. 5-6).

5-49. REEL END WARNING SWITCH. The point at which the warning switch is activated is controlled by the setting of an adjusting

screw on the warning switch arm. To perform this adjustment, remove the brake access cover. The lock nut which holds the adjusting screw is accessible through the opening in the cast frame. Use an offset screwdriver to make the adjustment; running the screw in will increase the reel end warning time, running the screw out will decrease the warning time. Tighten the lock nut before replacing the brake access cover.

5-50. SAFETY SWITCH ARM. Spring tension on the safety switch arm should be such that the safety switches are positively actuated when the arm is released. A light spring scale pulling upward on the tape guide on the arm should indicate a maximum of 1.5 ounces when the arm is one inch above the bottom of its slotted opening, measured with the tape transport assembly in its normal operating position. This may be adjusted by loosening the locking nut and rotating the safety switch arm bushing. Tighten the locknut before re-checking the spring tension on the arm.

5-51. BRAKES. Brake tensions are fixed by the low tension and high tension springs. The equipment is relatively insensitive to wide ranges of brake tensions (see Table 5-2). If they fail outside the specified ranges the brakes should be reconditioned (see paragraph 5-54) or the springs should be replaced.

5-52. MEASURING BRAKE TENSION

Step 1. Place the POWER switch in its OFF position.

Step 2. Place the empty reel on either turntable.

Step 3. Wind the string on the reel by manually rotating the reel in a clockwise direction.

Step 4. Attach the free end of the string to the spring scale.

Step 5. Use the spring scale to pull the string from the reel. (The reel will rotate counterclockwise). Take the reading with the scale in steady motion. Correct scale readings are shown in Table 5-2.

Step 6. Wind the string on the reel by manually rotating the reel in a counterclockwise direction.

Step 7. Use the spring scale to pull the string from the reel. (The reel will rotate clockwise). Take the reading while the scale is in steady motion. Correct scale readings are shown in Table 5-2.

5-53. TAKE-UP AND HOLD BACK TENSION. No adjustments are possible. Incorrect take-up or holdback tension may result from a defective take-up or rewind motor, or a defective motor capacitor or dropping resistor.

5-54. RECONDITIONING OR REPLACING THE BRAKES

5-55. GENERAL. After long usage the neoprene-asbestos material used for brake linings may take on a glaze that will cause a squeal

when the brakes are applied. This can be remedied by removing the brake bands and reconditioning the linings by lightly brushing them with a fine wire brush.

-CAUTION-

Do not bend the brake bands while re-conditioning the linings.

5-56. REMOVING THE BRAKE BANDS

Step 1. Remove the reel turntables, the capstan idler, and the brake access cover from the tape transport assembly.

Step 2. Disconnect the brake tension springs where they are attached to the brake assembly.

Step 3. Remove the retainer ring from the top of the fixed pin which holds the loop at one end of the brake band.

Step 4. Remove the elastic stop nut, the spacer, and the washer from the end of the brake release rod.

Step 5. Remove the brake rod bar under which the brake release bar passes. The brake band can now be lifted off.

5-57. RE-ASSEMBLING THE BRAKE BANDS

Step 1. Reverse the procedure in paragraph 5-56.

Step 2. After re-assembly is complete, adjust the elastic stop nut at the end of the brake release rod by threading the nut on the rod and manually actuating the brake solenoid arm. Proper adjustment is obtained when the end of the brake band bends a barely perceptible amount just as the solenoid reaches

its fully actuated position. It will be necessary to check as the unit is being run, until this condition is achieved.

5-58. REPLACING THE BRAKE BANDS. After very long usage the brake bands may fail to respond to reconditioning. Faulty braking action, abnormal brake tensions, or when a visual inspection reveals that the loop in the end of the brake band contacts the fixed pin when the rewind brake drum is manually rotated counterclockwise or the take-up brake drum is rotated clockwise are all indications that the brakes should be replaced. Follow the removal and re-assembly procedure quoted in paragraphs 5-56 and 5-57.

5-59. TROUBLE SHOOTING PROCEDURES

5-60. The following outlined trouble shooting information can be used as an aid to finding and correcting various malfunctions of the system.

5-61. CAUSES OF FAILURE TO MEET FREQUENCY RESPONSE SPECIFICATION

5-62. FAULTY RECORD OR REPRODUCE AMPLIFIERS. Check responses of each amplifier without the head as described in paragraph 5-46. Standard amplifier trouble shooting techniques can be followed in locating electrical faults or component failure.

5-63. MAGNETIZED HEAD. The demagnetization procedure is described in paragraph 5-17.

5-64. MISALIGNMENT OF HEADS. This is generally characterized by a failing response at the higher frequencies. Reproduce head alignment is described in paragraph 5-36, and record head alignment in paragraph 5-42.

5-65. POOR CONTACT BETWEEN THE HEADS AND TAPE. This usually results in poor high frequency response. Observe the output while simultaneously recording and reproducing at a frequency where response begain to fall out of specifications; use a clean, soft cloth and apply a gentle pressure first at the record head, then at the reproduce head. If this results in response within specifications, clean the heads as described in paragraph 5-7.

5-66. DEFECTIVE HEAD. Replace the head.

5-67. CAUSES OF FAILURE TO MEET NOISE SPECIFICATIONS

5-68. MAGNETIZED HEADS. Random background noise and "popping" sounds may be indication of magnetized heads or misadjusted noise balance control. The demagnetization procedure is explained in paragraph 5-14.

5-69. MISADJUSTED NOISE BALANCE CONTROL. Adjustment of this control is discussed in paragraph 5-45.

5-70. MICROPHONIC TUBES. Replace tubes found to be microphonic.

5-71. HUM FROM EXTERNAL SOURCES. Hum from electrostatic sources may be induced in the amplifiers where levels are low and the impedance and amplifications are high, such as is the case in the early stages of the amplifiers. Hum from magnetic sources is most easily picked up by the heads or by the transformers in the amplifiers. Check for such sources which may have been placed in close proximity to the equipment.

5-72. CAUSES OF FAILURE TO MEET DISTORTION SPECIFICATIONS

5-73. MAGNETIZED HEADS. The demagnetization procedure is discussed in paragraph 5-14.

5-74. RECORD BIAS IMPROPERLY ADJUSTED. Check and if necessary adjust the record bias as described in paragraph 5-41.

5-75. RECORD LEVEL INDICATORS IMPROPERLY CALIBRATED. This may result in recording at too high a level. Check and if necessary adjust the calibration as described in paragraph 5-44.

5-76. DEFECTIVE RECORD OR REPRODUCE AMPLIFIERS. Tube or component failure, or unbalance in the push-pull amplifier stages could result in distortion. Follow standard amplifier trouble shooting techniques in locating the faulty circuit.

5-77. CAUSES OF FAILURE TO MEET FLUTTER SPECIFICATIONS

5-78. GENERAL. Flutter and wow are a result of irregularities in tape speed and appear as cyclic frequency deviations in

recording and reproducing. They can often be detected as variations in pitch when reproducing a steady tone. The frequency of flutter and wow can be determined by viewing an oscilloscope connected across the output of the flutter measuring instrument. Table 5-3 lists the rotational periods of components in the tape drive system; if the flutter frequency corresponds to one of these periods it is an indication that the indicated component is contributing to the condition. If the component has not been damaged (or, as might be the case in the upper capstan bearing, is not in need of lubrication), the trouble is probably due to the presence of oil or an accumulation of some foreign matter such as dirt. Clean the component thoroughly using denatured alcohol.

-CAUTION-

Do not allow the cleaning agent to contact the head assembly or to enter any bearings.

5-79. DIRT ON HEADS, TAPE GUIDES, OR TAPE GUIDE POSTS. This may cause the tape to vibrate at a natural resonant frequency (in the manner of violin string). Clean the surfaces over which the tape passes, using denatured alcohol.

5-80. DRIVE MOTOR OUT OF SYNCHRONISM. This may be a result of low line voltage; excessive drive belt tension; dry or binding bearings in the drive motor, capstan, capstan idler, or drive belt

idler; defective drive motor capacitor; or defective drive motor.

5-81. DAMAGED RUBBER TIRE ON THE CAPSTAN IDLER. If a flat or dented spot is developed on the rubber tire of the capstan idler, which will generally occur only if a malfunction allows the idler to engage the capstan when the capstan is not rotating, it will result in flutter or wow. Run the equipment in either the record or reproduce mode for several hours; if the tire is then not restored to normal, the capstan idler must be replaced.

5-82. DEFECTIVE OR IMPROPERLY INSTALLED DRIVE BELT. This includes a belt with a poor splice, one installed with the spliced end on the inside of the belt, or mis-alignment of the drive motor so that the belt tracks against the flange of the drive motor or capstan pulley.

5-83. IMPROPER TAPE TENSION. A guide to proper tape tension is given in paragraph 5-53.

5-84. BENT OR MIS-SHAPED REELS. If the tape scrapes against the flange of either reel, the reel should be straightened or discarded.

5-85. DRAGGING BRAKES. This may be caused by improperly installed take-up or rewind motor assemblies, foreign matter between the brake drum and brake lining, mechanical obstruction of brake action, a defective brake solenoid, improper adjustment of the

stop nut on the brake release rod (see paragraph 5-57) or a brake band which has been bent.

5-86. ADJUSTMENTS AND TESTS

5-87. GENERAL. The equipment is shipped from the factory in a ready-to-operate condition; once physical installation has been completed it should be necessary only to set the record level or the reproduce level for the signal strength involved. However, a few simple tests will quickly indicate whether any damage or mis-alignment has occured during transit.

5-88. DEFINITIONS OF TERMS

5-89. Normal Operation Level: This refers to the recording level at which the total harmonic distortion generated by the non-linearity of magnetic tape characteristics is one percent at a frequency of 400 cps. This corresponds to approximately two percent over-all distortion when the reproduce circuit is delivering one watt into an eight ohm load.

5-90. INPUT. Wherever it is specified that an oscillator signal be applied to the input a definite input is specified, connections and input signal voltage will vary with the input used. These connections and input signal voltage will vary with the input used. These connections and input signal requirements are detailed in Fig. 4-5 and Tables 4-1 and 4-2.

5-91. MEASUREMENTS. Measurement of frequency response, noise, and distortion are all made with a reference signal recorded at normal operating level. Reproduce outputs for the various tests are specified in the different discussions.

5-92. FLUTTER AND WOW. Flutter and wow are cyclic frequency deviations produced by periodic irregularities in tape speed. As a general term flutter includes wow; but specifically, flutter refers to variations occurring at a relatively high rate (above approximately five cycles per second) while wow refers to variations in frequency of the recorded signal.

-CAUTION-

Become familiar with the operating instructions contained in Section 3, before attempting the following procedure.

5-93. CHECKING TAPE MOTION

5-94. CAPSTAN ROTATION. Capstan rotation may be checked as follows:

Step 1. Thread blank tape (or a tape previously recorded with information which is not to be saved) on the recorder-reproducer.

Step 2. Place the POWER switch on the front panel of the amplifier assembly in its ON position. The capstan should start rotating, but the tape should remain stationary. The power

indicator should light.

Step 3. Place the REPRODUCE switch in its 1 position. Tape should start in motion at the speed selected by the 3.75- 7.5- 15 switch on the recorder-reproducer as the capstan idler clamps against the capstan.

Step 4. Move the 3.75- 7.5- 15 switch to its outer position. Tape motion should continue at a speed either half or double the original speed (depending upon the original position of the 3.75- 7.5- 15 switch).

Step 5. Return the REPRODUCE switch to its NEUTRAL (middle) position. Tape motion should cease as the capstan idler moves away from the capstan.

Step 6. Place the RECORD switch in its 1 position by holding the record interlock in its full left position and simultaneously moving the RECORD switch lever. Tape motion should start at the speed selected by the 3.75- 715- 15 switch. The record indicator should light.

Step 7. Place the REWIND-FAST FWD switch in its FAST FORWARD position. This should have no effect on tape motion or the record mode.

Step 8. Return the RECORD switch to its neutral (middle) position. The record indicator should be extinguished and the tape should immediately go into the fast forward operation set in Step 7.

Step 9. Place the REPRODUCE switch in its 1 position. This should have no effect on the fast forward operation. Return this switch to its neutral (middle) position.

Step 10. Return the REWIND-FAST FWD switch to its neutral (middle) position. Tape motion should stop.

Step 11. Place the REWIND-FAST FWD switch in its REWIND position. Tape should start in a reverse direction to normal tape travel at a fast winding rate.

Step 12. Place the REPRODUCE switch in its 1 position. This should have no effect on the rewind operation.

Step 13. Return the REWIND-FAST FWD switch to its neutral (middle) position. Tape motion should stop, then (after a delay of approximately three seconds) start in the normal direction at the seed selected by the 3.75- 7.5- 15 switch.

Step 14. Stop tape motion by returning the REPRODUCE switch to its neutral (middle) position.

Step 15. Proceed to the remote control unit. If possible maintain communication with an operator at the recorder-reproducer proper. The STANDBY indicator at the remote control should be lighted.

Step 16. Place the STANDBY RECORD switch on the remote control in the RECORD position. The RECORD indicator should light and the STANDBY indicator should be extinguished. At the recorder-reproducer proper, tape motion should start at the speed selected by the 3.75- 7.5- 15 switch and record indicator 1 should light.

Step 17. Return the STANDBY-RECORD switch to its STANDBY position. The RECORD indicator should be extinguished, the

STANDBY indicator should light; at the equipment proper tape motion should stop and record indicator 1 should be extinguished.

Step 18. Have the operator at the recorder-reproducer proper transport the tape in the fast forward mode until only a small amount of tape remains on the supply reel (less than five minutes supply at 7.5 ips) then stop tape motion.

Step 19. Place the STANDBY-RECORD switch on the remote control in its RECORD position. The STANDBY indicator should be extinguished. The RECORD indicator should flash on and off approximately once per second to provide end-of-reel warning.

Step 20. Return the STANDBY-RECORD switch to its STANDBY position. Return the POWER switch on the recorder--reproducer to its OFF position. Tape motion has now been completely checked.

5-95. EQUIPMENT REQUIRED-ADJUSTMENTS AND TESTS

a. Resistive load-eight ohms, 2 watts

b. A-c vacuum tube voltmeter-Hewlett-Packard, Model 400D.

c. Audio oscillator-Hewlett-Packard, Model 200AB or equivalent.

d. Harmonic wave analyzer-Hewlett-Packard, Model 300C or equivalent.

e. Shielded resistance- 150 ohms, 1 watt

f. Flutter meter-see paragraph 5-100.

5-96. TESTING OVER-ALL FREQUENCY RESPONSE

Step 1. Remove any loudspeaker or other load from both outputs of the channel to be tested. Connect the eight ohm resistive load across either the speaker connections on the terminal board or the telephone jack on the front of the amplifier assembly.

Step 2. Connect the a-c vtvm across the eight-ohm load.

Step 3. Connect the audio oscillator to the bridging input (see Fig. 5-10). Set the oscillator to 1,000 cps at the maximum voltage shown in Fig. 5-10.

Step 4. Thread a reel of tape on the recorder-reproducer.

Step 5. Place the POWER switch in its ON position. Allow a 30 second warm-up period.

Step 6. Set the RECORD LEVEL control for normal operating level as indicated on the record level indicator.

Step 7. Place both the RECORD and REPRODUCE switches in their 1 position. The equipment will now simultaneously record and reproduce.

Step 8. Set the REPRODUCE LEVEL control for a vtvm indication of +10db (2.4 volts rms).

Step 9. Sweep the oscillator slowly through the specified response range and observe the output voltage versus frequency. Note that if the oscillator output is not essentially constant a suitable correction must be applied. Response should be as specified under General Data.

Step 10. Repeat the entire procedure for the second tape speed.

Step 11. Repeat steps 1 through 10 for the second channel.

5-97. TESTING OVER ALL NOISE

Step 1. Repeat steps 1 and 2 under Testing Overall Frequency Response, paragraph 5-96.

Step 2. Connect the audio oscillator to the microphone input to Channel A or the 600-ohm balanced line input of Channel B (see Fig. 5-11). Set the oscillator output to 50 cps at the minimum voltage shown in Fig. 5-11.

Step 3. Thread a reel of tape on the recorder-reproducer.

Step 4. Place the POWER switch in its ON position. Allow a 30-second warm-up period.

Step 5. Set the RECORD LEVEL control for normal operating level as indicated on the record level indicator.

Step 6. Place the 3.75- 7.5- 15 switch in its 7.5 position.

Step 7. Place both the RECORD and REPRODUCE switches in their 1 position. The equipment will simultaneously record and reproduce.

Step 8. Set the REPRODUCE level control for a vtvm indication of +10db (2.4 volts rms). This corresponds to approximately one watt across eight ohms. Maintain this setting.

Step 9. Stop tape motion and rewind the tape to the beginning of the 50 cps signal.

Step 10. Set the RECORD LEVEL control in its full counterclockwise position. Disconnect the audio oscillator and replace it with a shielded 150-ohm resistor.

Step 11. Place the RECORD switch in its 1 position. The signal will be erased by the erase head.

Step 12. Stop tape motion and rewind the tape to the beginning of the erased portion.

Step 13. Place the REPRODUCE switch in its 1 position to reproduce the erased portion of the tape. Note the indication on the vtvm. The noise level should be as specified under General Data.

Step 14. Repeat the entire procedure for the other Channel.

5-98. TESTING OVERALL DISTORTION

Step 1. Repeat Step 1 under Testing Overall Frequency Response, paragraph 5-96.

Step 2. Connect the a-c vtvm across the eight-ohm load; also connect the harmonic wave analyzer across the load resistor.

Step 3. Connect the audio oscillator to the microphone input of Channel A or the 30,000-ohm balanced bridging input of Channel B (see Fig. 5-12). Set the oscillator output to 50 cps at the minimum voltage indicated in Fig. 5-12.

Step 4. Thread a reel of tape on the recorder-reproducer.

Step 5. Place the POWER switch in its ON position.

Step 6. Set the RECORD LEVEL control for normal operating level as indicated on the record level indicator.

Step 7. Place the 3.75- 7.5- 15 switch in its 7.5 position.

Step 8. Place the RECORD switch in its 1 position.

Step 9. Record at minimum signal input (set in Step 13) frequencies of 50 cps, 1kc, and 10kc. Then stop tape motion.

Step 10. Set the audio oscillator output to 50 cps at the maximum voltage indicated in Fig. 5-12, for the inputs involved. Set the RECORD LEVEL control for normal operating level as indicated on the record level indicator.

Step 11. Place the RECORD switch in its 1 position.

Step 12. Record at maximum signal input level (see in Step 10) frequencies of 50 cps, 1kc, and 10kc. Then stop tape motion.

Step 13. Rewind the tape to the beginning of the distortion test data.

Step 14. Place the REPRODUCE switch in its 1 position. The equipment will reproduce the series of tones recorded in Steps 11 and 12. Set the REPRODUCE LEVEL control for an output of 2.83 volts as indicated on the vtvm. This corresponds to one watt across eight ohms.

Step 15. Follow the instructions provided with the harmonic wave analyzer in measuring the harmonic distortion. Total

distortion will be the square root of the sum of the squares of the harmonic components. Distortion should fall within specifications quoted under General Data.

-NOTE-

If a fundamental nulling type instrument is used for measuring distortion, rather than the harmonic wave analyzer, which is recommended, the procedure outlined above will apply. However, this type of instrument will measure noise and flutter in addition to distortion, so these components should be checked prior to making the distortion run. High frequency distortion will probably be completely masked by modulation noise when using this type of instrument.

Step 16. Repeat the entire procedure for the other Channel.

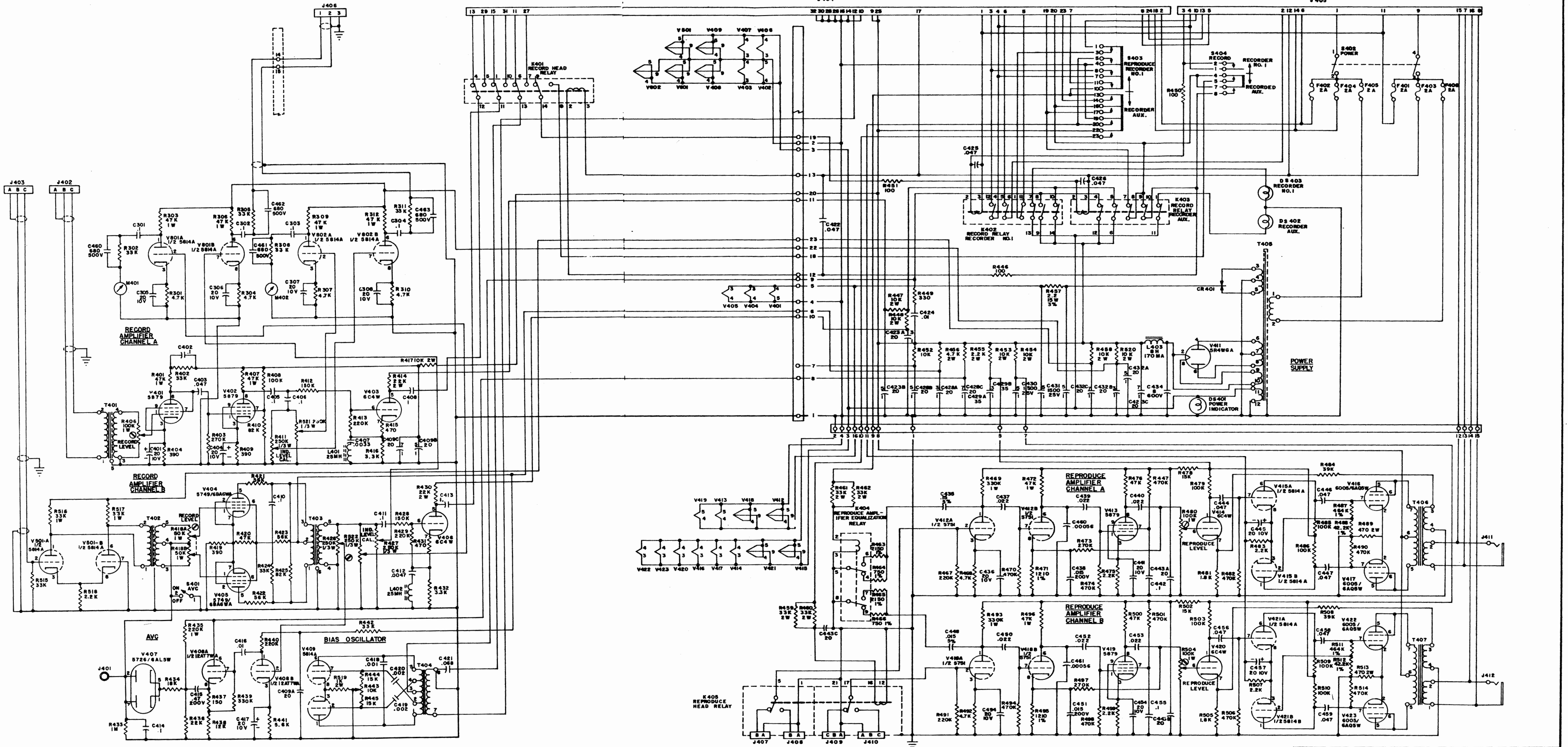
5-99. TESTING FLUTTER

5-100. Flutter should be measured with an instrument that meets the requirements specified by the I.R.C. (Institute of Radio Engineering, Inc. 1 East 79 Street, New York 21, New York) in their Standard 53 I.R.C. 19-S2.

5-101. Follow the instructions provided with the flutter measuring equipment used. As these instructions will vary with individual flutter measuring devices it is impossible to specify any particular procedure.

REVISIONS

REV		MFR DATE	MFR APPD	USN DATE	USN APPD



ITEM	REQD	PART NO	DESCRIPTION	MATL	MATL SPEC	UNIT WT

LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS DECIMALS ANGLES
±1/64 ±.005 ±0°30'

DWG D.E.LYTLE
CHK [signature]
APP'D [signature]
DATE 4-22-60
APP'D DATE

AMPLIFIER ASSEMBLY SCHEMATIC DIAGRAM

(ARTWORK FOR 92H479)

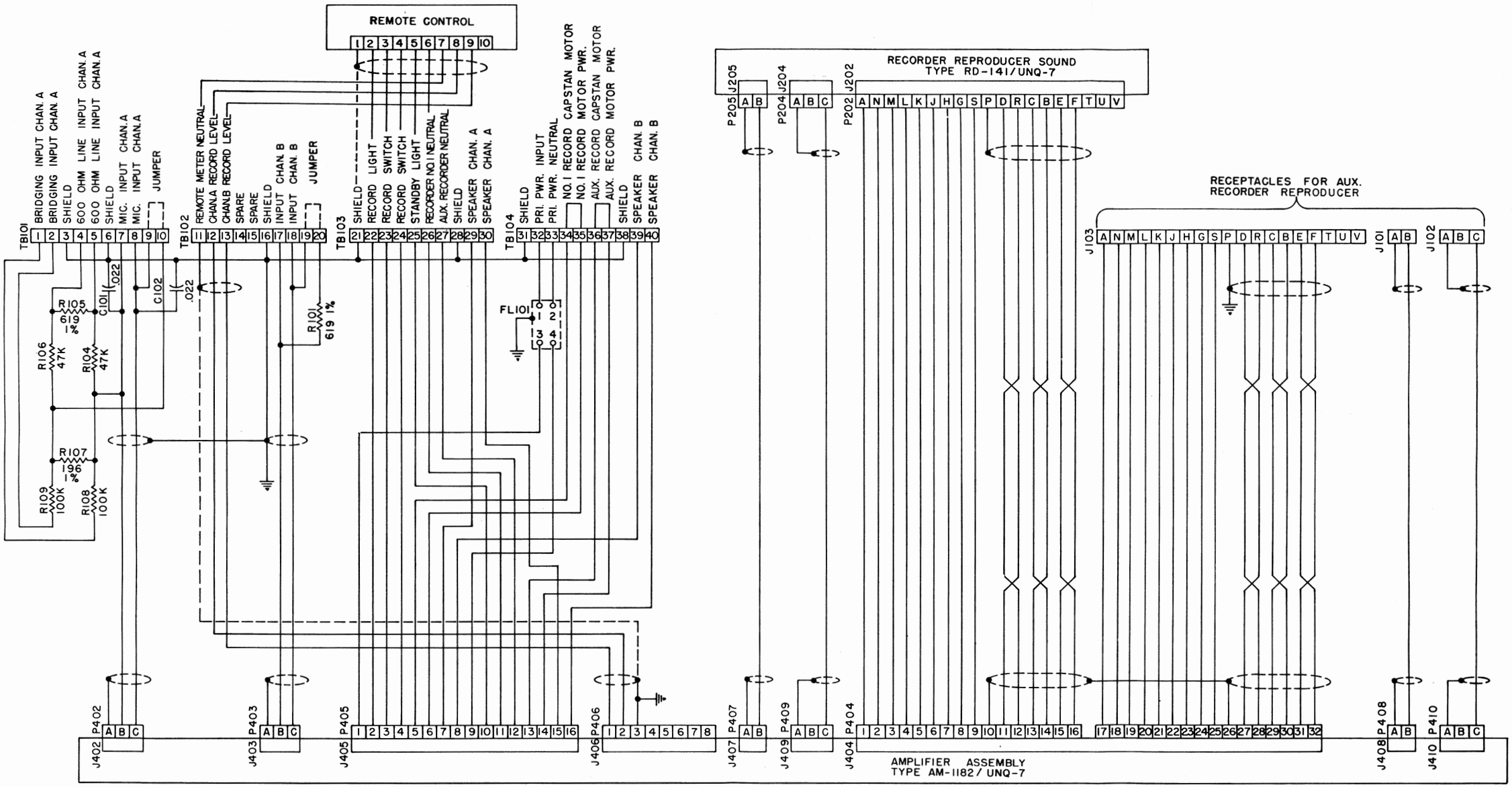
MIDWESTERN INSTRUMENTS
TULSA, OKLA.

96H282

NAVY DEPT | BUSHIPS DWG NO | REV
H

SCALE | WT CALC ACTUAL | CONT ON SHT | SHT NO

REVISIONS					
REV		MFR DATE	MFR APPD	USN DATE	USN APPD



ITEM	REQD	PART NO	DESCRIPTION	MATL	MATL SPEC	UNIT WT

LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS DECIMALS ANGLES
±1/64 ±.005 ±0°30'

DWG CAYWOOD
CHK
APP'D
DATE 4-22-60
APP'D DATE

RECORDER REPRODUCER SET SOUND, TYPE AN/UNQ-7 SCHEMATIC DIAGRAM

(ARTWORK FOR 92D393)

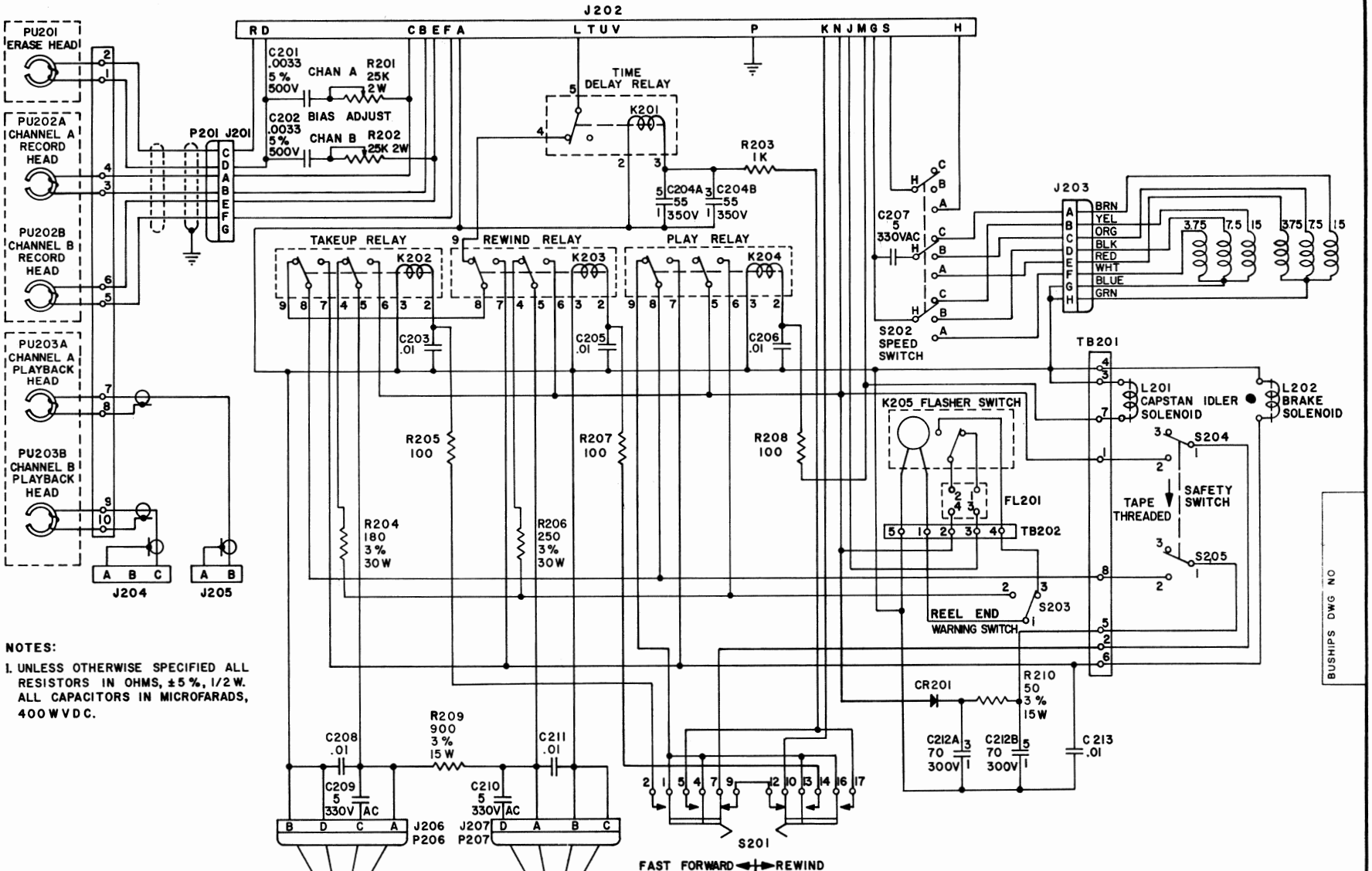
SCALE | WT CALC ACTUAL

MIDWESTERN INSTRUMENTS
TULSA, OKLA.

96D283

NAVY DEPT	BUSHIPS DWG NO	REV
	D	

CONT ON SHT | SHT NO



NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTORS IN OHMS, ±5%, 1/2W. ALL CAPACITORS IN MICROFARADS, 400WVDC.

ITEM	REQD	PART NO	DESCRIPTION	MATL	MATL SPEC	UNIT WT

LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS DECIMALS ANGLES
±1/64 ±.005 ±0°30'

DWG CAYWOOD
CHK
APP'D
DATE 4-21-60
APP'D DATE

RECORDER-REPRODUCER, SOUND, TYPE RD-141/UNQ-7
SCHEMATIC DIAGRAM
(ARTWORK FOR 92C463)

SCALE
WT CALC ACTUAL

MIDWESTERN INSTRUMENTS
TULSA, OKLA
96C284

NAVY DEPT	BUSHIPS DWG NO	REV
	C	

CONT ON SHT
SHT NO

REVISIONS					
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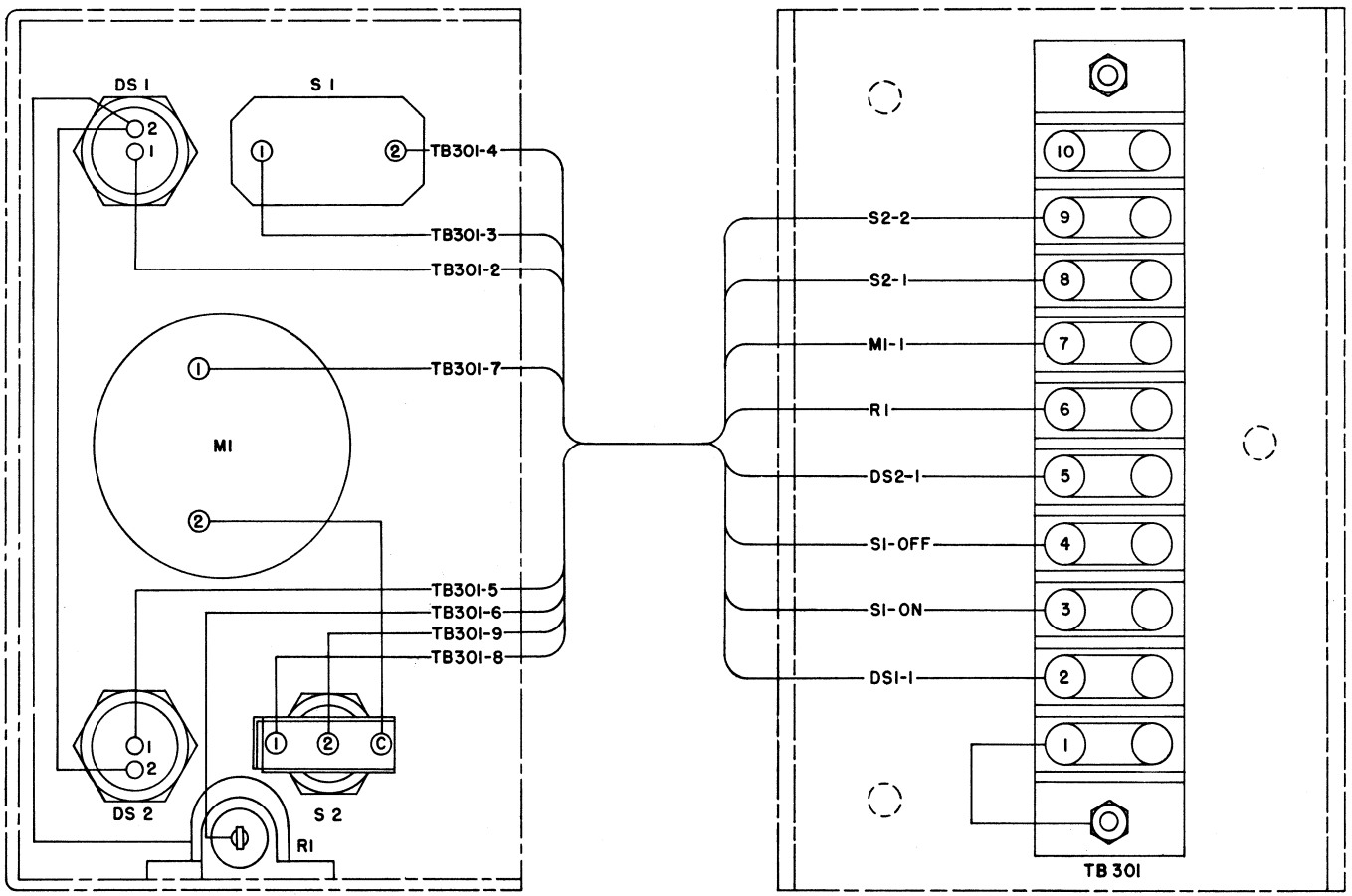

BUSHIPS DWG NO

ITEM	REQD	PART NO	DESCRIPTION	MATL	MATL SPEC	UNIT WT

LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES ±1/64 ±.005 ±0°30'	DWG CAYWOOD CHK B. MARG APP'D DATE 6-10-60 APP'D DATE	REMOTE CONTROL BOX WIRING DIAGRAM ARTWORK FOR 92C394	MIDWESTERN INSTRUMENTS TULSA, OKLA 96C285	NAVY DEPT	BUSHIPS DWG NO / REV
		SCALE / WT CALC ACTUAL		CONT ON SHT	SHT NO
					C