CHAPTER 6

MAGNETIC TAPE RECORDERS

INTRODUCTION TO MAGNETIC TAPE RECORDERS

Magnetic tape, whether analog or digital, is used quite extensively throughout the Naval Security Group for recording purposes. It provides a permanent record of collection and is available for reproduction of communication signals when necessary. As such, the preparation, production, and care of magnetic tapes and proper operation of magnetic tape recorders is of paramount concern. Not all magnetic tape recorders are alike. They differ in size, complexity, capability, and application. The ensuing discussion concerning the principles of magnetic tape recording applies primarily to the analog method. Principles applicable to digital recordings will be addressed later in this chapter.

PRINCIPLES OF MAGNETIC TAPE RECORDING

A substance is said to be MAGNETIC if it has the property of magnetism; that is, if it has the power to attract metalic substances such as iron, steel, nickel, or cobalt, which are known as MAGNETIC MATERIALS. A piece of metal which is magnetized exhibits two points of maximum attraction—one at each end, with no attraction at its center. The points of maximum attraction are called MAGNETIC POLES.

The MAGNETIC FIELD, which exists around every magnet, consists of invisible lines along which a MAGNETIC FORCE acts. These lines emanate from the north pole of the magnet and enter the south pole, returning to the north pole through the magnet itself, thus forming closed loops. The entire quantity of magnetic lines surrounding a magnet is called MAGNETIC FLUX. How readily flux flows through a magnetic circuit is a measure of that circuit's PERMEABILITY. High permeability indicates less resistance to the flow of flux.

A MAGNETIC CIRCUIT is a complete path through which magnetic lines of force may be established under the influence of a magnetizing force. A magnetic circuit is similar to an electric circuit, which is a complete path through which current is caused to flow under the influence of an electromotive force.

MAGNETIC PROPERTIES OF TAPE

Most magnetic tape consists of a plastic base material that is thinly coated on one side with a mixture of an adhesive and iron oxide particles. In the recording process, the tape is drawn past a record head. The record head is nothing more than an electromagnet with a small gap which sets up a magnetic field (figure 6-1A). The field consists of magnetic lines of force (flux) which are closed loops through the electromagnet and across the lead gap. As the signal applied to the record head varies in strength (flux density) and direction, the field produced by the recording head varies in strength and direction. When the tape passes across the record head gap and through the magnetic field (figure 6-1B), the flux lines prefer the path of least resistance presented by the tape as opposed to the higher resistance path of air.

FREQUENCY RESPONSE

Frequency response is the range of frequencies that can be recorded, depending upon the limitations of the recording material, recording device, and/or the tape speed of the recording.

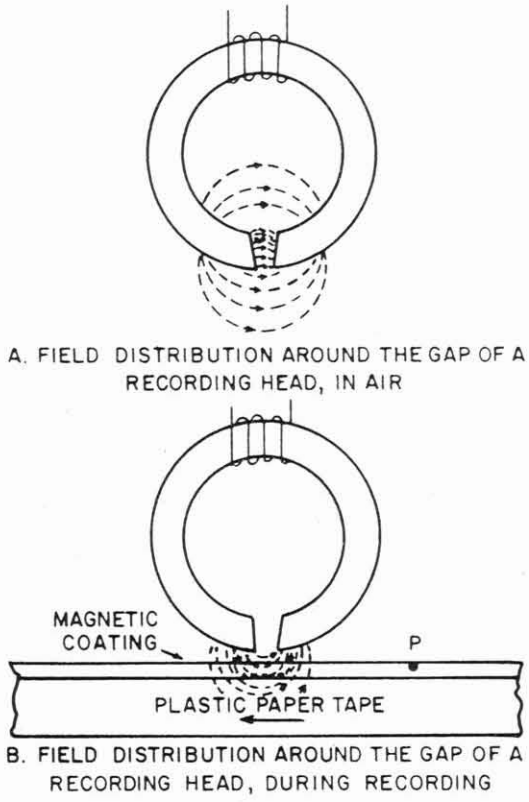

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Figure 6-1.—Recording head magnetic field distribution.

Recording Material

The size of the adhesive/iron oxide particles is one factor which determines the frequency response that may be recorded. Each particle acts like a small bar magnet, and the smaller the particle size; the higher the frequency response. The small particle size not only makes the recording of high frequencies possible, but also makes it easier to obtain a smooth surface, even particle distribution, and a constant thickness of coating. These factors are essential for the production of a high quality recording.

Air Gap

The principal limitation in reproducing higher frequencies is the reproduce head gap width. The record head gap width is not as critical as the reproduce gap since the signal is put on the tape by the record head trailing edge. If the recording head shown in figure 6-1B had no air gap, the magnetic field set up around the electromagnet would be weak and would run in a direction 90 degrees to the field shown; that is, into and out of the paper. A magnetic field of this type would be of little use for magnetic recording. Therefore, an air gap is used to provide a suitable magnetic field. The smaller the air gap can be made, the better the high-frequency response improvement in this direction.

Frequency-Tape Speed Relationship

Increasing the tape speed increases the length of tape passing the record head in a given period of time. It follows that for any given frequency, the distance between magnetic patterns is directly dependent upon the speed at which the tape moves past the recording head. Therefore, if the frequency to be recorded increases beyond certain values, the tape speed must be increased to gain an accurate reproduction of that frequency. This requirement is met in present generation tape recorders by making more than one recording speed available to the operator. For example, some recorders presently in use in the Navy record accurately frequencies up to approximately 100,000 hertz at a tape speed of 7½ inches per second. This capability theoretically doubles as the speed of operation doubles. With present generation equipment it is possible to record 2 MHz at 120 inches per second. In theory, this is an endless progression; increase the tape speed and the maximum recordable frequency is increased. Mechanical considerations, however, limit the maximum tape speed that can be used and the present trend is toward using increasingly smaller gap widths and improved amplification circuitry to gain increased frequency response.

THE BASIC RECORDER

Magnetic recorders are not particularly complicated. As previously discussed, magnetic tape is drawn past a recording head. As it passes

through the magnetic field set up by the recording head, the material on the tape becomes and remains magnetized. The amount of magnetization remaining in the material at each instant is governed by the magnetic properties of the tape and the strength of the magnetic field set up by the recording head. The magnetic field set up by the recording head is directly proportional to the signal being recorded. In reproduction, the magnetization which remains in the recording material induces corresponding voltages in the coil of the reproduce head. The voltage variations in the coils of the reproduce head are amplified and the original signal is recovered. The recording and reproduce heads may be incorporated into a single unit.

Basic components of magnetic recorders include a record head, a reproduce head, and an erase head. In addition there are other component parts such as a transport mechanism, spools or containers for the tape, a compensated record and playback amplifier, and special filter systems.

MULTITRACK RECORDERS

The vast majority of magnetic tape recorders used in the Naval Security Group are multitrack recorders, i.e., 2, 7, 8, and 14 tracks. Multitrack recording is made possible by using more than one record head, one for each track. The record heads are placed side by side in what is called the "head stack". A laminated magnetic shield is used between each track to prevent interference. In effect, each record head acts as a separate recorder with its own amplifier circuits. Figure 6-2 illustrates the head stack of a 4-track recorder.

There are times when it is desirable to record two or more related signals simultaneously. Also, in some applications, it is desirable to record, in addition to the signal(s), information such as voice annotations, standard time transmissions, or standard reference tone for tape speed check. The multitrack recorder makes possible such multiple recordings.

Careful spacing of the record heads is necessary to minimize overlap or "crosstalk" in multiple-track recordings.

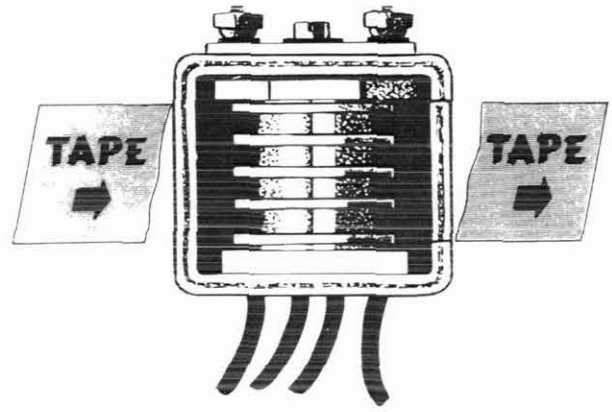

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Figure 6-2.—Four-track recorder head stack.

MAGNETIC TAPE ERASURE

One advantage of magnetic recording tape is that recordings may be erased and the tapes reused a number of times. Magnetic tapes may be erased by a d.c. field and/or an a.c. field.

D.C. Erasure

Erasure can be accomplished by magnetizing the medium to saturation with a very strong d.c. field or with the field from a strong permanent magnet. However, this method is not satisfactory because such a field, while it obliterates the previously recorded signal, leaves the tape particles strongly magnetized in one direction and produces a large amount of noise and considerable distortion in the next recording.

A.C. Erasure (Degaussing)

A better erasure system is to demagnetize the tape by the use of an a.c. field which drives the medium to saturation alternately in both directions and then gradually reduces to zero in the course of many alternations. This process is commonly known as "degaussing." In order to achieve many alternations in a small gap length, and to prevent any residual fields which will cause an audible note, the frequency of the erasing current for audio type recorders should

be 3 to 5 times higher than the highest recorded frequency.

To better understand the degaussing process, consider a single magnetized particle on the tape. During the degaussing process the magnetizing force of the erasing field brings the degree of magnetization of that particle first to saturation in one polarity and then to saturation in the opposite polarity. As the tape moves out of the erasing field and the influence of the erasing field and dies away gradually, the degree of magnetization of that particle continuously decreases in alternate polarities until a state of zero magnetization is achieved and erasure is complete.

For erasure to achieve complete demagnetization, (1) the head must be free of permanent magnetization, (2) there should be no d.c. field in the vicinity (such as from magnetized steel parts, meter movements, etc.), and (3) the waveform of the erase current must by symmetrical (equal positive and negative peaks).

If the following procedures are observed, troubles caused by poor erasure should be greatly reduced:

1. If recordings are not completely erased in one pass, repeat the erasure.
2. Carefully monitor the recording level to avoid overdriving the signal, thereby causing a "memory effect" in which the recorded signal will return after erasure.

Automatic Tape Degaussers

Although tape erasure by the recorder is satisfactory for some applications, it requires the tape to be run through the recorder (as in recording) and is time consuming. In addition, most precision tape recorders designed for special applications do not have an erase capability. To erase magnetic tapes quickly and efficiently, an automatic tape degausser is available at most field stations.

An automatic tape degausser (such as the one shown in figure 6-3) completely erases signals from magnetic tape by moving the whole reel of tape slowly and steadily into and out of an intense, alternating magnetic field while continuously rotating the reel. This subjects all portions of the tape to a thorough degaussing action. Heavy duty coils excited by an a.c. power source provide the erasing field. The coils are mounted in the rear of the degausser housing. One coil is positioned above the tape reel (when the reel is in the erasing field); the other is positioned below the tape reel.

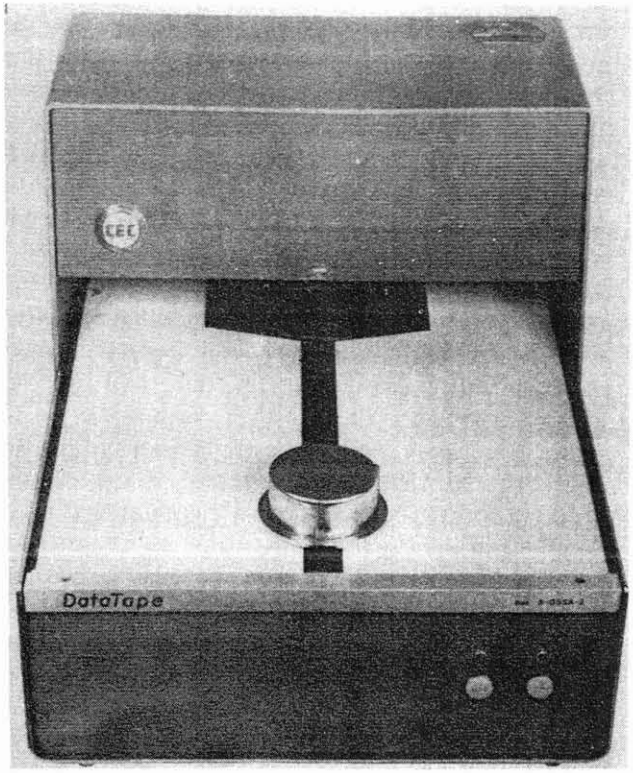

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Figure 6-3.—Automatic tape degausser.

AN/TNH-11 RECORDER-REPRODUCER

The AN/TNH-11, with an APPLIQUE unit, (figure 6-4) is a two-track magnetic tape recorder/reproducer system designed and constructed to applicable military standards. It performs dependably both at fixed stations and under mobile conditions. The AN/TNH-11 operates at a speed of 3 3/4 inches per second (ips). However, the recorder has a speed control switch which can be adjusted to increase or decrease the tape speed. The AN/TNH-11 requires quarter-inch tape on seven inch reels. An 1800 foot reel will provide a recording time of one and one-half hours at 3 3/4 ips.

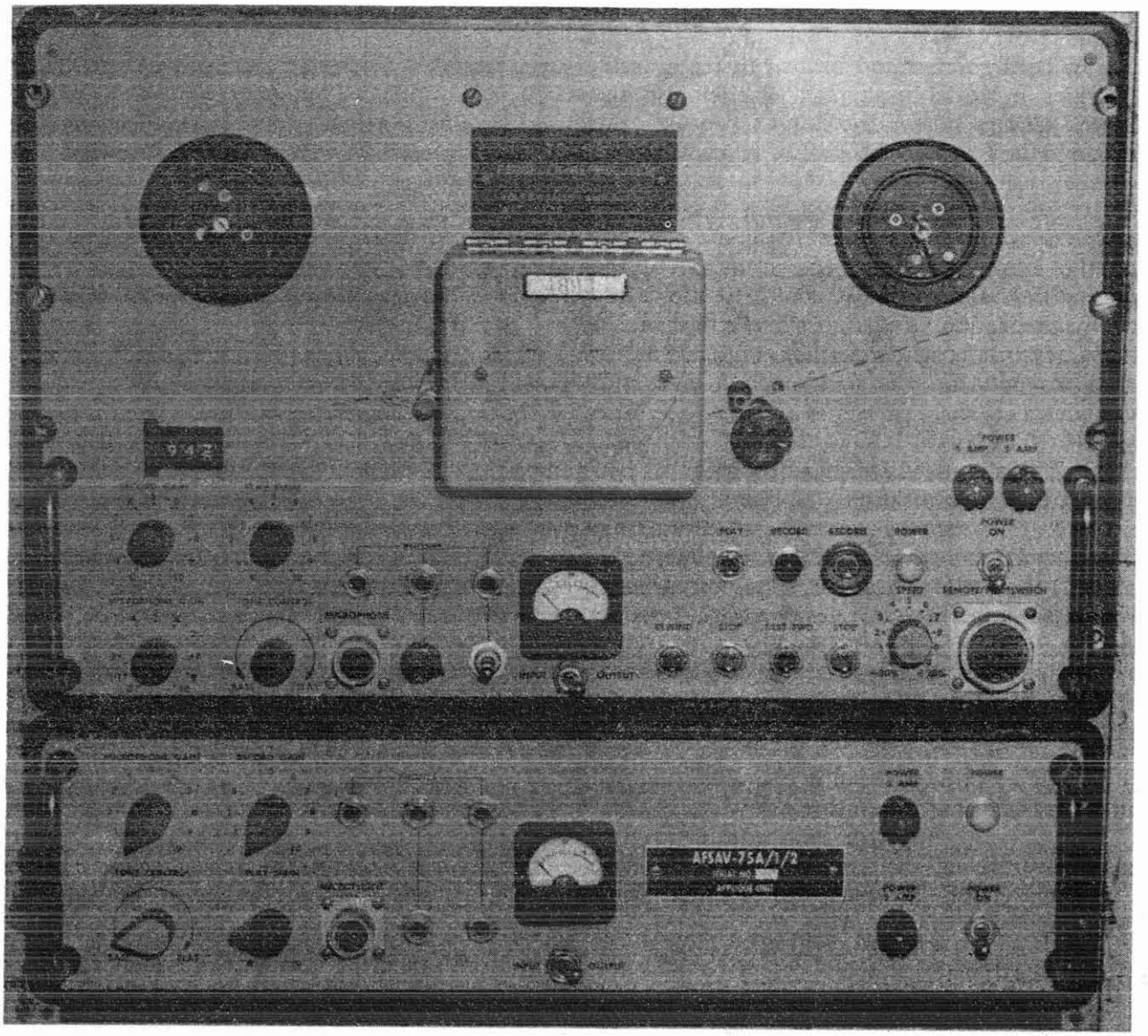

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Figure 6-4.—AN/TNH-11 tape recorder with applique unit.

AN/TNH-11 Accessory Units

The AN/TNH-11 accessories include the following units:

REMOTE CONTROL UNIT.—This unit controls the tape in both the record and reproduce mode.

MICROPHONE.—The microphone uses a push-to-talk switch which opens the microphone circuit to the recorder.

FOOTSWITCH.—A three position pedal control which provides foot operation in three positions: first position—Reproduce mode, second position—Stop mode, and third position—Rewind mode.

Controls and Functions

The controls and functions contained in the applique unit are identical to the controls contained in the main unit. Therefore, only the main unit controls and functions will be explained in table 6-1.

Tape Loading

The AN/TNH-11 tape loading procedures are listed in the following steps: (refer to figure 6-5)

1. Load a 7-inch reel of tape on the supply (left) spindle. (Several feet of tape should be allowed to hang from the supply wheel.)

Table 6-1.—AN/TNH-11 Recorder/Reproducer Controls and Functions

CONTROL	FUNCTION
POWER ON switch	Supplies power to the main unit and applique unit when in the ON position. The power ON condition is indicated by the illumination of the yellow POWER indicator lamp.
SPEED control	The SPEED control is graduated zero through ten with an extreme counter-clockwise OFF position. In PLAY MODE ONLY, the SPEED control may be utilized to vary the tape speed between plus 20 per cent and minus 30 per cent of the basic 3-3/4 ips obtained with the SPEED control in the OFF position.
RECORD switch	The momentary-press type RECORD switch is red and places the recorder in the record mode. Operation in the record mode is indicated by the illumination of the red RECORD indicator lamp.
PLAY switch	Selects the mode of operation for reproducing previously recorded tapes.
FAST FORWARD switch	Causes the tape to be wound on the take-up reel at an accelerated rate of approximately 250 ips.
STOP switch	Stops the tape. When going from either REWIND or FAST FWD mode to PLAY, or RECORD, the STOP button must be depressed before the PLAY or RECORD button is selected.
REWIND switch	Causes the tape to be rewound onto the supply (take-up) reel.
AMPLIFIER controls	Four AMPLIFIER controls used to regulate the record or reproduce gains: RECORD GAIN, color-coded red; PLAY GAIN, color-coded green; MICROPHONE GAIN, color-coded blue; TONE CONTROL, color-coded black.
INPUT/OUTPUT switch	Applies the input (record) signal to the VU meter in the INPUT position. Applies the playback (reproduce) signal to the VU meter in the OUTPUT position.
DIGITAL COUNTER	Provides an arbitrary figure as a reference aid so the operator may return to certain locations on the tape.

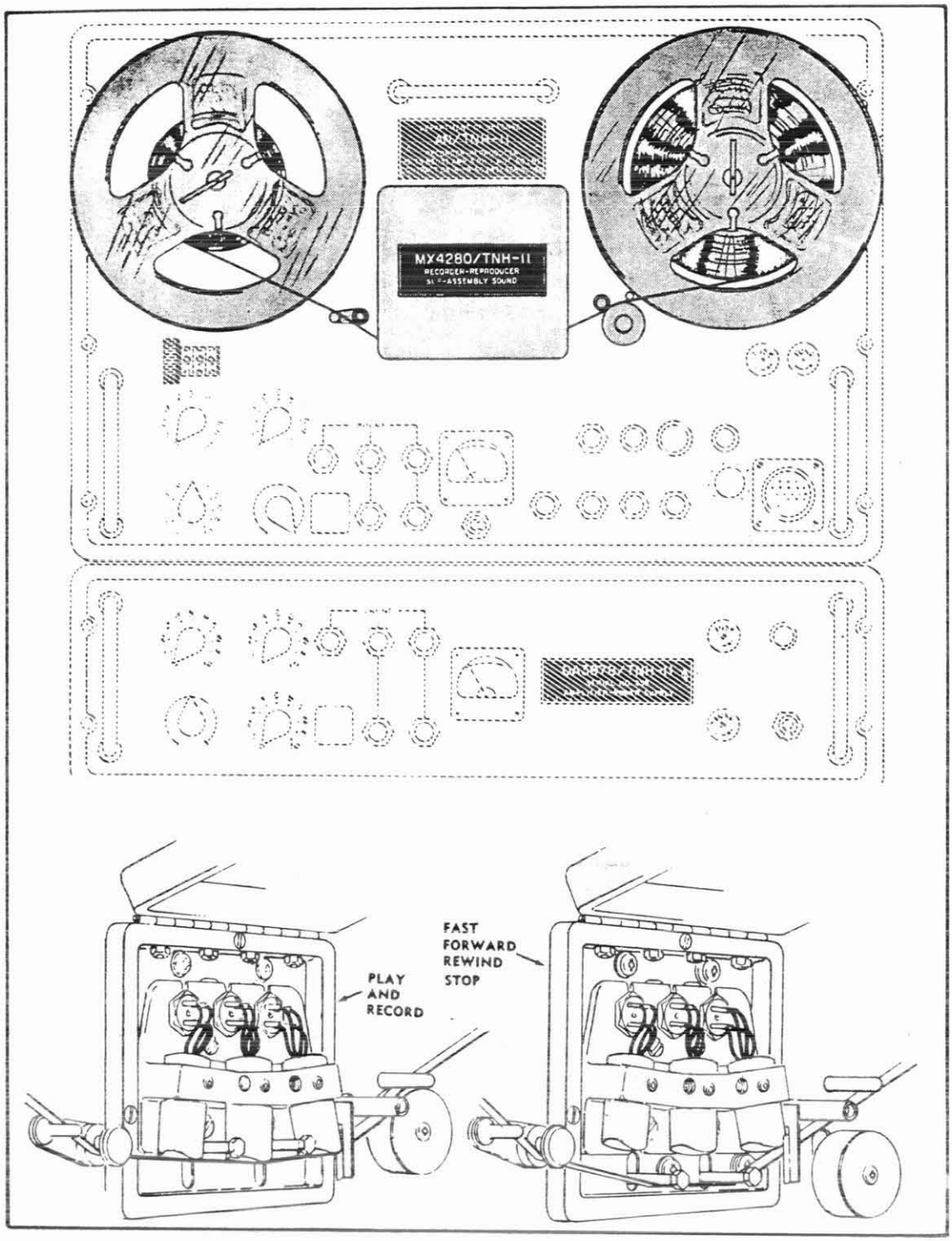

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Figure 6-5.—AN/TNH-11 tape threading.

2. Close the supply reel retainer and lock the tape reel.

3. Place an empty tape reel on the take-up spindle.

4. Close the empty reel retainer and lock the tape reel.

5. Thread the tape over the compliance arm, through the head cover slot, between the pressure roller and capstan, under the tape guide and onto the empty reel.

After the tape has been loaded on the reel and across the head area, the counter should be set to zero. This is done by revolving the serrated wheel on the left side of the counter until a zero reading is obtained. If it is then required to find a certain spot on the tape at a later time, and if adequate notations have been made on the reel container, the counter will be found to be quite useful as an approximation of a given portion of the recording.

Operating Procedure

The AN/TNH-11 can be used to record and/or reproduce previously recorded information. Each type of operation will be discussed briefly.

RECORDING OPERATION.—Set the line input level. This is done by setting the INPUT/OUTPUT switch to INPUT and adjusting the RECORD GAIN so that peaks of the signal read approximately zero vu's on the VU meter. If a microphone input is also to be used, the MICROPHONE GAIN should also be set for a reading of zero vu's on the meter using the peaks of the individual's voice as a signal source. Depress the RECORD switch and begin recording. Depress the "push-to-talk" switch on the microphone to make overriding commentary announcements. When it is desired to end the recording, depress the STOP pushbutton.

PLAYBACK OPERATION.—The PLAY pushbutton should be depressed and the PLAYBACK GAIN control adjusted so that the output is zero vu's or a comfortable listening level. The TONE control may be adjusted for a comfortable listening tone. When the TONE control is in the FLAT position, playback tone is the same as the recorded tone. When operating in the PLAY mode the speed control can be used to vary the tape speed between plus 20 per cent and minus 30 per cent of the basic 3-3/4 ips. This is to compensate for a recording made at a speed other than 3-3/4 ips or to vary the speed as an aid for transcription.

NOTE: The magnetic heads must be cleaned after each 10-15 hours of operation. This is primarily the operator's responsibility. To clean the heads, moisten a clean cotton swab with the available head cleaner and gently wipe the heads to remove dirt and oxide accumulated from the tape.

AN/GSH-19 SIGNAL DATA RECORDER/REPRODUCER

The AN/GSH-19 (figure 6-6) is an eight-track analog recorder/reproducer that is primarily used to provide analog back-up recording of data being recorded in digital form on up to three AN/GSQ-76 positions (TEBO). The analog recording can be used for special analysis and high-speed processing when the digital recorder on the TEBO system fails to operate. It is also used to record signals that cannot be processed on the TEBO system. The AN/GSH-19 uses 1/2 inch magnetic tape on 10½ inch tape reels (3600 ft.) and operates at one of three available tape speeds: 1-7/8, 3-3/4, and 7-1/2 ips for a recording/reproduce time of 360, 180, and 90 minutes, respectively.

Components

The AN/GSH-19 is contained within a single equipment bay and is comprised of:

a. Tape Transport Units (upper and lower) which provide uniform tape tension and speed across the record and reproduce heads.

b. Control/Indicator Assembly which contains all tape motion controls and the monitoring, both visual and aural, circuitry.

c. Data Amplifiers (upper and lower) which contain the amplifiers for record and reproduce functions of the AN/GSH-19 for upper and lower tape transports.

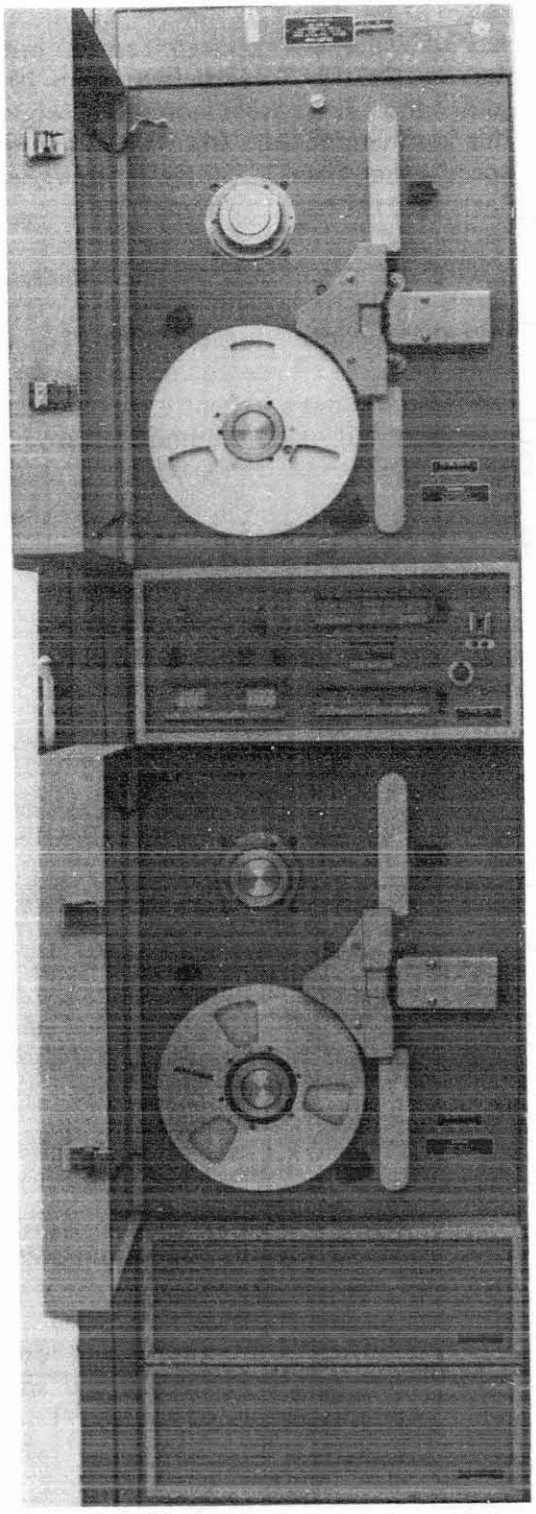

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Figure 6-6.—AN/GSH-19 analog recorder.

Functional Description

The AN/GSH-19 has four (4) operating modes: RUN, RECORD, FORWARD, and REWIND. Provision for automatic tape transport control is facilitated by three photo-conductive cells (tape sensing devices); the TAPE TENSION or PROGRAM sensor, the TAPE BREAK sensor and the LOW TAPE sensor. Normal procedure is to record with one transport while the alternate transport is being reloaded. However, simultaneous transport operation is possible. Sequential operation of transports is made possible by the LOW TAPE sensor. When the tape reaches a point on the supply reel where there is approximately three minutes left, the photoconductive cell is allowed to complete its circuit and thereby starts the next transport, providing the overlap.

Controls and Functions

All controls needed for operation of the AN/GSH-19 are located on the Control/Indicator Assembly panel (figure 6-7). Separate controls are used for operation of either tape transport. Oscilloscopes and controls for visual and aural monitoring are available for checking the input and recorded signals. Controls/Indicators and their functions are listed in table 6-2.

Operating Procedures

The following operating procedures should be used when operating the AN/GSH-19.

TAPE SELECTION.—Prior to operation of the AN/GSH-19, ensure that the following has been accomplished:

a. Analog magnetic tape has been selected (analog tapes have aluminum reels while digital tapes used with TEBO positions are plastic with green flanges).

b. Analog tape reel is not warped or otherwise damaged.

c. Magnetic tape is smoothly wound on the tape reel and contains no "bunched up" areas.

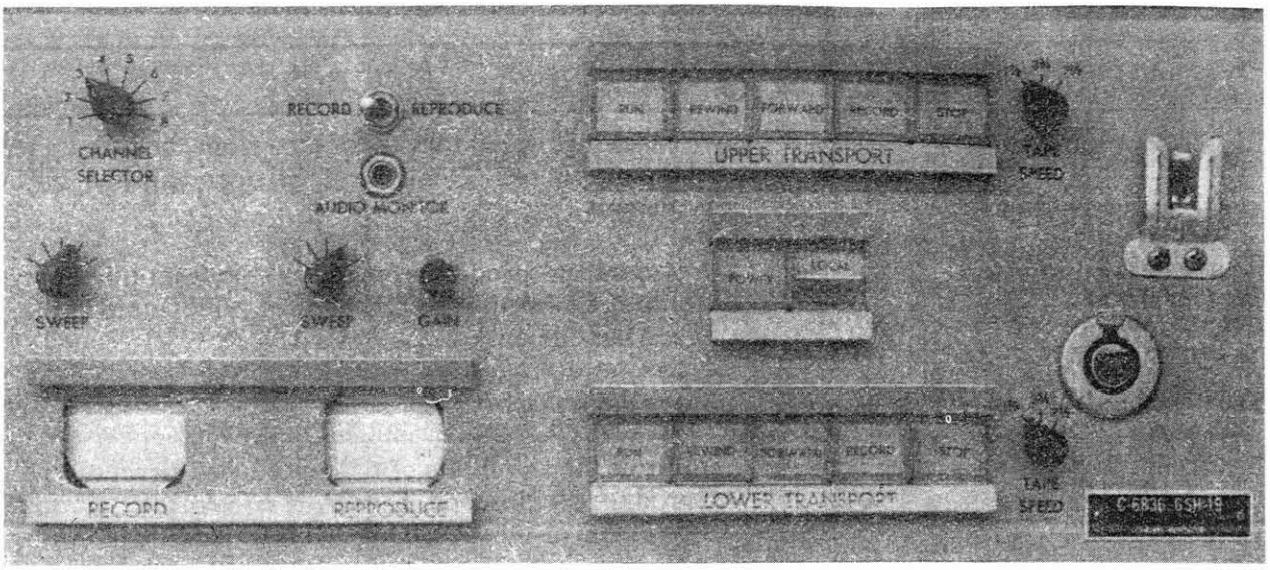

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Figure 6-7.—AN/GSH-19 control/indicator assembly panel.

Table 6-2.—AN/GSH-19 Controls/Indicators and Functions

CONTROLS/INDICATORS	FUNCTIONS
POWER pushbutton	Controls the a.c. input to components of the AN/GSH-19.
LOCAL/SEQUENTIAL pushbutton	An alternate action pushbutton that selects the desired mode of operation. This pushbutton is depressed and released until the appropriate portion, LOCAL or SEQUENTIAL, of the control lights up. LOCAL mode - Provides independent operation of each tape transport. The LOCAL mode will be used for all recording/reproducing. SEQUENTIAL mode - This mode provides for continuous running from one transport to the other. SEQUENTIAL mode will NOT be used by the operator.
RUN pushbutton	Energizes the selected transport at the speed selected by the TAPE-SPEED selector.
RECORD pushbutton	Applies record current to the record head. It must be activated before the RUN pushbutton is depressed to record.

Table 6-2.—AN/GSH-19 Controls/Indicators and Functions—Continued

CONTROLS/INDICATORS	FUNCTIONS
REWIND pushbutton	Provides high-speed transfer of tape from the take-up reel to the supply reel. This control will operate in the LOCAL mode only.
FORWARD pushbutton	Provides high-speed transfer of the tape from the supply reel to the take-up reel. This control will operate in the LOCAL mode only.
STOP pushbutton	Stops the transport.
GAIN control	Controls the amplitude of the reproduced signal on the reproduce oscilloscope. The GAIN control also controls the volume of the AUDIO MONITOR jack.
TAPE-SPEED selector	Selects the tape speed in inches per second.
SWEEP controls (2)	These are five-position rotary controls that select one of five sweep rates for oscilloscopes. The SWEEP controls have no effect on the recording.
CHANNEL SELECTOR switch	This is an eight-position rotary switch that selects the individual channel (track) to be monitored on the oscilloscope and at the AUDIO MONITOR jack.
RECORD/REPRODUCE switch	This is a two-position toggle switch that connects either the input signal to be recorded or the reproduced signal to the headset jack (AUDIO MONITOR).
RECORD OSCILLOSCOPE	Displays the input signal.
REPRODUCE OSCILLOSCOPE	Displays the reproduced signal.
AUDIO MONITOR	Headset jack. The signal heard via the monitor will depend upon the position of the CHANNEL SELECTOR switch. Volume of the signal heard is controlled by the GAIN control.

TAPE LOADING.—(refer to figure 6-8).

a. Insert a reel of tape on the upper (supply) reel hub and seat it firmly against the hub. Lock the reel hub by exerting pressure against the center of the lock, pushing in.

b. Install an empty reel on the lower (take-up) reel hub using the same procedures for locking as in step a.

c. Rotate the supply reel counterclockwise to release about four feet of tape for threading.

d. Thread the loose tape over the upper-guide roller, through the upper guide, between the upper capstan and pressure roller, over the record and reproduce heads, between the lower capstan and pressure roller, through the lower guide, over the lower guide roller to the take-up reel.

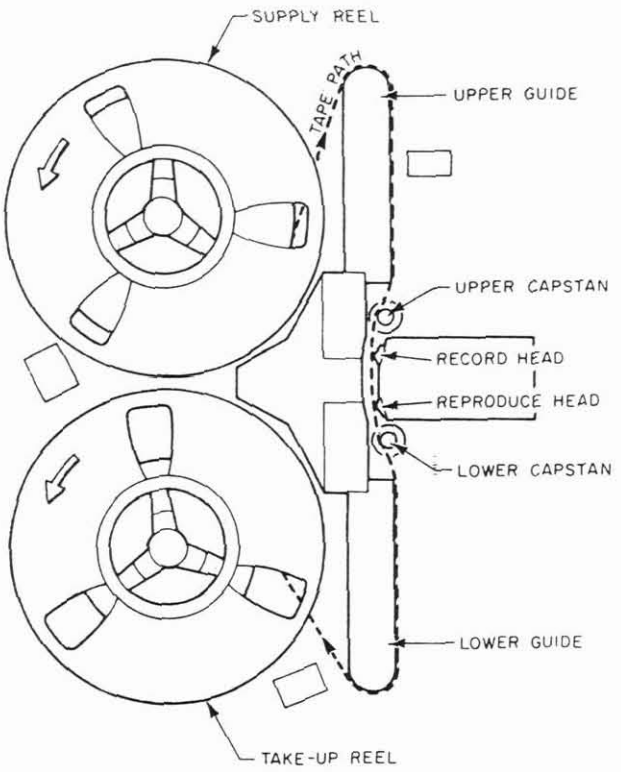

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Figure 6-8.–AN/GSH-19 tape loading.

e. Hold the end of the tape to the take-up reel and rotate the reel counterclockwise until the tape is secured to the take-up reel.

RUN MODE.–The run mode is used for reproducing a prerecorded tape as follows:

(1) With a prerecorded tape loaded on the supply reel, press the RUN selector. The transport should move tape in the forward direction with the pressure rollers engaged. The RUN selector should illuminate.

NOTE: A reproduce amplifier plug-in circuit card must be installed in the Upper or Lower Data Amplifier assemblies in order to reproduce a prerecorded tape. One plug-in circuit card is needed for each individual track being reproduced.

(2) If a stop condition is desired on the transport, press the STOP selector. (The transport will stop automatically at the end of the reel.)

FORWARD MODE.–If reproduce is desired from the tape at some distance from the beginning, the forward mode provides fast drive to that point as follows:

(1) Press the FORWARD selector. The FORWARD selector illuminates, and the transport moves the tape in the forward direction at a fast rate. The pressure rollers are not engaged, and no usable information is reproduced.

(2) When the desired point on the tape is reached, press the STOP selector. If the reproduce mode is desired at this point, press RUN as previously described.

REWIND MODE.–When the end of the run or record program is reached, the tape may be rapidly transferred back to the supply reel as follows:

(1) Press the REWIND selector. The tape moves in the reverse direction at a fast rate. The REWIND selector illuminates.

(2) If stop is desired before the tape runs completely off the take-up reel, press the STOP selector.

RECORD MODE.–With a freshly degaussed, clean reel of tape loaded on the supply reel hub, establish the record mode as follows:

(1) Press and hold the RECORD selector, then press the RUN selector. (If the RUN selector is pressed before the RECORD selector, the record mode will not engage.) The tape will run forward at the selected speed with the pressure rollers engaged. The RECORD and RUN selectors should illuminate.

NOTE: The Record plug-in circuit cards have to be installed in the Data Amplifier Assemblies for each individual track being recorded.

(2) The record mode may be cancelled by pressing any transport control selector (FORWARD, REWIND, or STOP).

NOTE: Any time the microphone press-to-talk switch is pressed during the record mode, the channel 1 data signal is interrupted. To insure that this does not occur, remove the microphone plug from the control-indicator panel microphone connector immediately after use.

LOCAL MODE.—Pressing the LOCAL selector engages the local mode so that only one transport (upper or lower) is used. In the Local-Record mode, both transports may be operated simultaneously allowing both transports to record the same information. In the Local-Reproduce mode, both transports may be used to reproduce different tapes if two sets of reproduce electronics (circuit cards) are installed.

SEQUENTIAL MODE.—The sequential mode provides for automatic switching of the record-run mode from one transport to the other. At the low-tape point of the first transport energized, sequential operation will occur and energize the second transport to the record-run mode. Both transports will run simultaneously until the tape runs off the supply reel of the first transport. At this time, the first transport will automatically shut down. In the sequential mode, the STOP, FORWARD, and REWIND selectors are disabled. If it is desired to stop the transport in the sequential mode, first press the LOCAL selector, then press STOP.

VOICE RECORDING.—At any time during the record-run mode, a voice signal may be introduced on channel (track) 1 in place of the normal data signal. This is accomplished by pressing the microphone press-to-talk switch and speaking into the microphone.

MONITOR OPERATION.—The monitor oscilloscopes (RECORD and REPRODUCE) provide a visual indication of the record and reproduce data signals. Operation is as follows:

(1) Select the data signal to be monitored with the CHANNEL SELECTOR.

(2) Adjust the SWEEP selector as necessary to obtain a good presentation of the signal.

(3) Adjust the GAIN as necessary to obtain the signal within the limits of the REPRODUCE oscilloscope viewing area.

(4) The data signals may be aurally monitored by connecting a headset to the AUDIO MONITOR and setting the RECORD-REPRODUCE selector to the desired position.

AN/UNQ-7E RECORDER-REPRODUCER

The AN/UNQ-7E (figure 6-9) is a dual track magnetic recorder-reproducer that is primarily used for recording Electronic Support Measure (ESM) and Electronic Countermeasures (ECM) information. It requires quarter-inch tape on seven inch reels and operates at speeds of 3-3/4, 7-1/2, and 15 ips. The AN/UNQ-7E is mounted in a shock and vibration isolated cabinet which enables it to be used in fixed station and mobile unit operations. A remote control unit provides facilities for starting and stopping the recorder from a remote area (see figure 6-10).

Because two separate heads are used, recording and reproducing can take place simultaneously. Although operators should NOT erase tapes at their position, previously recorded information can be erased prior to the recording function. Tapes can also be erased without recording any new information by running the tape in the RECORD mode, with the RECORD LEVEL controls in their fully counterclockwise position. On channel A, the input signal may come from a microphone or a line input, but the input signal for channel B must come from a line input from associated equipments.

Operator Controls, Indicators and Their Functions

The operator controls, indicators and their functions are shown in tables 6-3 and 6-4.

Pre-Operating Procedures

Before operating the AN/UNQ-7E, perform the following steps:

(1) Rotate all dimmer mechanisms on indicator lights counterclockwise to the full open position.

(2) Turn the POWER switch on the central control panel to ON. Observe that the white POWER light is illuminated.

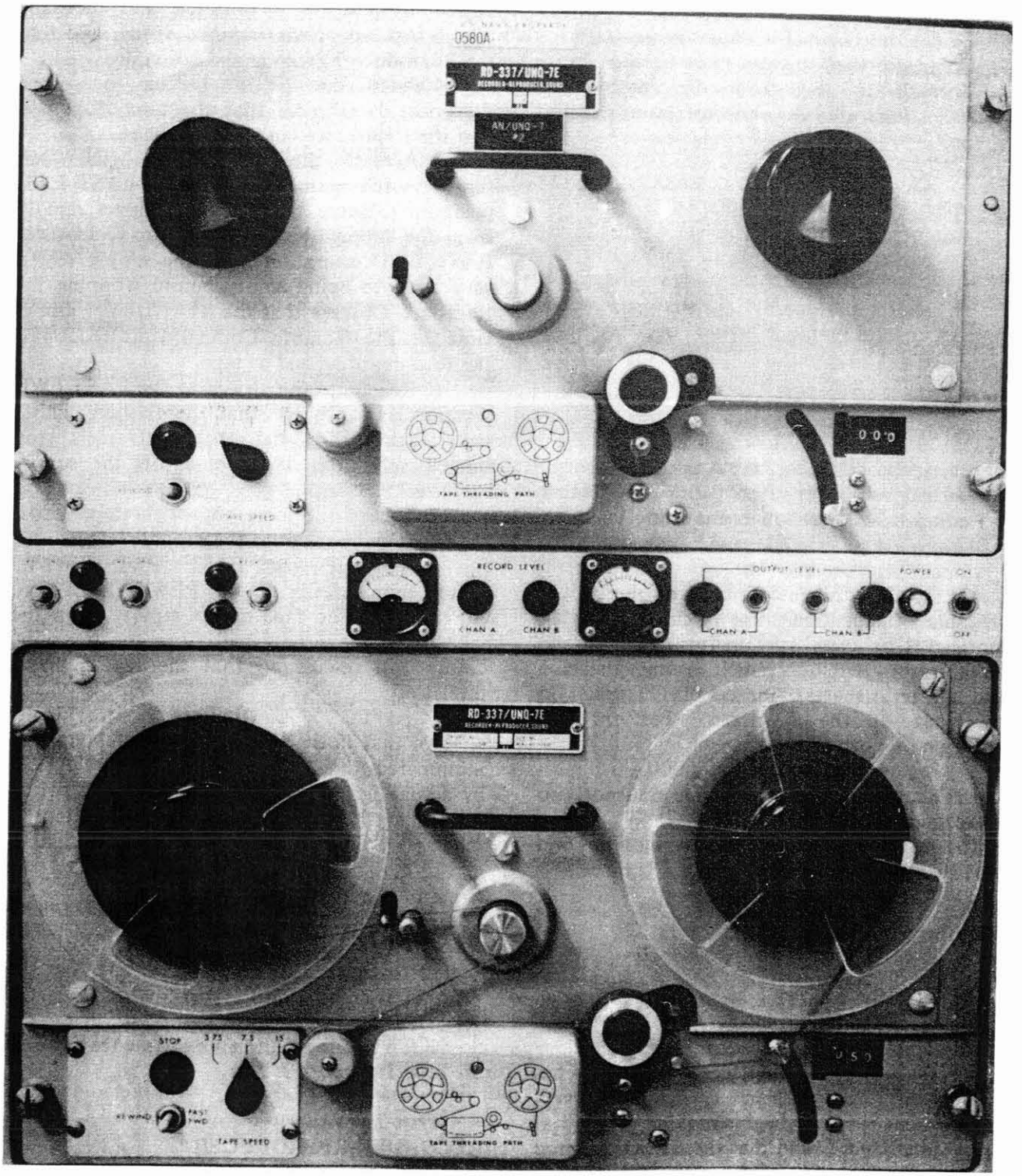

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Figure 6-9.–AN/UNQ-7E recorder/reproducer.

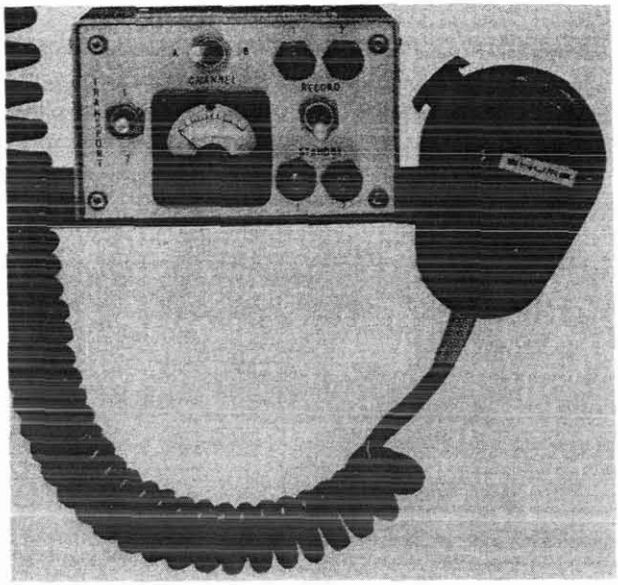

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Figure 6-10.—AN/UNQ-7E remote control unit.

(3) Install a full reel of tape on the supply turntable of tape transports 1 and 2. Place an empty reel on each take-up turntable. Thread the tape from the supply reel, through the tape head and onto the take-up reel (as illustrated on the front of the transport). Perform this operation on both transports.

(4) Set both tape counters to 000.

(5) Set speed selector on tape transports to the desired speed.

(6) Adjust signal input level (minus three to zero) by observing the appropriate VU meter.

Operating Procedures

Perform the following steps in operating the AN/UNQ-7E (transport 1):

1. Actuate both RECORD switches momentarily to position 1, simultaneously. Observe that the tape begins moving forward at the required speed, and that the RECORD 1 red lamp illuminates.

2. Press the STOP button on Tape Transport 1. Observe that the tape stops moving and that the RECORD lamp extinguishes.

3. Momentarily actuate the REPRODUCE switch to position 1. Observe that the tape moves forward at the required speed, and that the Reproduce 1 green lamp illuminates.

4. Press the STOP button on Tape Transport 1. Observe that the tape stops and that the Reproduce lamp extinguishes.

5. Actuate the FAST FWD - REWIND toggle switch momentarily to the FAST FWD position. Observe that the tape moves rapidly from the supply reel to the takeup reel. Allow FAST FWD operation until the supply reel is very close to being empty before stopping the transport. Observe that the STANDBY 1 amber lamp at the Remote Control Unit (RCU) is flashing, denoting end of tape.

6. Reactuate the switch to the FAST FWD position and observe that the flashing amber light extinguishes and that both reels stop immediately after tape comes off the supply reel.

7. Thread the loose end of the tape across the heads and back onto the supply reel.

8. Actuate the FAST FWD-REWIND switch momentarily to the REWIND position. Observe that the tape moves rapidly from the take-up to the supply reel. Stop the transport before full rewind so that the tape remains threaded.

9. At the RCU (Remote Control Unit) observe that both STANDBY amber lamps are illuminated, then initiate RECORD at the RCU by actuating the TRANSPORT SELECT switch to 1 and the RECORD-STANDBY switch to RECORD. Observe that STANDBY 1 amber lamp extinguishes and that the RECORD 1 red lamp illuminates.

10. Return the RECORD-STANDBY switch to STANDBY and the TRANSPORT SELECT switch to the center position. Observe that the STANDBY 1 lamp illuminates and the RECORD lamp extinguishes.

NOTE: Perform the above sequence of steps on Tape Transport 2.

AN/TNH-20 (V) RECORDER-REPRODUCER

The AN/TNH-20(V) (figure 6-11) is a transistorized, three-speed, four-channel magnetic tape recorder-reproducer set capable of

Table 6-3.—AN/UNQ-7E Operating Controls, Indicators, and Functions

CONTROLS/INDICATORS	FUNCTION	NORMAL POSITION OR INDICATION
Power Switch	Controls Power to Recorder—Reproducer	ON or OFF
Power Indicator Lamp	Indicates when power is applied to equipment	Illuminated white when power is ON
Tape Speed (1 on each tape transport)	Selects either 3.75, 7.5 or 15 ips.	As desired
Stop Button (1 on each tape transport)	Stops tape.	Momentarily depressed
	NOTE Stop button must be activated before change of operational mode.	
Fast FWD-REW switch (1 on each tape transport)	Initiates Fast Forward and Rewind	Center OFF
Tape Counter (1 on each tape transport)	Counts from zero to indicate tape usage	Setting of 000
Record switch (2)	Initiates Record function on tape transport 1 or 2, when actuated simultaneously.	Center OFF position
Record lights (2)	Indicates when tape transport 1 or 2 is in Record mode.	Illuminates red during Record function
Reproduce switch	Initiates Reproduce function on tape transport 1 or 2.	Center OFF
Reproduce lights (2)	Indicates when tape transport 1 or 2 is in Reproduce mode.	Illuminates green during Reproduce function.
Channel A Record Level Control	Controls Channel A record Signal level.	Not applicable
Channel B Record Level Control	Controls Channel B record Signal level.	Not applicable
Record Level VU Meters (2)	Indicates level of record signal.	Proportional to signal
Channel A output Level Control	Controls level of output signal in Reproduce mode.	Not applicable
Channel B output Level Control	Controls level of output signal in Reproduce mode.	Not applicable
Channel A and B output jacks	Provides for audio output monitor.	Not applicable

Table 6-4.—AN/UNQ-7E Remote Control Unit Controls, Indicators, and Functions

CONTROLS/INDICATORS	FUNCTION	NORMAL POSITION OR INDICATION
Transport Selector Switch	Locks out local control of transport 1 or 2 and prepares transport for record function.	Center off
Record-Standby Switch	Initiates Record function on transport selected by Transport Selector switch.	Standby
Standby 1 lamp	Indicates Tape Transport 1 is in Standby mode, or nearing end of tape.	Illuminates steady amber when in standby and flashes when near end of tape.
Standby 2 lamp	Same as above for Tape Transport 2.	Same as above
Record Level VU meter	Indicates level of record signal for either tape transport selectively.	Proportional to signal
Channel A or B Selector Switch	Selects channel to be monitored by VU meter.	At either A or B
Record 1 lamp	Indicates when Tape Transport 1 is in Record mode.	Illuminates red
Record 2 lamp	Indicates when Tape Transport 2 is in Record mode.	Illuminates red

Figure 6-11.—AN/TNH-20(V) recorder/reproducer. 264.90

recording and reproducing audio frequency signals. It is designed to perform dependably in fixed stations and in mobile units. The equipment uses standard 1/4-inch tape on reels up to seven inches in diameter and operates at speeds of 1-7/8, 3-3/4, and 7½ (ips). The 1-7/8 ips speed can be varied -30% to +50% in the reproduce mode. All operating functions are controlled by pushbutton-operated relays, and the unit is equipped with an automatic stop which ceases the operation if a tape is broken or at the end of a reel.

Operator Controls, Indicators and Functions

The operator controls, indicators and functions are described in table 6-5.

Table 6-5.—AN/TNH-20(V) Operating Controls, Indicators, and Functions

CONTROL/INDICATOR	FUNCTION
POWER ON switch	Controls power to Recorder-Reproducer
POWER Indicator Lamp	Indicates when power is applied to equipment
Tape SPEED SELECTOR	Selects either 1-7/8 variable, 1-7/8, 3-3/4, or 7-1/2 ips
Variable SPEED Control - 30% + 50%	Selects percent above or below 1-7/8 ips tape speed in Reproduce mode only.
RECORD pushbutton	Initiates Record function
RECORD Lamp	Indicates when tape transport is in the Record mode
REPRO pushbutton	Initiates Reproduce function
FAST FWD pushbutton	Initiates Fast Forward function
STOP pushbutton	Stops tape
REWIND pushbutton	Initiates Rewind function
CHANNEL SELECTOR switch	Selects channel to be monitored by VU meter
INPUT/OUTPUT switch	Selects either Record Input or Reproduce Output to VU meter
VU meter	Indicates level of Record and Reproduce signals
Channel MONITOR	Selects Reproduce channels to be monitored at headphone jacks and monitor output
TONE control	Adjusts frequency response at headphones and monitor output
VOLUME control	Adjusts volume at headphones and monitor output
Digital Counter	Counts from zero to indicate tape usage

Operating Procedures

All four channels are data channels with provisions for automatic gain control (AGC) and voice operated relay (VOR) operation. VOR allows for the simultaneous recording of data and voice comments in the same channel. Channel 4 is also a voice channel used for voice "dubbing." Record levels are indicated by the VU meter and automatically controlled when the AGC/DEFEAT switch (located on the rear panel) is in the AGC position. In the DEFEAT position, record levels are controlled by the REC GAIN control located on the RCDR/RPDR on the rear panel. If VOR is not desired, the VOR/DEFEAT switch (located on the rear panel) should be set in the DEFEAT position. Tape loading, record, and reproduce operating instructions are described below for both AGC and VOR operation.

TAPE LOADING.—The procedures for loading a tape on the AN/TNH-20(V) are listed in the steps below:

1. Install a full reel of recording tape onto the supply reel.
2. Place an empty reel on the take-up reel.
3. Thread the tape from the supply reel, across the tape heads, and onto the take-up reel (see figure 6-12).

RECORDING.—The procedures for making a recording on the AN/TNH-20(V) are listed in the steps below:

1. Set the tape counter to 000 and select the desired tape speed.
2. Depress the RECORD pushbutton and observe that the RECORD red lamp illuminates.
3. Verify that the input signal is being properly recorded by either observing the

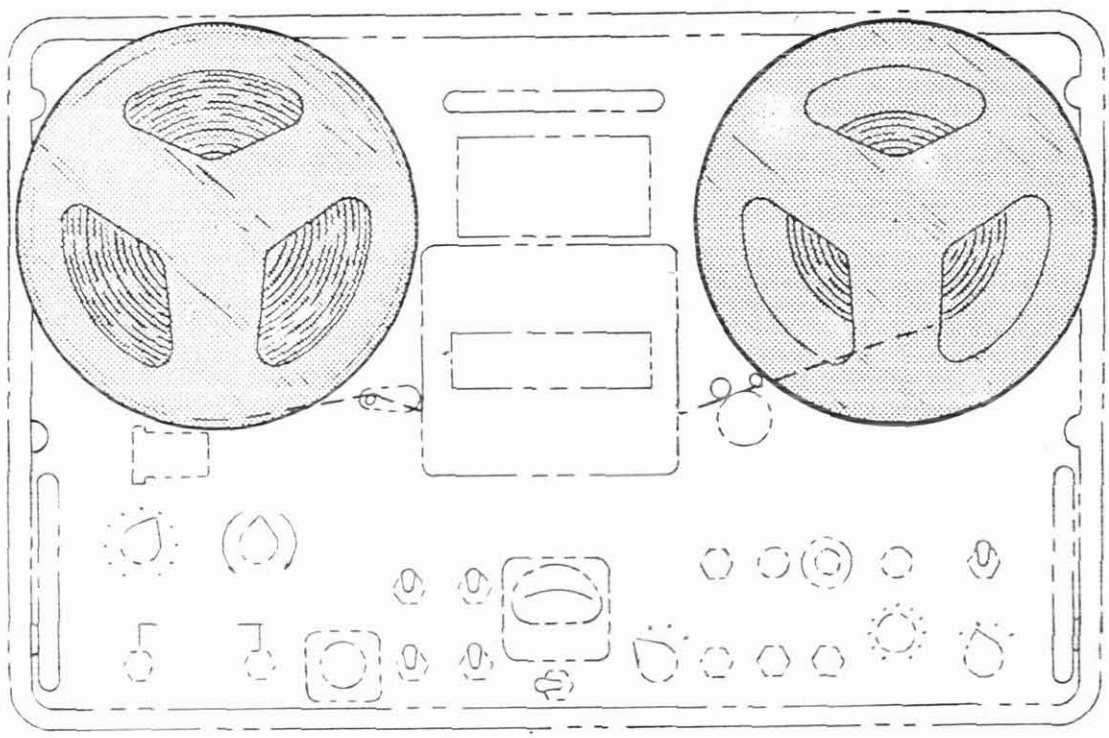

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Figure 6-12.—AN/TNH-20(V) tape loading.

reproduce output on the VU meter or by aurally monitoring the output signal with headphones.

4. To stop the recorder, depress the STOP pushbutton. (The FAST FWD and REWIND pushbuttons may be depressed for fast forwarding or rewinding the tape, respectively.

REPRODUCE.—The procedures for reproducing a recording on the AN/TNH-20(V) are listed in the steps below:

1. After properly positioning the tape, depress the REPRO pushbutton.
2. Select the desired channel to be monitored at the headphone jacks by using the appropriate channel MONITOR control switch.
3. The volume at the headphones can be adjusted by adjusting the VOLUME control to the desired level.
4. The signal tone can be adjusted by adjusting the TONE control to the desired level.

AN/TNH-21 RECORDER/REPRODUCER

The AN/TNH-21 (figure 6-13) is a four track, solid state, magnetic tape recorder/reproducer. It uses ¼-inch magnetic tape, and 4, 7, or 10½ inch reels and operates at five speeds: 15/16, 1-7/8, 3-3/4, 7-1/2, and 15 inches per second (ips). It also has a variable tape speed in the play mode of +50 to -30 percent. In addition to the usual tape recorder modes of play, record, stop, rewind, and fast forward, the AN/TNH-21 has two special modes; a variable search mode, and a repeat mode that allows for continued repetition of up to ten (10) seconds of tape in the reproduce mode. A remote control unit allows for the seven operating modes to be remotely controlled.

Operating Controls, Indicators, and Functions

The AN/TNH-21 operating controls, indicators, and functions are described and explained in table 6-6. (Refer to figure 6-13).

Tape Threading and Reel Installation

Follow the steps listed below for tape threading and reel installation: (Refer to figure 6-14). Either plastic or metal 4, 7, or 10½ inch reels, may be used.

NOTE: The power may be ON or OFF when installing a reel and threading the tape.

1. If plastic reels are being used, remove the hub assembly from the reel spinde. Pull out on the knurled end of the reel spindle and rotate to remove the reel retaining detents. If metal reels are being used, insure that the metal reel hub assemblies are installed and that the guide and reel retaining tabs are aligned.
2. Place a full reel of tape on the supply reel side so that the tape unwinds from the left side of the reel. When installing plastic reels, place the reel onto the reel spindle and then secure by rotating the knurled end of the reel spindle to release the reel retaining detents. When installing a metal reel, place the reel on the hub assembly, and while holding the reel in place, pull out on the hub assembly and rotate 60 degrees in either direction to the detents.
3. Install an empty reel on the take-up reel spindle following the procedure in Step 2 above.
4. Slide the lower head cover down to the thread tape position.
5. Unwind about 4 feet of tape and thread the tape as shown in figure 6-14. Take a couple of turns around the take-up reel and turn the reel until there is tape tension.
6. Slide the head cover up to the operate position.
7. Set the REEL SIZE switch to the position corresponding to the reel size installed.
8. Set the reel revolution counter to 0000 by pressing the reset button.

Operating Procedures

There are seven modes of operation, including stand-by (STOP). All are selected by the mode control button/indicator on the front panel. Any mode may be selected while the recorder/reproducer is in any other mode. The button/indicators light to indicate the mode the

recorder is in. Each mode of operation is explained below.

STANDBY (STOP) MODE.—When power is first applied, or when the tape path has been broken, i.e., when a new tape is threaded, the STANDBY mode must be selected before any other mode can be initiated. The STANDBY mode must be achieved as follows:

1. Install and thread a reel of tape, if needed.

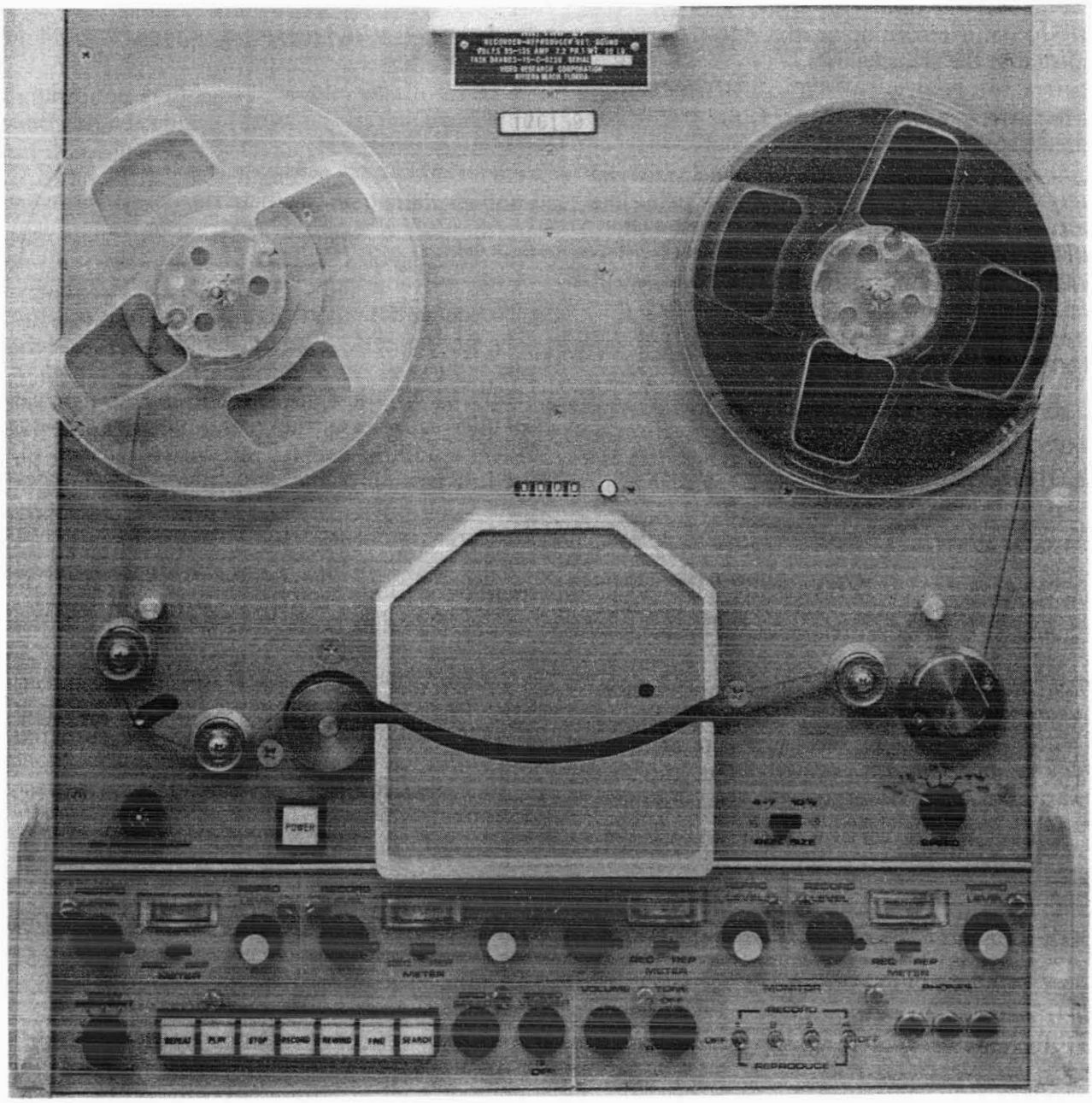

Figure 6-13.—AN/TNH-21 recorder/reproducer. 264.92

Table 6-6.—AN/TNH-21 Operating Controls, Indicators, and Functions

CONTROL OR INDICATOR	FUNCTION
POWER Switch/Indicator	Control primary a.c. power: push ON - push OFF.
TAPE SPEED switch	Select one of the five standard, fixed, play/record tape speeds: 15/16, 1 7/8, 3 3/4, 7 1/2, or 15 ips.
REEL SIZE switch	Changes the reel motor torque to compensate for different reel size.
TAKE-UP REEL COUNTER	Four digit counter that counts take-up reel rotation. The counter can be reset manually by pressing the adjacent button, or is automatically reset at the end-of-tape, when the recorder is in the rewind mode.
SCAN SEGMENT Control	The SCAN SEGMENT controls are operative only when the recorder/reproducer is in the repeat mode. They adjust the length of the repeat scan segment from at least 10 seconds of tape to near zero. The BEGIN control (outer knob) adjusts the point where the play segment begins. The END control (inner knob) adjusts the end of the play segment.
REPEAT switch/indicator	When the REPEAT button is pressed, the recorder will repeat a segment of tape from near zero to at least 10 seconds in length, or as determined by the SCAN SEGMENT control.
PLAY switch/indicator	When the PLAY button is pressed, the recorder will go into the play mode and reproduce the data recorded on the tape at the selected tape speed.
STOP switch/STAND-BY indicator	Stops tape motion, and initiates the standby mode. Any mode of operation can be initiated when the STOP button/indicator is lit. When power is first applied or when the tape path has been broken, i.e., when a new tape is threaded, the STOP button must be pressed to initiate standby before any other mode can be initiated.
RECORD switch/indicator	The RECORD button activates the record electronics (including erase electronics) when pressed simultaneously with the PLAY button.
REWIND switch/indicator	Initiates the rewind mode when pressed. When stopping from any forward mode the recorder will momentarily go into the rewind mode for braking.

Table 6-6.—AN/TNH-21 Operating Controls, Indicators, and Functions—Continued

CONTROL OR INDICATOR	FUNCTION
FWD switch/indicator	When the FORWARD button is pressed the recorder goes into the fast forward mode.
SEARCH switch/indicator	The SEARCH button/indicator initiates and indicates the variable speed search mode. The tape moves forward at a speed determined by the setting of the SRCH SPEED control.
SRCH SPEED control	Varies the tape speed from 3.5 to 60 ips when the recorder/reproducer is in the search mode.
SPEED VERNIER control	Varies the tape speed between -30 and +50 percent of that selected by the SPEED switch. With the SPEED VERNIER in the OFF position, the selected tape speed is maintained. NOTE: The SPEED VERNIER is NOT operable in the record mode.
RECORD LEVEL control	Adjusts the input signal record level.
SIGNAL LEVEL meter	Indicates the record and reproduce output signal levels.
REC/REP METER switch	Selects the signal monitored by the meter: REC for record input level; REP for the reproduce output level.
REPRO LEVEL control	Adjusts the output level of the reproduced signal.
VOLUME control	Controls the volume for the monitor PHONES jacks (3).
TONE control	Controls the tone for the monitor PHONES jacks. In the OFF position, the monitor has a flat frequency response, B is for bass tone, and T is for treble tone.
RECORD/REPRODUCE MONITOR switch	Selects the signal(s) to be monitored at the PHONES jacks. RECORD for signal being recorded, REPRODUCE for reproduce output monitoring. Any combination of record and reproduce may be monitored.
PHONES	Phone jacks for three earphones.

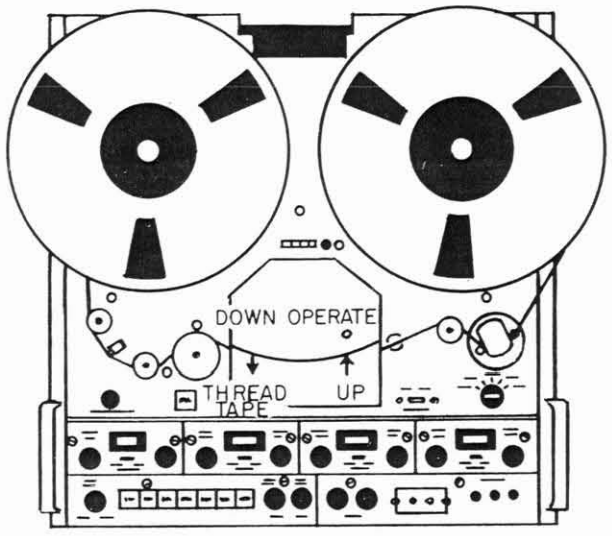

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Figure 6-14.—AN/TNH-21 tape loading.

2. Press the POWER switch and then the STOP button. The POWER and STOP (Standby) indicator should light.

FAST FORWARD (FWD) MODE.—The Fast Forward Mode moves the tape rapidly from the supply reel to the take-up reel. It can be selected at any time by pressing the FWD button/indicator, and removed by selecting any other mode. If the fast forward mode continues until the tape runs out, the recorder/reproducer will stop automatically. A tape must be rethreaded and the standby mode must be reestablished before another mode can be selected.

REWIND MODE.—The Rewind Mode operates the same as the fast forward (FWD) mode except it moves the tape from the take-up reel to the supply reel. If the tape runs out in the rewind mode, the reel revolution counter will automatically reset to 0000.

PLAY MODE.—The Play Mode reproduces recorded tapes. The reproduced signals may be monitored at the monitor PHONE Jacks on the front of the recorder. The tape speed is controlled by the capstan and determined by setting of the SPEED Switch. The tape speed may be varied +50 to -30 percent by the SPEED VERNIER control. To reproduce a recorded tape, proceed as follows:

1. Thread the tape to be reproduced on the recorder and obtain the Standby Mode as previously described.
2. Set the SPEED switch to the tape speed at which the reel of tape was recorded.
3. Press the PLAY button/indicator. Tape monitor should start and the PLAY button/indicator should light.
4. Place the METER switch of each channel to the REP position.
5. Adjust the REPRO LEVEL control of each channel for the desired reproduce signal level.
6. The play mode may be cancelled at any time by selecting any other mode.

RECORD MODE.—Follow the procedures listed below when operating in the Record Mode.

1. Install a reel of tape and thread and obtain the standby mode as previously described.
2. Set the SPEED switch to the desired tape speed.
3. Place the METER switch of each channel to the REC position.
4. Adjust the RECORD LEVEL control of each channel for over reading on the signal peaks, or for the maximum anticipated input.
5. Simultaneously, press the PLAY and RECORD buttons. Both button/indicators should light and the tape will begin moving under the capstan control at the selected speed.

NOTE: When recording, either the record and/or reproduce signals may be monitored. Monitoring the reproduce signal may be more meaningful because it is a reproduction of the signal being recorded.

6. The Record Mode may be cancelled at any time by selecting any other mode.

SEARCH MODE.—The Search Mode is a variable speed, forward mode for searching a

recorded reel of tape to locate data. In the search mode, the tape speed is adjustable by the SEARCH SPEED Control from 3.5 ips to 60 ips. The monitor electronics are active in the search mode which are inactive during the fast forward (FWD) mode. The search mode is normally used when an analog time signal has been recorded on the tape. Data is located on the tape by knowing the approximate time that the data was recorded and by monitoring the play-back time readout. To operate the search mode, proceed as follows:

1. Thread the tape and obtain the standby mode as previously described.
2. Set the SEARCH SPEED control to any desired position.
3. Press the SEARCH button. The button/indicator should light and tape movement begins.

NOTE: If the reel revolution counter is being used to locate a portion of the tape, press the FWD button and then the SEARCH button as the counter approaches the desired reading.

4. The Search mode may be canceled by selecting any other mode, or the search mode will continue until the tape runs out.

REPEAT MODE.—The repeat mode continuously repeats a segment of tape from at least 10 seconds to near zero in length. Both the beginning and end of the scan segment are adjustable by the SCAN SEGMENT Controls. The point where the REPEAT button is pressed, is the end of the scan segment. The tape will immediately backspace the length of the scan segment to the begin play point (determined by the BEGIN Control setting), and then go into the play mode. The play mode will continue to the end of the scan segment (determined by the END control setting), and then backspace again. This will continue until another mode is selected. The procedures for REPEAT mode operations are as follows:

1. Thread the tape and obtain the standby mode as previously described.
2. Set the SPEED switch to the proper tape speed.
3. Locate the segment of tape to be repeated in any appropriate mode and press the REPEAT button/indicator at the point where the scan segment is to end. The REPEAT button/indicator will light and the tape will backspace the length of the scan segment and go into the play mode.

NOTE: The SCAN SEGMENT controls may be set to any position; however, a setting midway between the maximum and minimum scan length in most cases will provide the best results since this will allow adjustment of both ends of the scan segment in both directions when the repeat mode is selected. The Capstan SPEED VERNIER Control may be used in the repeat mode as in the play mode. It will vary the tape play speed to +50 to -30 percent. This will affect the time it takes to scan the segment of tape, but the length of tape will remain the same (determined by the SCAN SEGMENT controls).

4. The repeat mode will continue until canceled by selecting another mode.

MONITORING.—The normal signal input and output signals may be monitored from the front of the recorder by up to three headsets. None of the monitor functions have any effect on the recorder/reproducer input or output signals. The monitor is always operative in the play, record, and search modes and the play portion of the repeat mode. Monitor operation procedures are as follows:

1. Plug headset into the PHONES jack.
2. Place the recorder/reproducer in the desired mode of operation.
3. Set the MONITOR switches as desired. The center position is OFF, in the up (RECORD) position, the record input signal is monitored, and in the down (REPRODUCE) position, the reproduce output is monitored. The signals can be monitored in any combination. The switches can be set in any position without affecting the recorder/reproducer operation.
4. Set the VOLUME and TONE controls as desired.

REMOTE.—The AN/TNH-21 may be operated from a remote position. The remote

controls and indicators function the same as those of the main unit.

Cleaning

The tape handling surfaces should be cleaned just prior to recording or reproducing. Use only approved cleaning agents when cleaning the AN/TNH-21 or any other magnetic tape recorder.

AN/GSH-28(V) RECORDER-REPRODUCER

The AN/GSH-28(V) (figure 6-15) is designed for use as a backup recorder-reproducer for the FLEXSCOP system. It is an analog recorder-reproducer which records or reproduces 18 tracks of data. The first 16 tracks are used for data, one track is blank, and one track is used for a time code signal to correlate the recorded information. The AN/GSH-28(V) uses reels up to 15 inches in diameter and 1/2 inch magnetic tape. It operates at speeds of 15/16, 1-7/8, 3-3/4, 7-1/2, 15, 30, 60, and 120 ips.

Operator Controls, Indicators, Fuses and Functions

The operator controls, indicators, fuses and functions are listed in table 6-7.

Operating Procedures

The operating procedures for the AN/GSH-28(V) recorder-reproducer are discussed below.

TAPE LOADING.—Use the instruction below when loading the AN/GSH-28(V):

1. Open the transport assembly front access door.
2. Unlock (pull out) the supply (upper) reel hub and the take-up (lower) reel hubs locking mechanisms.
3. Place a full reel of tape on the upper reel hub so tape feeds down the right side (see figure 6-16 or the instructions on the inside of transport access door). Ensure that the reel seats are all the way back on the hub.

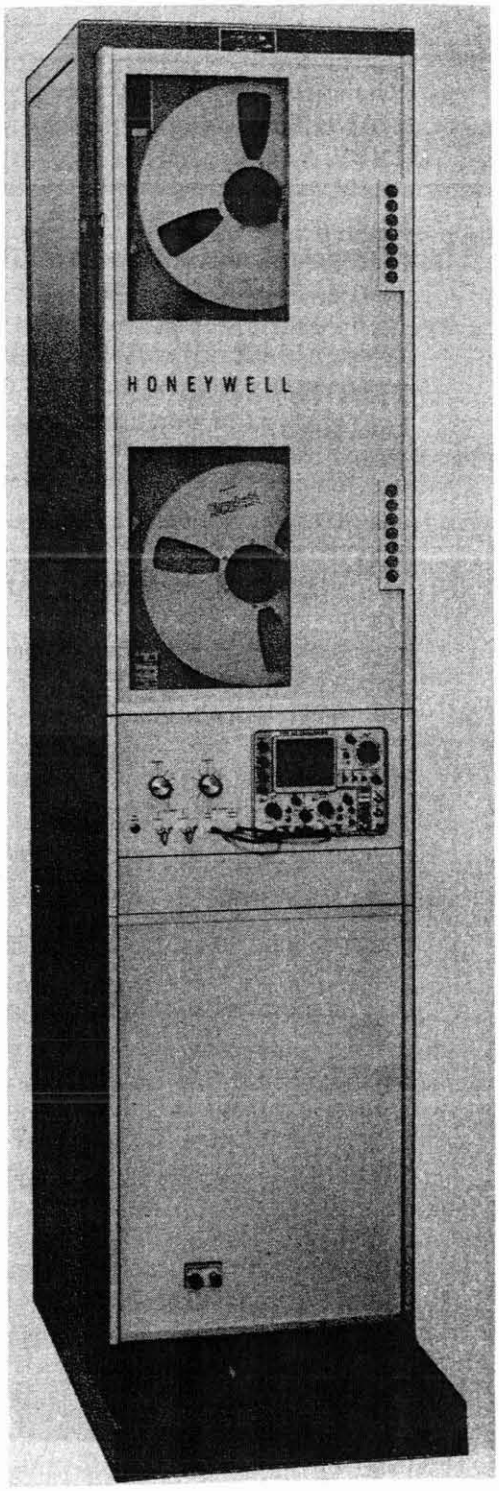

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Figure 6-15.—AN/GSH-28(V) tape recorder.

Table 6-7.—AN/GSH-28 Operating Controls, Indicators, and Functions

CONTROL AND/OR INDICATOR	FUNCTION
RESET FT CTR	Electrical reset for local and remote tape footage counter (remote counter not supplied). When depressed, resets the footage counters to zero feet.
REMOTE LOCAL	Selects either remote or local control of the Recorder/Reproducer selector functions. In remote operation, all push-button control panel selectors are disabled except READY and RESET FT CTR.
LOOP REEL	Not used. Must be in the REEL position to operate. Provides for operation with a loop adapter (not supplied) in the LOOP position.
READY	Establishes the ready condition before any tape movement can occur. Illuminates to indicate the ready condition.
 FAST	FAST reverse selector. Establishes the fast reverse mode. Illuminates to indicate condition.
 DRIVE	DRIVE reverse selector. Establishes the drive reverse mode. Illuminates to indicate condition.
STOP	STOP selector. Establishes the stop mode. Illuminates to indicate condition.
DRIVE 	DRIVE forward selector. Establishes the drive forward mode. Illuminates to indicate condition.
FAST 	FAST forward selector. Establishes the fast forward mode. Illuminates to indicate condition.
RECD	Record selector. Establishes the record mode in conjunction with the DRIVE forward or DRIVE reverse selector. Illuminates to indicate condition.

Table 6-7.—AN/GSH-28 Operating Controls, Indicators, and Functions—Continued

CONTROL AND/OR INDICATOR	FUNCTION
Transport Release (Not labeled)	Release for transport locking mechanism to allow the transport to hinge outward.
120 (black) 60 (red)	120 ips speed selector for the high speed range. 60 ips speed selector for the low speed range. Illuminates to indicate speed.
60 (black) 30 (red)	60 ips speed selector for high speed range. 30 ips speed selector for low speed range. Illuminates to indicate speed.
30 (black) 15 (red)	30 ips speed selector for high speed range. 15 ips speed selector for low speed range. Illuminates to indicate speed.
15 (black) 7-1/2 (red)	15 ips speed selector for high speed range. 7-1/2 ips speed selector for low speed range. Illuminates to indicate speed.
7-1/2 (black) 3-3/4 (red)	7-1/2 ips speed selector for high speed range. 3-3/4 ips speed selector for low speed range. Illuminates to indicate speed.
3-3/4 (black) 1-7/8 (red)	3-3/4 ips speed selector for high speed range. 1-7/8 ips speed selector for low speed range. Illuminates to indicate speed.
1-7/8 (black) 15/16 (red)	1-7/8 ips speed selector for high speed range. 15/16 ips speed selector for low speed range. Illuminates to indicate speed.
TAPE CAPSTAN	CAPSTAN position selects servo off capstan only. TAPE position provides servo off tape if tape signal is present and automatic switching to servo off capstan if tape servo signal is lost.

Table 6-7.—AN/GSH-28 Operating Controls, Indicators, and Functions—Continued

CONTROL AND/OR INDICATOR	FUNCTION
SHUTTLE OFF	SHUTTLE position enables the Recorder/Reproducer to automatically change direction of drive at the low tape points.
CAL	In CAL position, enables the record circuits to function without driving tape. Record light illuminates.
TYPE 422 OSCILLOSCOPE	Channel monitor. Allows observation of input and output signals.
INTL OUTPUT REPRO CHAN 2 ATTENUATED 10:1	Provides output of reproduce data circuits as selected by channel selectors and to the monitor oscilloscope. Signal at this output is attenuated 10:1 to the output at the rear patch panel A8.
INTL OUTPUT RCD CHAN 1	Provides front panel output of record data inputs as selected by channel selectors and to the monitor oscilloscope.
+28V SUPPLY 15A SLO	Fuse for protection of the +28 VDC transport power supply.
SUPPLY RESET	Reset for +28 VDC transport power supply overvoltage and overtemperature protection circuits.
DATA SUPPLY 2 3A SLO	Not used.
DATA SUPPLY 1 3A SLO	Fuse for protection of ±12 and 5.6 VDC data power supply number 1.
TRANSPORT SUPPLY 3A SLO	Fuse for protection of ±12 and 5.6 VDC transport power supply.
POWER PULL ON	Main POWER circuit breaker functions as main power overload protection and as main power on-off switch.

Table 6-7.—AN/GSH-28 Operating Controls, Indicators, and Functions--Continued

CONTROL AND/OR INDICATOR	FUNCTION
POWER	Main POWER indicator. Illuminates when main power is applied by closing the main POWER circuit breaker.
EXT INPUT CHAN 2	Provides an external input to oscilloscope input 2 when channel selector X10 is set to EXT position.
EXT INPUT CHAN 1	Provides external input to oscilloscope input 1 when channel selector X10 is set to EXT position.
MIC INPUT	Not used. Provides a microphone patch to rear panel of channel monitor.
CHANNEL X1	Data channel selector for units digit of channel desired.
CHANNEL X10	Data channel selector for tens digit of channel desired.
PHASE LOCK	Indicator illuminates when capstan is running at selected speed, locked to crystal.
SHUTTLE	Indicator illuminates when shuttle mode is selected.
TAPE	Illuminates when TAPE/CAPSTAN switch is in the TAPE position with a tape servo signal present.
CAPSTAN	CAPSTAN indicator illuminates when servo is from capstan tone wheel (remains illuminated when drive mode is established).
HIGH SPEED RANGE	Indicator illuminates when high-speed range is selected.
LOW SPEED RANGE	Indicator illuminates when low-speed range is selected.
(Not labeled)	Footage counter mechanical reset.
TAPE FOOTAGE COUNTER	Indicates the amount of tape used. Counts up in the forward direction and down in reverse.
TAPE FOOTAGE COUNTER OFF-ON	Switch to engage the tape footage counter.

4. Depress the supply reel locking mechanism and check tightness of the reel on the hub. If loose, unlock the hub and while holding the tape reel with one hand, tighten the reel hub with the other hand by turning the locking mechanism clockwise. Depress the locking mechanism.

5. Place an empty tape reel on the take-up (lower) hub.

6. Depress the take-up reel hub locking mechanism and check reel tightness as in step 4.

7. Manually turn the supply reel clockwise, unwinding sufficient tape (about 4 feet) to reach the take-up reel. Guide the tape around the upper tape guide idler, under the record head, around the capstan, over the reproduce head, and around the lower tape guide idler as shown by the solid line in figure 6-16 and the decal on the inside of the access door.

NOTE: Opening the vacuum column facilitates easier threading.

8. Thread the tape onto the take-up reel, making certain that the tape is not twisted and is properly positioned on the guides.

9. Turn the take-up reel and supply reel clockwise until at least five turns of tape are tightly wound on the take-up reel.

NOTE: It may be necessary to unwind additional tape from the supply reel manually to allow five turns on the take-up reel. Do NOT allow tape to drag on the capstan causing it to rotate.

10. Turn the supply reel further clockwise while guiding the tape into the upper vacuum column.

11. Turn the take-up reel counterclockwise while guiding the tape into the lower vacuum column.

12. Turn the supply reel as necessary to position the tape loop in the upper vacuum column between the two upper vacuum column viewing ports.

13. Repeat step 12 for the take-up reel and the lower vacuum column.

NOTE: With the tape loop properly positioned in the vacuum column, light from the vacuum column light source should be visible in the upper- and lower-right viewing ports. The upper-and lower-left ports should be dark.

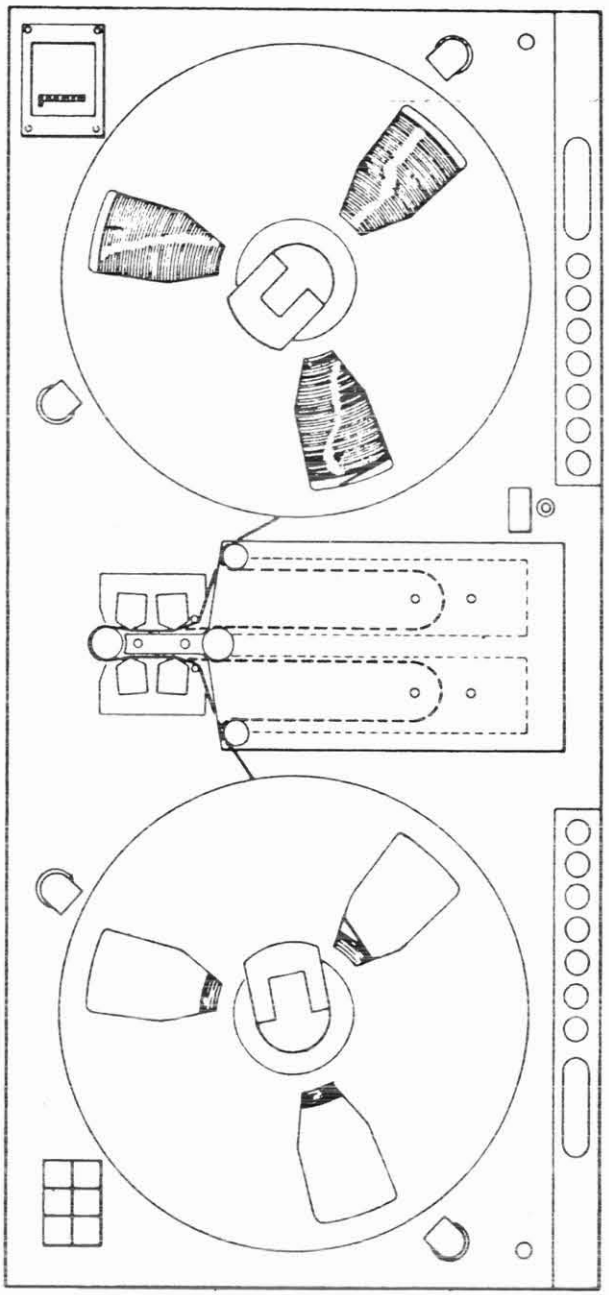

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Figure 6-16.—AN/GSH-28(V) tape loading.

14. If it is desired to load a tape for reverse operation, the same procedure is used; however,

the tape must be removed from the take-up (lower) reel, with five turns of tape placed on the supply (upper) reel. The direction of rotation of the reels is reversed.

MODES OF OPERATION.–The AN/GSH-28(V) modes of operation are described below:

Ready Mode.–The tape must be properly loaded before the ready mode can be established.

(1) With the tape loaded on the transport as described above, depress the READY pushbutton. The ready button and the STOP button should illuminate indicating a ready condition has been established.

(2) Depress the desired speed pushbutton. The button will illuminate. (If a speed is not selected, no operating mode can be established.)

Drive Forward/Reverse Reproduce Mode.–Reproduce information recorded on the tape as follows:

(1) Forward reproduce–With a reel of prerecorded tape positioned on the supply reel hub, depress the DRIVE ↓ pushbutton and the CAPSTAN indicator should illuminate and the tape should drive in the forward direction. When the capstan is driving at the proper speed, the PHASE LOCK indicator should illuminate. The Recorder/Reproducer is now reproducing information recorded on the tape and each channel may be monitored on the monitor oscilloscope.

(2) Reverse Reproduce - With a reel of prerecorded tape positioned on the takeup hub, depress the DRIVE ↑ pushbutton. The DRIVE ↑ pushbutton and the CAPSTAN indicator should illuminate. The PHASE LOCK indicator will illuminate when the capstan reaches the selected speed.

(3) Stop and Rewind–When it is desired to stop the tape motion, depress the STOP pushbutton. Rewind is accomplished by depressing either the FAST ↑ or the FAST ↓ pushbutton as applicable.

NOTE: If the low tape sensors are in use, the transport will automatically stop when the tape has reached the low tape point. Depressing the same direction run control (DRIVE or FAST) will override the low tape stop condition to allow the tape to be driven completely off the reels.

Forward/Reverse Record Mode.–To record in the forward or reverse direction proceed as follows:

(1) With the ready condition established, depress and hold the RECD button and then depress either the DRIVE ↓ or DRIVE ↑ pushbutton as desired.

NOTE: The Recorder/Reproducer will reproduce information recorded in the forward direction while a recording is in progress, but does not reproduce information being recorded in the reverse direction.

(2) When recording is completed, depress the STOP pushbutton. Rewind is accomplished by depressing the FAST ↑ or FAST ↓ as applicable.

RD-289 DIGITAL MAGNETIC TAPE RECORDER

The RD-289 digital magnetic tape recorder (Figure 6-17) is primarily used to record formatted data from AN/GSQ-76 (TEBO) and FLEXCOP positions in digital form. It contains two units: Magnetic Tape Transport, (Figure 6-18) which is made up of 2 identical tape transports, and Magnetic Tape Transport Control. The Magnetic Tape Transport unit contains all controls and indicators for its operation while the Magnetic Tape Transport Control unit contains the electronic circuits which operate the Magnetic Tape Transport.

The RD-389 uses ½-inch 7-track IBM 729 compatible magnetic tape on IBM-type 10½-inch reels (2400 feet). The actual recording is not continuous. Data is stored in the memory unit of the AN/GSQ-76 or FLEXSCOP system until 1024 bits of information has been obtained. Then, it is "dumped" or recorded on the magnetic tape. An end-of-tape/beginning-of-tape (EOT/BOT) sensor assembly detects the tape position from silver reflector strips mounted on the tape.

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Figure 6-17.—RD-289 digital tape recorder.

Operating Controls, Indicators and Functions

The operating controls, indicators and functions are shown in table 6-8. (Refer to figure 6-17).

Operating Instructions

The tape loading, operating, tape unloading, and turn-off procedure will be the same for both RD-289 Tape Transports.

TAPE LOADING.—Load tape on the tape transport as follows: (See figure 6-19).

(1) Turn the REWIND-LOCAL-REMOTE switch to LOCAL.
(2) Turn the REVERSE-STOP-FORWARD switch to STOP.
(3) Place the POWER ON-OFF switch to ON.
(4) Press the UNLOAD switch.
(5) Place a full reel of tape on the upper reel hub and an empty reel on the lower reel hub.

NOTE: When threading tape through the drive mechanism, handle only the end of the tape. Avoid touching the tape at any other point.

(6) Unwind approximately three feet of tape from the upper reel.
(7) Insert tape under the upper vacuum column fixed post and roller.
(8) Insert tape between the mirror and window of the EOT/BOT assembly.
(9) Insert tape between the upper capstan and pinch roller.
(10) Open the head-pad assembly.
(11) Place tape over the read/write head assembly and upper and lower trough guides.

CAUTION: Do not allow head-pad assembly to slam shut.

(12) Close the head-pad assembly.
(13) Insert tape between the lower capstan and pinch roller.
(14) Place the end of the tape around the take-up reel and wind clockwise until the BOT

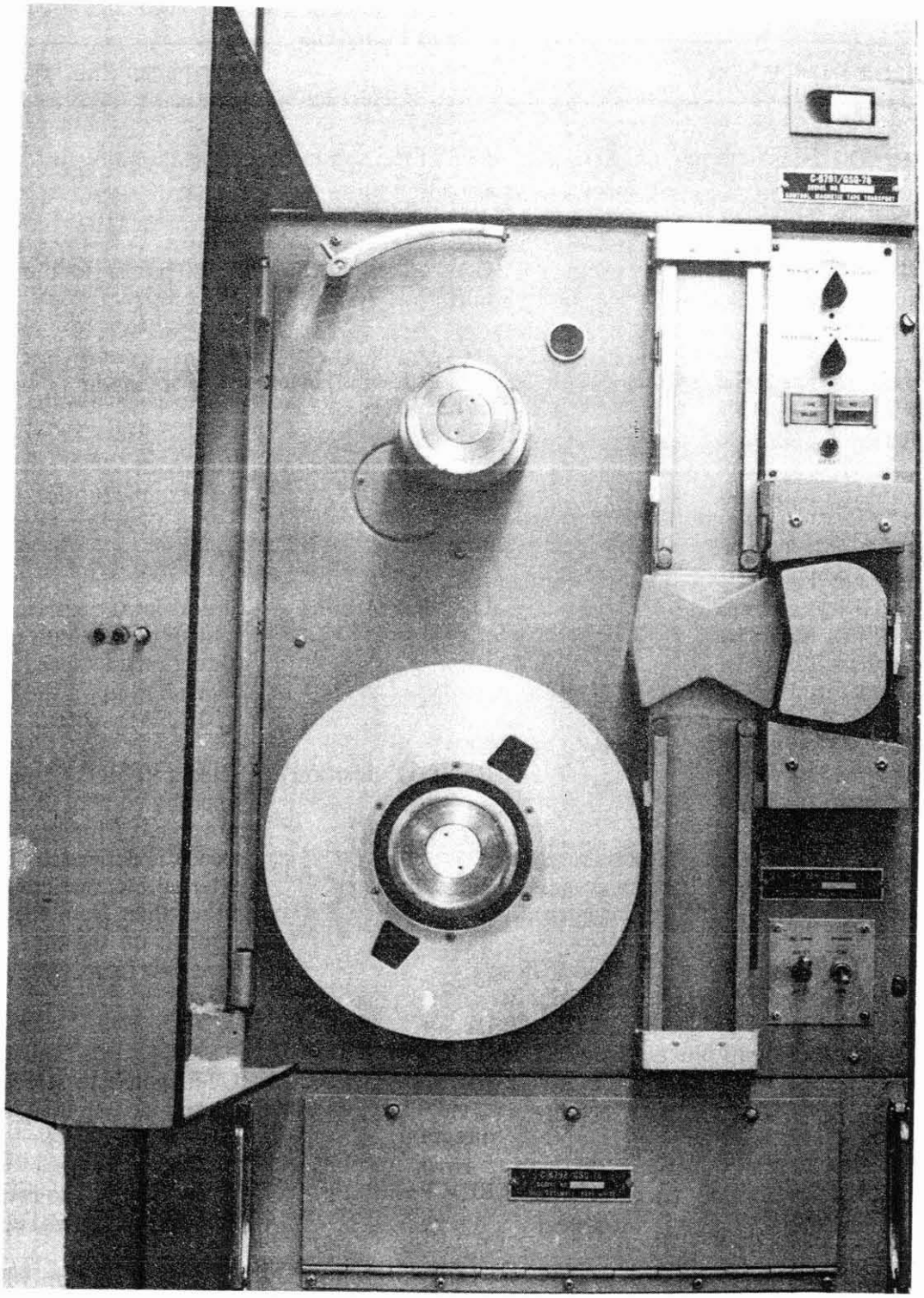

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Figure 6-18.—RD-289 digital tape transport.

Table 6-8.—RD-289 Tape Transport Operating Controls, Indicators, and Functions

CONTROL OR INDICATOR	FUNCTION
AC LINE 60 CY - 50 CY switch	Selects the appropriate capstan motor for 60 or 50 cps line frequency.
POWER ON-OFF switch	Controls application of a.c. power to the control unit.
REWIND-LOCAL-REMOTE switch	Selects rewind, local, or remote mode of operation: REWIND position - Used with STOP position. Selects tape motion in the reverse direction at rewind speed. LOCAL position - Selects local operation. The control of tape movement (direction and speed) is dependent upon the REV-STOP-FWD switch. REMOTE position - Selects REMOTE operation, whereby control of tape movement (direction and speed) is dependent upon external command signals rather than from the manual controls on the tape transport front panel.
REV-STOP-FWD switch	Used with REWIND and LOCAL positions of REWIND-LOCAL-REMOTE switch to select normal start and stop of tape motion and direction: REV Position - Moves tape in the reverse direction at normal speed. STOP Position - Stops tape motion when operating in the local mode. FWD Position - Moves tape in the forward direction at normal speed.

Table 6-8.–RD-289 Tape Transport Operating Controls, Indicators, and Functions--Continued

CONTROL OR INDICATOR	FUNCTION
LOAD-UNLOAD switch	Used with LOCAL position and STOP position for local operations.
	LOAD position - This position loads the tape into the vacuum columns, turns the LOAD light "on", and drives the tape in the reverse direction. The tape stops at the loadpoint (BOT silver marking strip on tape). The BOT lamp lights at the loadpoint. The LOAD operation does not function when the REWIND-LOCAL-REMOTE switch is in the REMOTE position. Load operation will occur only when the REWIND-LOCAL-REMOTE switch is in the LOCAL position.
	UNLOAD position - Turns the UNLOAD light "on", and stops the tape transport operation.
RESET pushbutton	Operates in combination with LOCAL operation of the tape transport. Pressing the RESET pushbutton stops tape motion during load point search.
BOT-READY indicators	The BOT lights go on when the BOT marker strip is sensed. The READY light goes on when the REWIND-LOCAL-REMOTE switch is in the REMOTE position and the tape is ready for operation.

marker strip has passed through the drive mechanism.

(15) Press LOAD switch.

NOTE: The tape will move in a reverse direction and stop on the BOT marker strip. The BOT lamp lights.

(16) Check that the packer arm is set against the tape.

OPERATING PROCEDURES.–The RD-289 can be used in either manual or remote operation.

Remote Operation.–Proceed as follows for remote operation:

(1) Turn REVERSE-STOP-FORWARD switch to STOP.

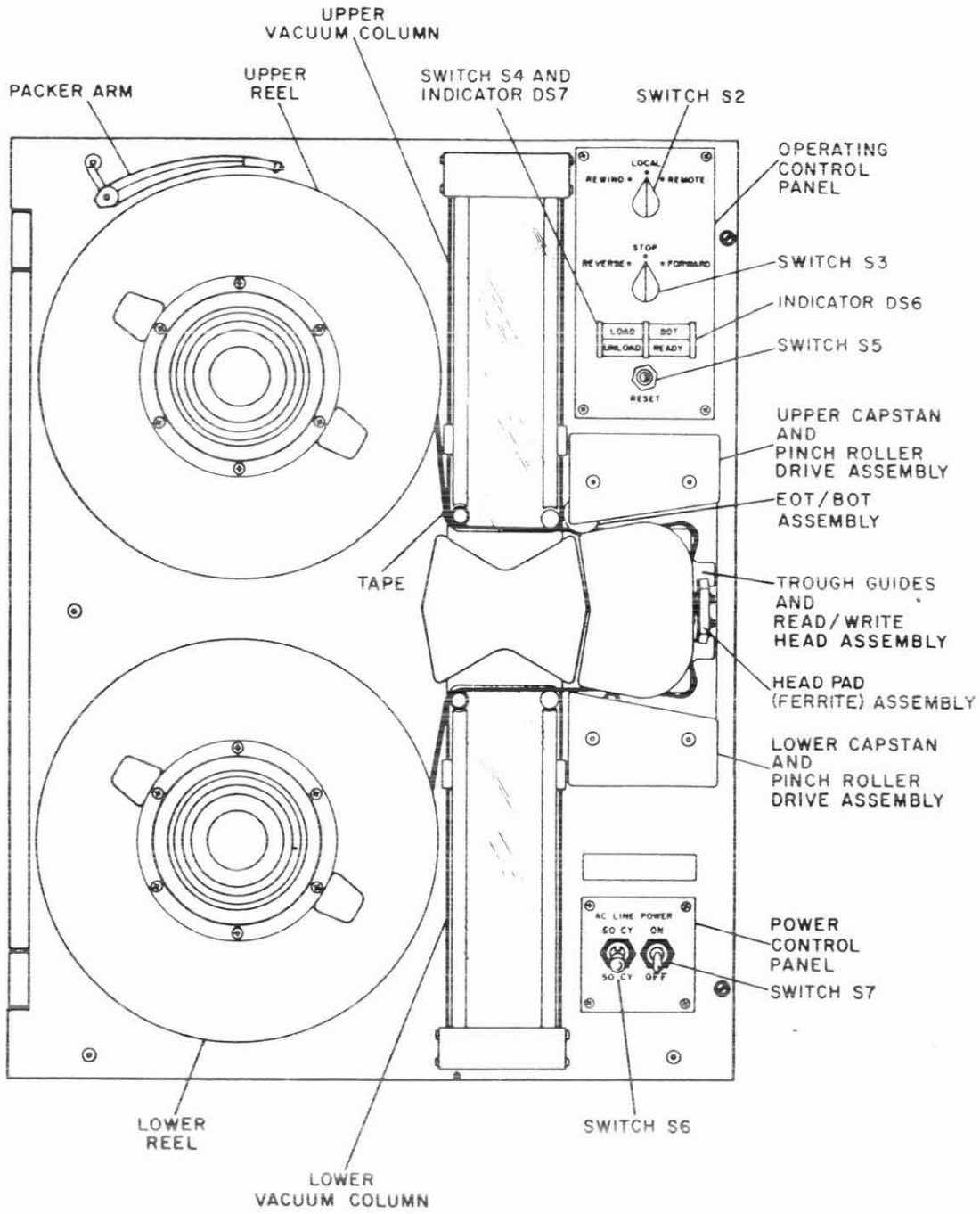

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Figure 6-19.—RD-289 tape loading.

(2) Turn REWIND-LOCAL-REMOTE switch to REMOTE.
(3) Check that the capstans rotate and the READY light is on.

MANUAL OPERATION.—Proceed as follows for manual (local) operation:

(1) Turn the REWIND-LOCAL-REMOTE switch to LOCAL.
(2) Select the mode of operation, forward or reverse, by placing the REVERSE-STOP-FORWARD switch in the desired position.

TAPE UNLOADING PROCEDURE.—Unload (remove) tape from the tape transport as follows:

(1) Turn the REVERSE-STOP-FORWARD switch to STOP.
(2) Turn the REWIND-LOCAL-REMOTE switch to REWIND.
(3) Observe that the tape rewinds on the upper reel at rewind speed, stops at BOT marker, loads into vacuum columns, and moves in reverse and off the lower reel.
(4) Turn the LOAD-UNLOAD switch to UNLOAD.
(5) Set the tape packer arm to the raised position and remove the upper tape reel.

TURN-OFF PROCEDURE.—Turn off the RD-289 tape system as follows:

(1) Turn the REWIND-LOCAL-REMOTE switch to LOCAL.
(2) Turn the REVERSE-STOP-FORWARD switch to STOP.
(3) Press the UNLOAD switch.
(4) Set the POWER ON-OFF switch to OFF.

Cleaning Procedures

The RD-289 tape transports should be cleaned thoroughly prior to the loading of a new reel of tape. Methyl Chloroform should be used on the read/write heads, tape guider, vacuum column and rollers, and capstan. Isopropyl Alcohol should be used on the pinch rollers only. Vacuum cleaners should be used in surrounding areas to keep dirt and dust circulation to a minimum.