RECORDER

KS-19326 L1

DESCRIPTION AND OPERATION

CONTENTS PAGE

1. GENERAL

1.01 This section covers the physical and operational description, and magnetic tape handling and storage for the KS-19326 L1 recorder (Fig. 1) used as an input/output device in the summarizer of the Traffic Data Recording System (TDRS) No. 1A.

1.02 This section is reissued for the following reasons.

- To update all illustrations
- To include physical and operational descriptions (Parts 2 and 3) and to revise the section title accordingly
- To revise format and make additions and changes as required.

Since this is a general revision, arrows ordinarily used to indicate changes have been omitted.

1.03 Tape recording and reading periods may vary in accordance with local office requirements. The time and reason for the tape to be loaded or removed depends upon system requirements and operating procedures.

2. PHYSICAL DESCRIPTION

2.01 The KS-19326 L1 recorder is a three-speed multichannel tape handler designed for start-stop operation with relay-switching facilities for providing remote control of tape motion. All recorder functions except tape loading and removal are controlled by the system.

2.02 Power sources required for operation of the recorder are 117-volts (±10 percent), single phase, 60 Hz ac; and 42-52 volts dc with positive ground.

2.03 Individual servo systems are provided for the supply and take-up reel motors. Provided also are: tape brakes, reel motor brakes, separate photo-reflective beginning of tape (BOT) and end of tape (EOT) sensors; means for detecting high tape tension, tape breakage, BOT/EOT lamp failure, and DC power failure. Solid-state electronics are provided for the servo systems and the BOT and EOT sensors. Read-write electronics are provided by the system and are described in system practices covering the TDRS No. 1A in the 252 division.

2.04 The recorder accommodates 1-inch wide, 1-mil thick, mylar base, 4600- or 4700-foot long thin oxide magnetic tape (3M-551 magnetic tape or approved equivalent). Tape is supplied on 10-1/2 inch diameter reels.

2.05 The recorder is designed for mounting in a 19-inch relay rack or cabinet and occupies 24.5 inches of vertical space. It has a total depth of 17.3 inches; 3.9 inches in front of the panel and 13.4 inches from the panel to the rear of the recorder. The recorder weighs 150 pounds.

2.06 The recorder is equipped with retractable slides and a hinged front panel for accessibility to the interior of the unit for maintenance purposes. A hinged front cover door with a transparent area for observing tape reel motion is provided. The front cover door opens to the left to a 90-degree

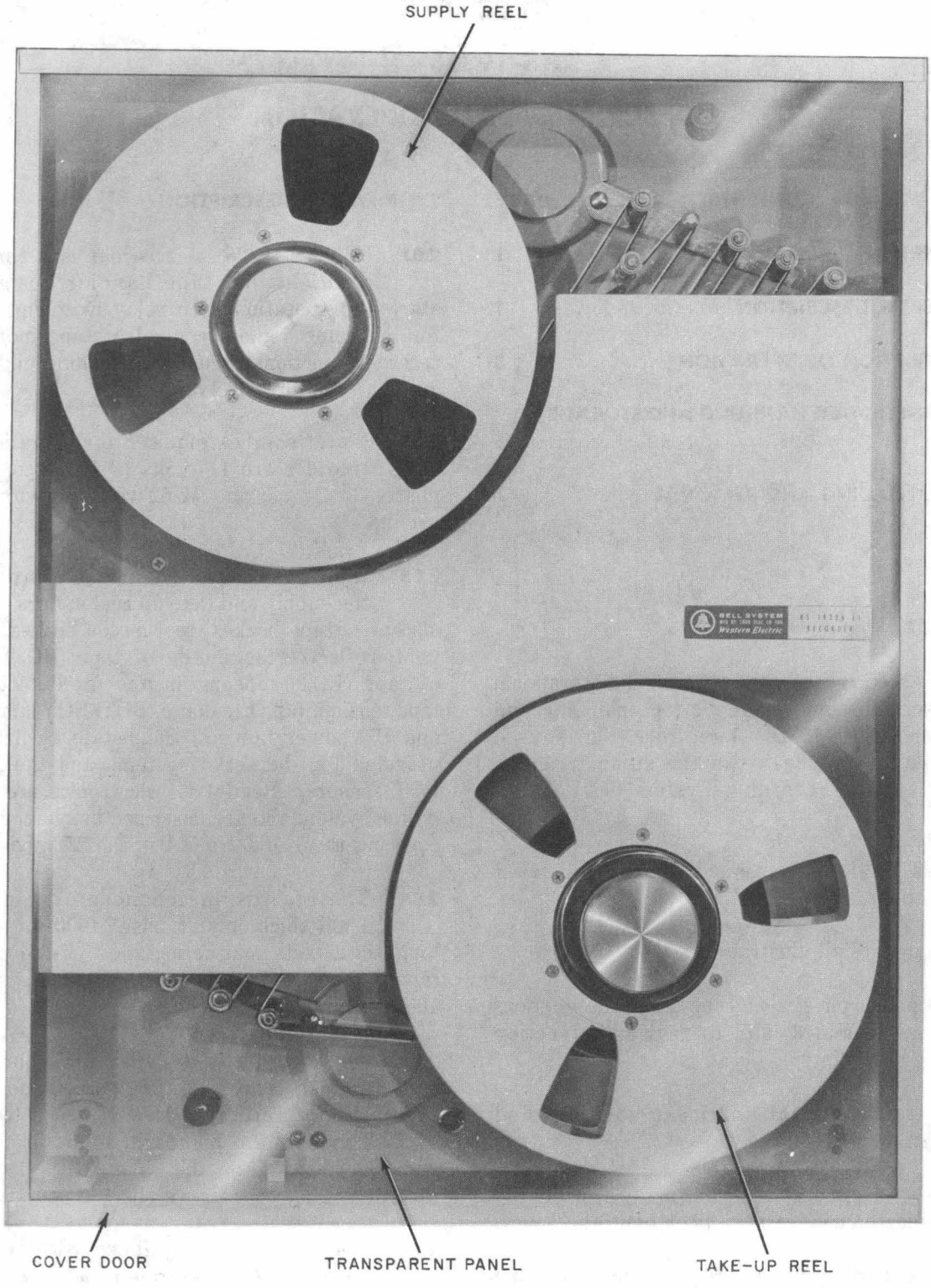

Fig. 1—KS-19326 L1 Recorder—Front View

position and, when closed, actuates a safety interlock switch. The purpose of the switch is to remove operating power from the recorder when cover door is opened. A manual override feature is provided for use when it is necessary to operate the recorder with the cover door open.

3. DESCRIPTION OF OPERATION

3.01 The KS-19326 L1 recorder operates in an ambient temperature range of 32 to 115 degrees fahrenheit and in a relative humidity range of 35 to 75 percent without condensation. The acoustical noise produced by the recorder during start-stop operation does not exceed 60 dB, American National Standards Institute (ANSI) Curve B, when measured 5 feet in front of the recorder with front door closed.

3.02 The recorder contains a 40-track write-read head assembly for digital writing, single-channel serial, in the non-return-to-zero (NRZI) mode. The packing densities are 940 bits per inch at a tape speed of 1-1/4 inches per second (ips) (470 bpi when writing all zeros) and 430 bits per inch at a tape speed of 75 (215 bpi when writing all zeros) ips. The head assembly also has the capability of reading tapes with packing densities of 215 and 940 bits per inch recorded on KS-19326 recorders and with 940 bits per inch recorded on KS-19325 recorders.

3.03 The tape speed of 1-1/4 ips is available in the forward direction only. A bi-directional tape speed of 75 ips is provided for sequential write-read and start-stop mode of operation. A capstan driven, bi-directional tape speed of 150 ips is also available for tape scanning and tape wind purposes.

3.04 ***Servo System***

(a) Tension Arm: A tension arm is mounted on the front panel adjacent to each storage reel. Its primary function is input or position sensing for the servo system. The arm has a number of spindles (one of which is fixed on upper arm) which operate in conjunction with corresponding stationary spindles for the temporary storage of tape. The spindles hold approximately 30 inches of tape at mid (null) position. During operation the length of tape in this area may vary by as much as 50 percent in either direction. The tape is held taut by a torsional (clock type) spring which is attached to the pivot shaft of the tension arms. When, due to forward capstan actuation, the tape moves across the head assembly and away from the upper tension arm, the tension on the arm will increase and move the tension arm down (clockwise) because the amount of tape entering the upper tension arm spindles is less than the amount of tape leaving the spindles. Due to arm movement the upper servo system responds and the supply reel supplies tape to the arm to restore the balance of tape entering and leaving the arm and move the arm back toward the null position. The tape moves toward the lower tension arm from the supply reel and the tension on the lower arm is reduced. The torsion spring will move the arm counterclockwise because the amount of tape entering the lower tension arm spindles is greater than the amount of tape leaving the spindles and entering the take-up reel. As the lower servo system responds and the take-up reel takes the tape, the lower tension arm will move clockwise toward the null position and restore the balance of the amount of tape entering and leaving the lower tension arm spindles.

(b) Error Sensing Potentiometer: The error sensing potentiometer, which is attached to the tension arm shaft, in conjunction with the other components in the servo system, controls the reel motor. When the tension arm moves off the null position, the servo circuitry determines the magnitude and direction of acceleration of the reel motor.

(c) Servo Amplifier and Current Control: The servo amplifier consists of a lead network, a difference amplifier, ramp generator circuits, and pulse forming circuits.

(1) To provide for very rapid changes in arm position, the lead network is placed at the input of the difference amplifier. The lead network operates a differentiator or a detector for the rate of change in voltage. The rate of change in voltage is proportional to the velocity of tension arm movement. For very rapid changes in tension arm position, the network provides a virtual short circuit resulting in greatly increased input to the difference amplifier. The input is amplified and the amplifier circuit produces a low impedance input to the ramp generator circuits.

(2) Two separate ramp generators are used with each servo system. Each ramp generator is used to convert dc to ramp (triangular) waveforms for one direction of servo action. The slope of the ramp is proportional to the voltage outputs of the difference amplifier and is thus proportional to the velocity and magnitude of displacement of the tension arm.

(3) A pulse circuit is connected to the output of each ramp generator . The pulse circuit produces a current pulse which is conducted through the primary winding of its associated pulse transformer. Each transformer has two secondary windings; two output pulses are generated for each direction of rotation of the reel motor. Each pulse is approximately 5 volts in amplitude.

(4) Four silicon control rectifiers (SCR) control current to each reel motor. Two SCR gates are opened by pulses from each pulse transformer. Each SCR pair with its associated gating pulse circuit provides full wave rectification and phase controlled current for one motor field winding (one direction of rotation).

(5) Direction of rotation for each reel motor is determined by the direction of tension arm movement. When the forward capstan is actuated, the upper tension arm will be displaced in a positive (clockwise) direction. The error signal will be amplified by the difference amplifier at the counterclockwise ramp output, and the counterclockwise pulse transformer will gate the counterclockwise SCR pair. Power will be applied to the counterclockwise motor field, the upper reel will turn in a counterclockwise direction to supply tape, and the tension arm will be moved toward the null position.

(6) The torque of the reel (servo) motor is a function of the net current in the motor fields. The current in each field is equal to the sum of the current pulses conducted by the associated SCR pair. Each current pulse varies with the time of conduction of an SCR. The conduction time is determined by the portion of the current pulse remaining after the gate pulse is received. The time the gate pulse is received is determined by the slope of the ramp produced by the ramp generator. The ramp slope is dependent on the amplified difference voltage. The amplified difference voltage is dependent on the magnitude and rate of change in potentiometer-tension arm position.

(d) Servo System Summary: The upper and lower servos respond to the voltage analog of tension arm positions. Whenever tape is accelerated by the capstan drive, the tension arms will move in the direction of tape motion. High velocity arm position changes will be matched by corresponding servo response; the tension arms will quickly return to near null position. As long as the tape continues to move, the tension arms will be slightly displaced from the stop position and the reels will continue to turn. When tape drive is stopped, the arms will move rapidly causing a corresponding servo action. The response of reel motors will quickly return the tension arms to null and the reels will stop. For all practical purposes, the position at the center detent may be called the null position. Normal tension arm position with constant speed and forward direction is displaced slightly from center toward the supply reel and away from the take-up reel. Arm position varies slightly with tape speed and reel pack diameter.

3.05 *Transport Protection, Interlocks, and Status Signals*

(a) Front Door Interlock: The front door interlock switch is connected to the command (remote control) connector. The interlock switch removes operating power from the recorder in the event the front door is inadvertently opened while the recorder is in operation. There is an override feature on the switch (activated by pulling the actuator plunger outward) which will restore operating power to the recorder for maintenance and tape service operations.

(b) Tension Interlock: Operating power in the recorder is interrupted if tape tension exceeds the limits (high or low tape tension). When a tension arm approaches either the inner or outer limit of travel, a sensing switch is actuated. When either switch is actuated, two relays (A2K1 and A2K2) are de-energized which interrupt operating power to the recorder.

(c) Reel Brakes: When both ac and dc are applied to the recorder, the mechanically

actuated reel brakes are held released by power supplied to the brake coil through the power contactor relay (A2K1). When ac or dc is interrupted, power is removed from the brake coil causing the reel brakes to be applied. This prevents the tape from spilling due to primary power failure, overload (fuse open), tape breakage, or power supply failure.

Note: Removal of a forward or reverse signal will apply tape brake only. Reel brakes are applied ***only*** when power is removed from the reel brake coil.

(d) Beginning of Tape and End of Tape: A signal is provided for Beginning-of-Tape (BOT) and for End-of-Tape (EOT) by amplifying a signal from the photoelectric detection of reflective markers on the tape. The circuitry for both BOT and EOT is contained on a single etched circuit board.

3.06 ***Power Distribution***

(a) Control of ac and dc: With no malfunction and the external power on, −20 volts dc (developed across A1CR13) operates A2K2 relay through the series circuit containing the EOT and BOT lamps and the limit switches (S1 and S2) on the tension arms. Since the operating voltage for the A2K2 relay is supplied through a series circuit, an open in the circuit caused by any component (EOT lamp, BOT lamp, S1 or S2 switch) will prevent the relay from operating and thus inhibit operating power to the recorder. Relay A2K1 operates through contacts in relay A2K2 and applies ac to the capstan motor, fan motors, and to the primaries of the transformers (T1 and A1T1). Relay A2K1 contacts also complete circuits which control dc power to the reel brake coils and provide −20 volts to the EOT and servo cards. The power transformer energizes the power supply which supplies voltage to the servo and control circuits. As a result, the reel drive motors position the tension arms and the recorder is ready for operation.

(b) Recorder Power Supply: The recorder power supply provides the operating voltages for the recorder circuitry. When −48 volt power (through the J4 connector) is applied to the recorder, the power supply receives 117 volts, 60 Hz ac. The full wave rectification from the center tapped secondary windings of a transformer is achieved using two diodes. The rectified voltage then passes through a filter network and is regulated by Zener diodes. This provides regulated +40 volts and +15 volts for the servo cards and two floating 20 volt supplies for the servo potentiometers. The last section of the power supply provides a full wave rectified voltage which is used as reset for the servo cards.

3.07 ***Tape Drive and Actuation Control:*** Two capstans (Fig. 5), one for forward tape motion and one for reverse, rotate when power is applied to the recorder. The tape is moved when a control signal results in actuation of the forward or reverse drive solenoid which causes its respective pinch roller to press the tape against the rotating capstan. The tape is stopped when the control signal is removed causing the drive solenoid to release and the associated brake solenoid to actuate pressing its pinch roller and the tape against the associated brake block.

3.08 ***Capstan Speeds:*** A transmission provides three speeds for forward tape movement and two speeds for reverse movement. (Three reverse speeds are available but only two are accurate.) The A2K3 and A2K4 relays provide the proper switching for transmission clutches and for selection of the proper speed of the capstan motor. With no speed commands, the capstan motor runs at 1800 revolutions per minute (rpm). With the medium speed command, the capstan motor runs at 1800 rpm producing a tape speed of 75 ips with a FWD or REV command given. When the high speed command is given, the capstan motor switches from 1800 to 3600 rpm which produces a tape speed of 150 ips with a FWD or REV command given. The high speed command is interlocked with move/stop commands and is valid only in the presence of FWD or REV command. When low speed command is given, the capstan motor is switched to 300 rpm and the clutch is switched, resulting in a tape speed of 1-1/4 ips on the forward capstan only with FWD command given.

4. MAGNETIC TAPE HANDLING AND STORAGE

4.01 ***Since tape damage of any kind may result in garbled tape recording,*** the following should be observed.

(a) Magnetic tape shall not be spliced.

(b) No external labels of any type shall be placed on the surface of the magnetic tape.

(c) Any tape that has been dropped should not be used.

(d) Tape shall not be exposed to strong magnetic fields except when it is being degaussed.

(e) Tape packs exposed to temperatures over 100 degrees shall be exercised (4.04).

(f) The end of the tape shall not be placed in the slot on the hub of the take-up reel, nor shall it be fastened to the hub with adhesive labels or tape.

(g) Each reel shall be visually checked for warpage and alignment to ensure that it will not wobble when seated on the reel adapter assembly and secured by the reel clamp.

(h) The inside surfaces of the take-up reel flanges shall be checked visually for burrs or other surface defects which may interfere with the smooth winding of the tape.

(i) Tape ends that are frayed, wrinkled, or otherwise damaged shall be cut off before threading the tape in the recorder.

(j) Tape reels shall always be mounted with the write-enable groove facing inward toward the front panel assembly.

(k) To avoid tape edge damage, tape reels shall be handled by reel hubs or outer edges of flanges. No force shall be applied to flanges in tape area.

(l) Care must be exercised to prevent any cleaning fluid from contacting tape reels or tape surfaces.

(m) Spare reels of tape shall always be stored in their containers. The containers shall be stored vertically to minimize damage to the edges of the tape.

(n) Tape shall be put back in its container immediately after its removal from the recorder.

(o) Keep empty containers closed and stored as if containing tape.

(p) Smoking shall not be permitted in the area of the recorder nor in the tape storage area. Ashes can contaminate the tape surface.

(q) Since body oils and other foreign matter can contaminate the tape, care should be exercised during the threading operation to avoid handling that part of the tape on which information will be recorded.

(r) Record magnetic heads shall be kept ***clean.*** The heads shall be inspected for dirt and oxide regularly. The tape path must be free of any contamination, such as tape oxide, wax, oil, and dust.

4.02 ***Heat and Humidity:*** Extremes of temperature and humidity should be avoided in tape storage areas. In general, recommended storage conditions for mylar-base magnetic tapes are

Temperature—60-80°F
Humidity—40-60% RH

Wide changes in temperature and humidity expand and contract the base material of the tape. This movement causes distortion that may make the tape useless.

4.03 ***Tape Exposure to Cold:*** Tape exposed to extremes in temperature during storage or shipment should be allowed time to adjust itself to ambient conditions before removal from its protective shipping container. This is especially important when the tape is exposed to subfreezing temperatures and then is brought into a warm, relatively humid room. In such cases, 24 hours of stabilization time is recommended for a full reel of tape to reach complete equilibrium. Follow by exercising the tape (4.04).

4.04 ***Exercising of Tape:*** New tape to be used for the first time or tape that has been exposed to extremes in temperature and humidity should be exercised before recording. Exercising of the tape can be accomplished by mounting the reel of tape as described in 5.01 and then performing a complete forward and reverse tape wind at a tape speed of 75 inches per second.

4.05 ***Storage Area:*** Storage areas away from magnetic fields caused by ac or dc current should be chosen. Tape should be kept away from permanent magnets. Tapes shall be stored in plastic or metal dust-proof containers positioned vertically in a storage bin. It is recommended that storage bins be equipped with partitions between each reel. ***Never leave tapes or open containers lying unprotected on shelves.***

4.06 Tape and Tape Reels

(a) ***Tape:*** The 1-inch wide, 1-mil thick, mylar-base magnetic tape shall have photoreflective markers affixed for beginning-of-tape (BOT) and end-of-tape (EOT) sensing by the recorder. The adhesive-coated markers shall be located on the tape as shown on Fig. 2.

(b) ***Reels:*** Use 10-1/2 inch reels having NAB (National Association of Broadcasters) hubs. The reel has a tape capacity of 4600 feet (nominal). Reels with metal hubs and flanges are recommended for locations where low humidity is encountered frequently.

(c) ***External Label:*** Reels of tape containing telephone traffic data shall have an external identification label affixed on the front flange of the reel. Information to be shown on the label such as date, time, number, location, etc, shall be in accordance with system requirements. A self-adhesive paper label or equivalent is recommended; the type and size of label to be used shall be in accordance with local instructions.

5. TAPE LOADING AND REMOVAL

5.01 ***Tape Loading***

Warning: Power must be OFF when loading tape on the recorder. Do NOT handle reels or tension arms when power is ON.

(1) Operate the PLO (power lockout) key on the recorder control panel (Fig. 3) to remove power from the recorder that has been selected for tape change service. The power indicator lamp (Fig. 4) on the recorder is extinguished.

Caution: Other conditions may extinguish lamp leaving power on.

(2) Open the front cover door of the recorder.

Note: The front door safety interlock switch is automatically actuated when the door is opened.

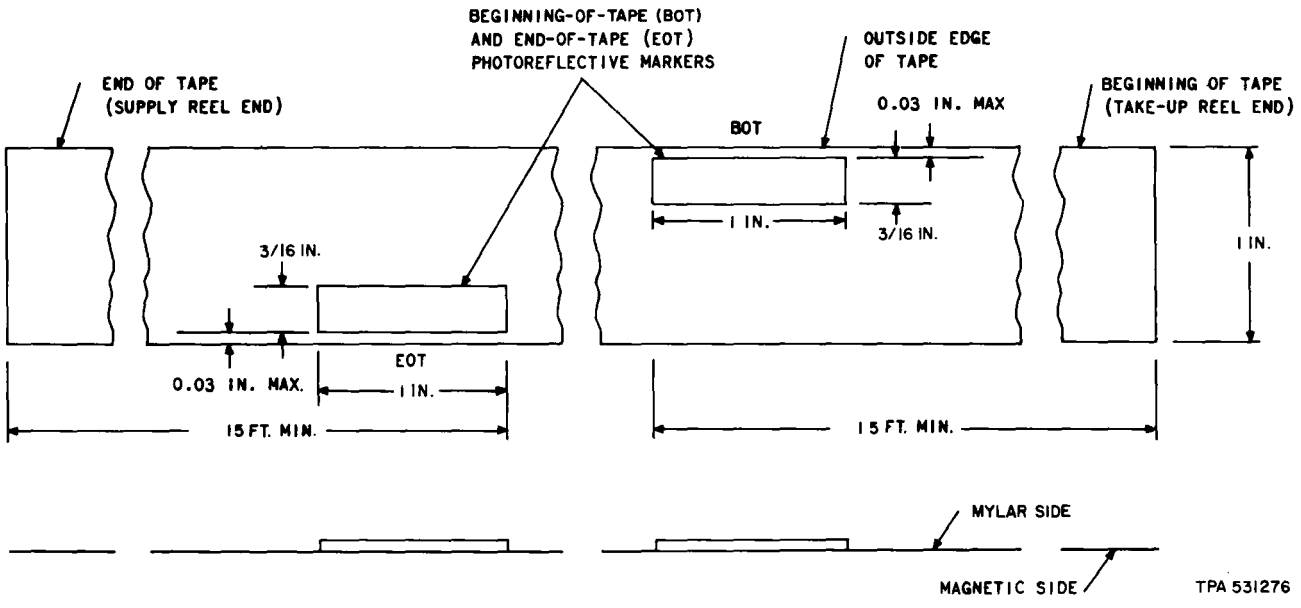

Fig. 2—Photoreflective Marker Placement on 1-Inch Magnetic Tape

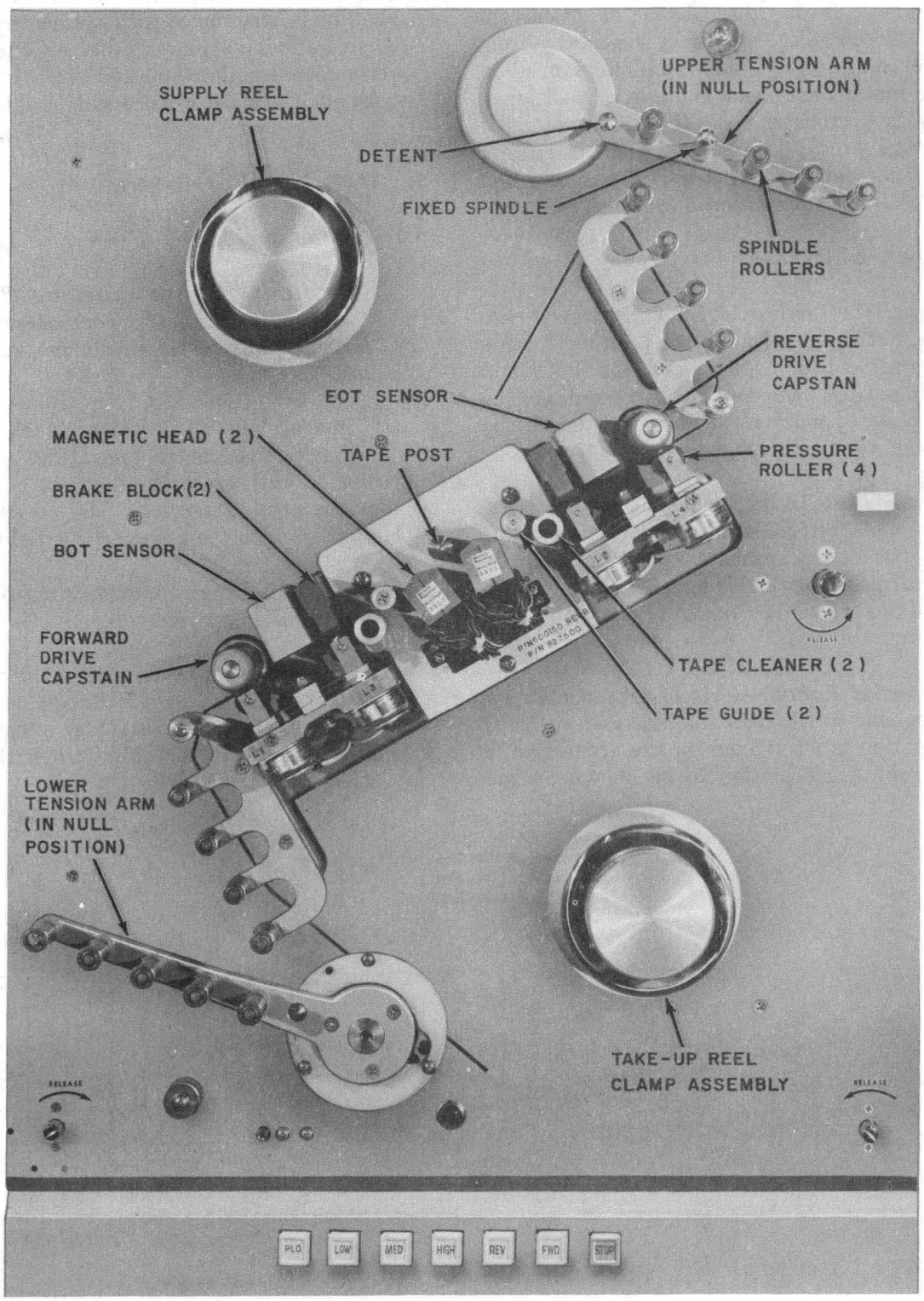

Fig. 3—KS-19326 L1 Recorder With Tension Arms in Center (Null) Position and Reels Removed

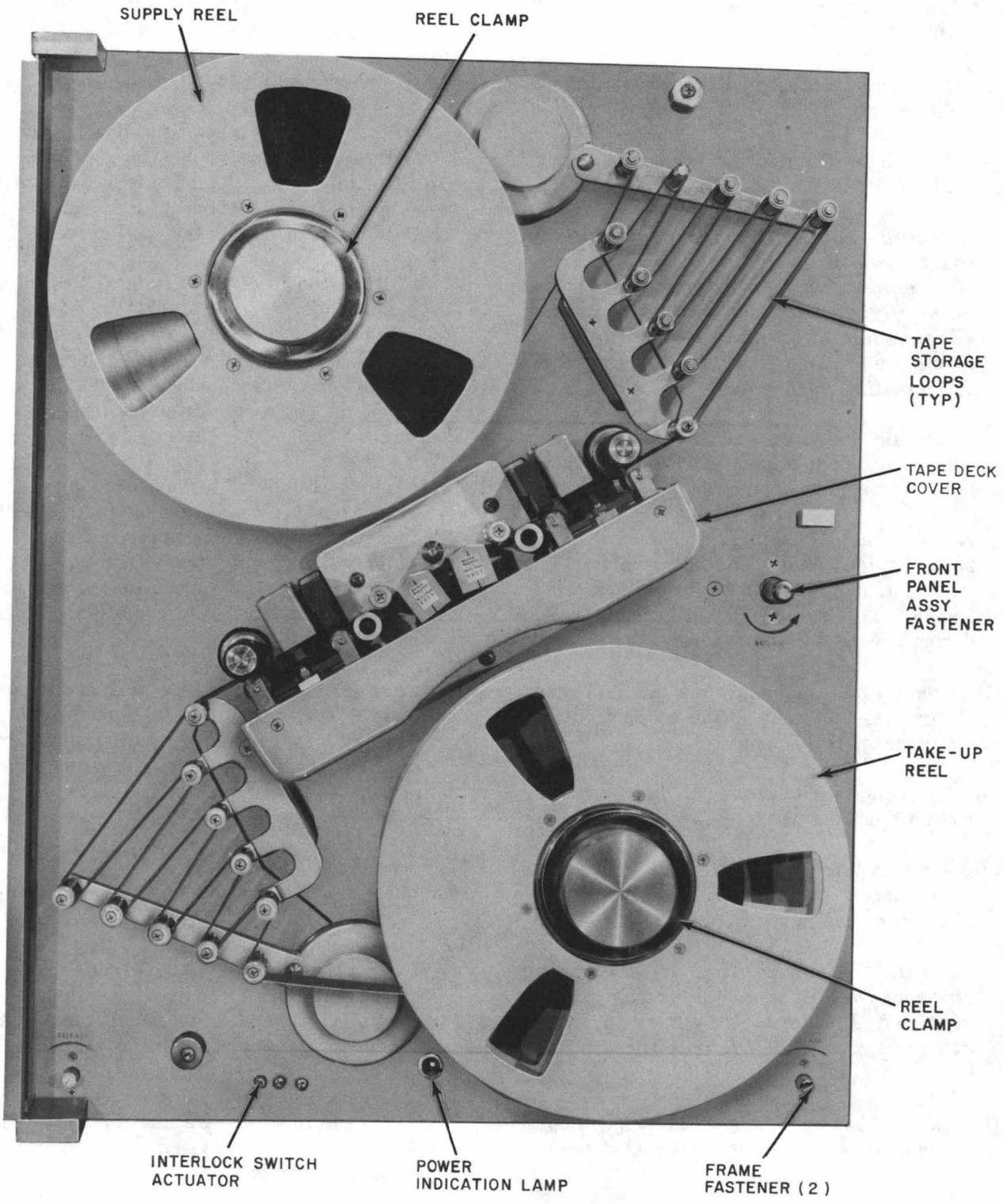

Fig. 4—KS-19326 L1 Recorder in Operating Position With Tape Loaded and Cover Door Open

(3) If applicable, remove tape in accordance with 5.02.

(4) Clean tape path components in accordance with Section 034-358-701.

(5) Remove both upper and lower reel clamps (Fig. 4).

Caution: Handle tension arms only by the tension arm castings. Do not grasp the tension arm spindle rollers when manually positioning the tension arms. Careless handling can cause misalignment of the spindles with resultant degradation in recording performance.

(6) Manually move both tension arms to their innermost limits (tape load position) as shown in Fig. 5 and engage detents.

Note: Each tension arm has two detent positions, load (inner) and null (center). The inner detent position is used during the tape loading and the center detent position is used during maintenance procedures.

(7) Mount a take-up (empty) reel and reel clamp (Fig. 4) on the take-up (lower) reel adapter and tighten the reel clamp.

(8) Select the tape to be mounted and carefully remove it from its protective container.

(9) When mounting a fresh tape, ensure that the tape is equipped with BOT and EOT markers as shown in Fig. 2.

Caution: Avoid pulling or pushing on the reel flanges when mounting reel on recorder. Handle reels by the outer edges of the flanges or by the reel hubs.

(10) Mount the reel of tape on the supply (upper) reel adapter and tighten the reel clamp.

Caution: Make certain that the supply reel is mounted so that the tape feeds to the right and from the bottom of the reel. See Fig. 5 for threading guide lines stenciled on panel of tape transport. See Fig. 5 for illustrated tape path.

(11) Pulling from the ***bottom*** of the supply reel, unwind a sufficient amount of tape to serve as the tape leader for threading. Do not permit the end of tape to touch the floor.

(12) Following the tape path shown in Fig. 5, thread the tape as illustrated. Wind 3 or 4 feet of tape onto the take-up reel by manually rotating the reel counterclockwise. This secures the leader end of tape to the take-up reel.

(13) Move the upper tension arm toward the stationary spindle bracket to release the locking detent. Manually rotate the supply reel counterclockwise until a sufficient amount of tape is fed into the tape spindles so that the upper tension arm moves to the outer limit (against tension arm bumper).

(14) Move the lower tension arm toward the stationary spindle bracket to release the locking detent. Move the upper tension arm to its null position forming the normal tape storage loops which will in turn move the lower tension arm to its null position with normal tape storage loops.

Caution: Check the tape path to determine proper threading (particularly over the flanged tape guides. Ensure that the reel clamps are in secured positions before closing the cover door.

(15) Close the front cover door.

(16) Release the PLO key at the recorder control panel.

(17) To restore power to the recorder, operate the appropriate 48V ON key located at the system key and lamp circuit panel. The power indicator lamp on the recorder shall light.

(18) The recorder is now ready for operation. Its return to service and its control shall be in accordance with system requirements and operational procedures.

5.02 ***Tape Removal***

Caution: Recorded data will be erased from the tape durng tape rewind operations if the recorder is programmed in the RECORD mode. The modes of recorder

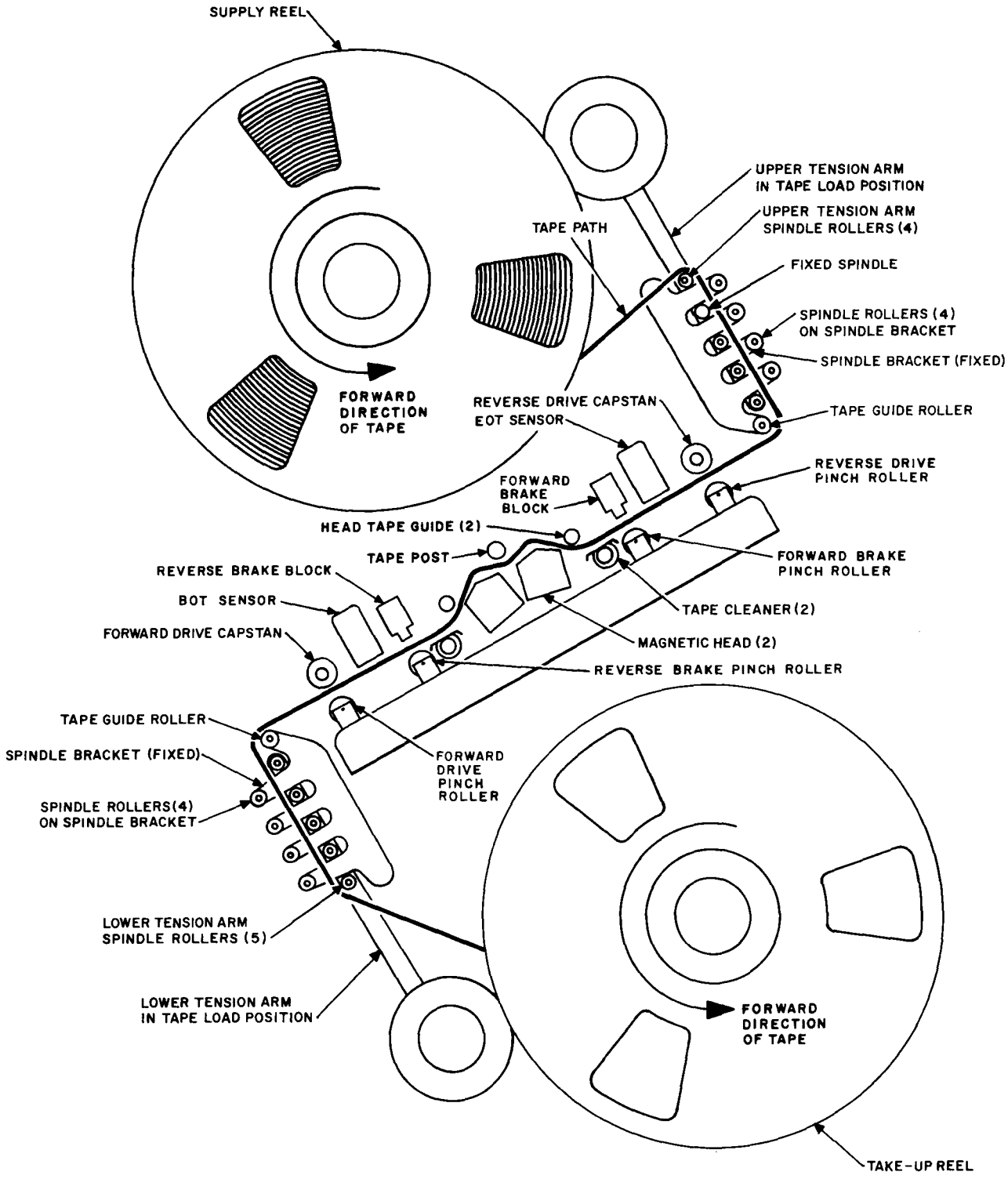

Fig. 5—KS-19326 L1 Recorder Tape Path

operation are remotely controlled via system write, read, and control circuits. Conditioning the recorder to provide protection against tape erasure shall be in accordance with system operational procedures.

(1) After the system control has released the selected recorder for manual tape change service, ***be sure the recorder is in the playback mode.*** If the tape is to be rewound to the supply reel, operate the HIGH and REV (reverse) keys at the recorder control panel. The tape shall rewind onto the supply reel until the BOT photoreflective marker is detected by the BOT sensor (Fig. 3). The tape stops with all the tape, except the tape leader, rewound onto the supply reel. If tape is not to be rewound to the supply reel, operate the HIGH and FWD keys at the recorder control panel. The tape stops on the EOT marker with all the tape except the tape leader wound on the take-up reel.

(2) Operate the PLO key on the recorder control panel to remove power from the recorder.

(3) Open the front cover door.

(4) Lock the tension arms (Fig. 5) in the load position. Manually rotate the supply (or take-up) reel in a clockwise direction to rewind the remaining tape leader onto the reel.

(5) Carefully hold the full reel by the hub or by the outer edge of the reel flange so that the reel cannot rotate; then loosen and remove the reel clamp. Remove the reel of tape from the recorder. If the tape removed is to be filed, place the reel in a clean dust-free container, and file it in accordance with local office procedure.

(6) Tape loading is covered in 5.01.

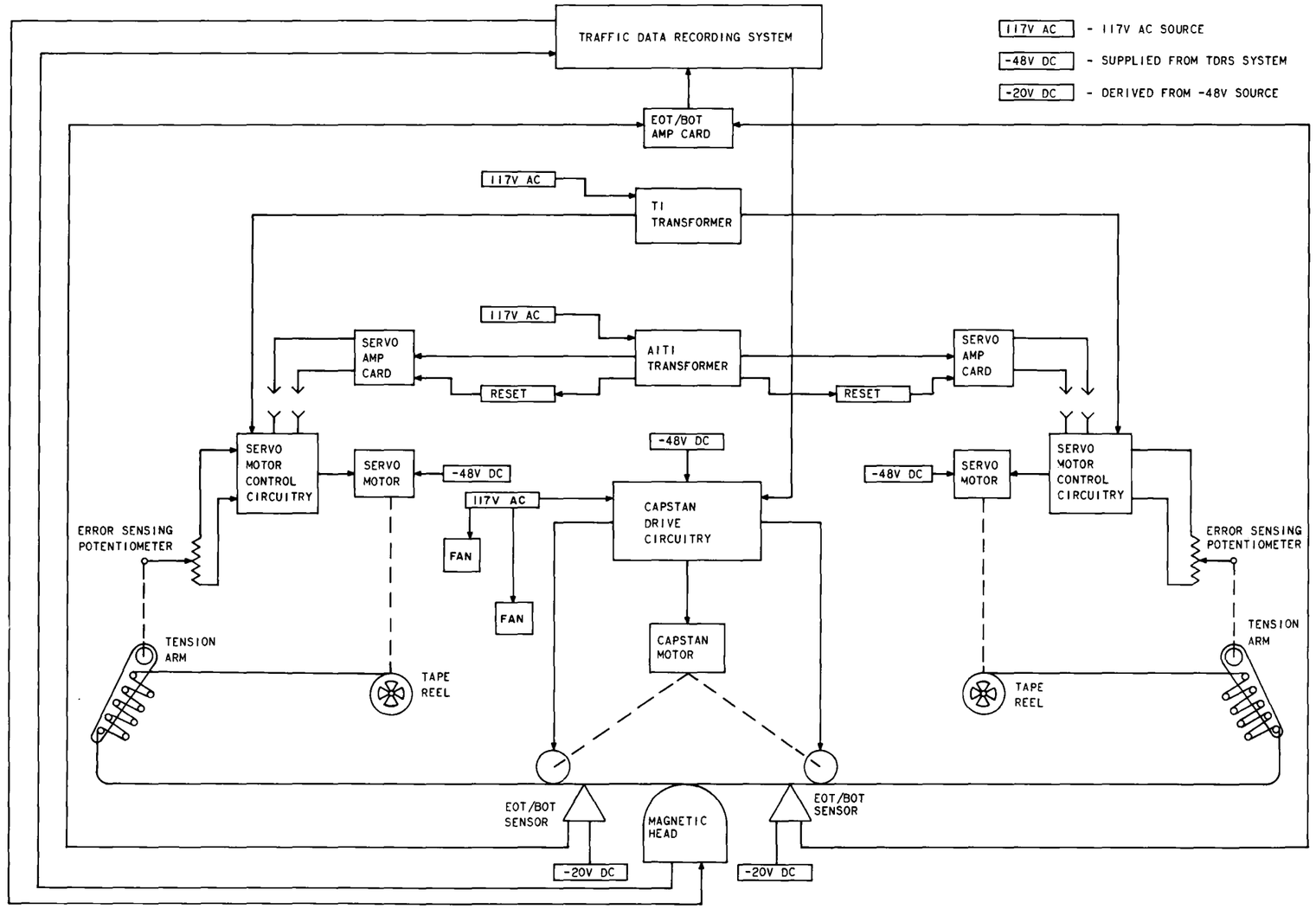

Fig. 6—Block Diagram of KS-19326 L1 Recorder