HIGH SPEED TAPE READER

(DX TYPE)

DESCRIPTION AND PRINCIPLES OF OPERATION

CONTENTS PAGE

1. GENERAL

1.01 This section provides description and principles of operation information for the DX type readers. It is reissued to include the latest engineering changes and corrections. Marginal arrows indicate changes or additions.

1.02 The high speed tape reader is an externally pulsed, magnet controlled, parallel output, perforated paper tape reader. Cantilevered sensing wires are utilized with electrical contacts to provide a parallel readout from the input perforated tape (Figure 1). Operating speeds are dependent upon the external pulsing rate up to 300 operations per second.

1.03 Mechanical and electrical inputs are required for the tape reading function. The mechanical input consists of a continuous torque drive to tape drive system, motivated by an electrical motor and metered through a magnetic, or hysteresis clutch.

1.04 The electrical signal input consists of an externally controlled master clock pulse, which is normally used as a command-to-step pulse by the reader driver circuitry. The required input power voltage is 115 v ac $\pm$ 10%, 60 Hz, at 115 watts under normal voltage and load conditions.

1.05 The tape reader is equipped with two independent rows of contact sensing wires; code and verify. Code contact sensing wires sense and transform perforated tape information into an electrical output. Verify contact sensing wires sense the same information, on the next step after code contact sensing wires, and are utilized as an input to the error detection circuit.

1.06 Variable operating speeds are dependent on the external input pulsing rate up to the maximum capability of 300 operations per second. The 5- to 8-level nonmetallic fully perforated or chadless tape, conforming to recognized standards, can be read by the tape reader, providing a parallel electrical output corresponding to the perforated code levels in the tape.

1.07 Contact outputs for indicating tape motion, tape-out, and tangled-tape conditions are also available on the reading head assembly. The tape reader can be operated in forward and reverse direction through external control of the motor windings.

1.08 The retractor mechanism is incorporated in the reading head to lower the code and verify contact sensing wires below the top

Prepared for American Telephone and Telegraph Company by Teletype Corporation

Printed in U.S.A.

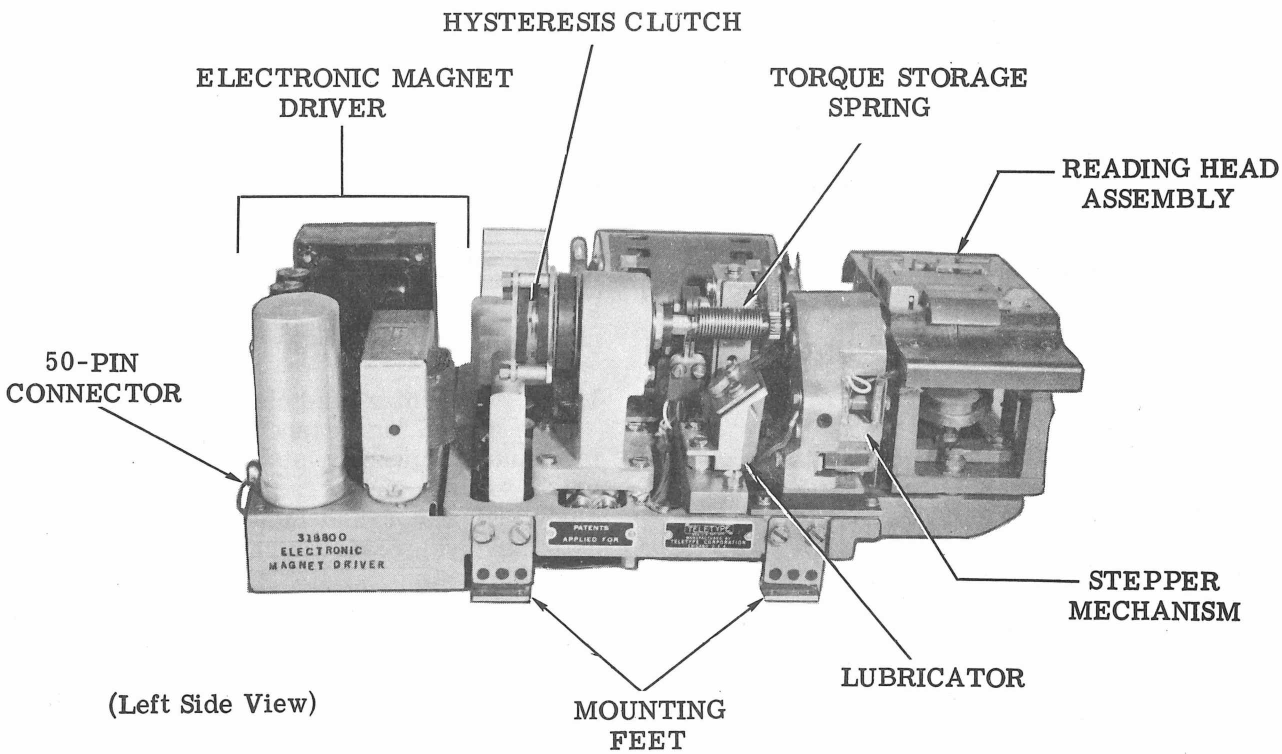

Figure 1 - High Speed Tape Reader

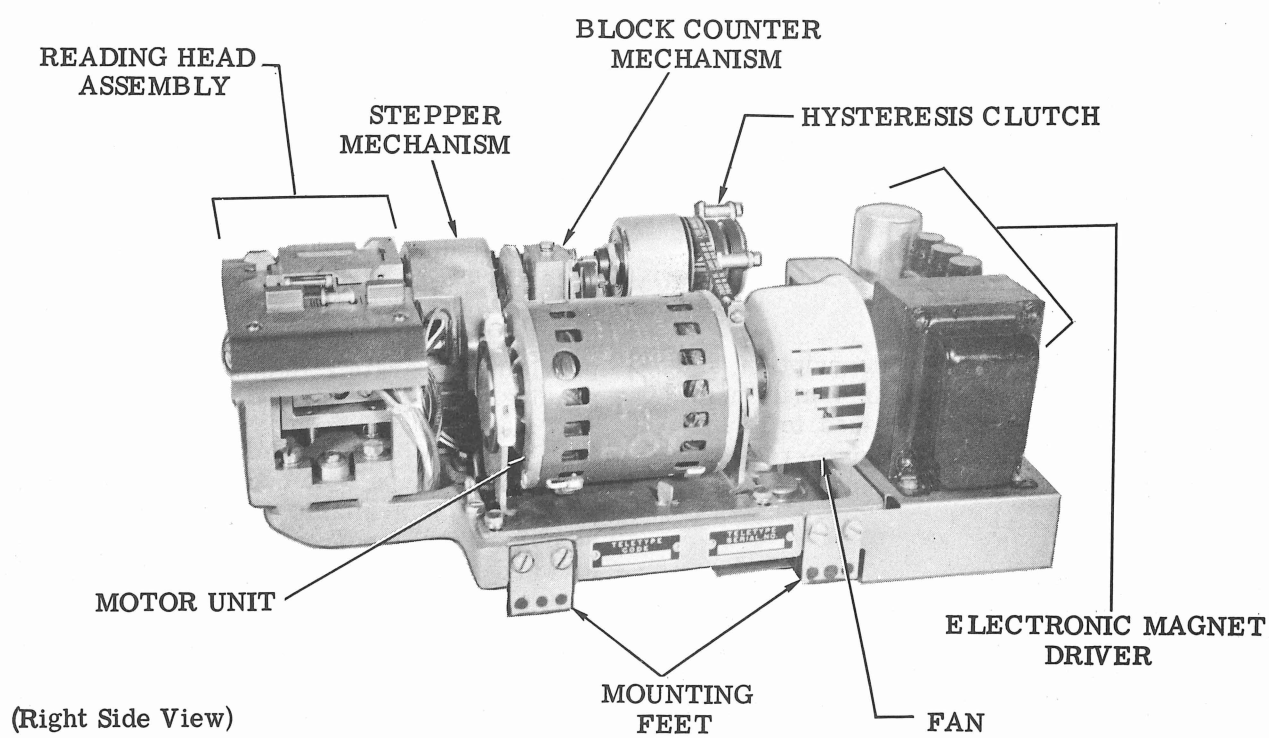

Figure 2 - High Speed Tape Reader (DX Type)

plate, and out of the tape path when operating the tape and motor in reverse direction. The retractor interlock switch prevents the motor from reversing until the contact sensing wires are retracted. Operating speeds in reverse are the same as in forward direction.

1.09 The electronic magnet driver receives external clock pulses to advance the tape through the tape transport mechanism. Fusing is provided for all input power to the tape reader on the electronic magnet driver. A 50-pin connector mounted at the rear of the reader provides electrical interface connections for all input and output service.

1.10 The tape reader is intended to be used with high speed tape sending sets, and other tape sending applications or it can be used as a self-contained unit.

1.11 The tape reader weighs approximately 24 pounds (less covers). Outside dimensions (less covers) are 5-1/4 inches high, 7-5/16 inches wide and 13-9/32 inches deep. Normal operating efficiency can be expected at 0 to 90% relative humidity, and at an ambient temperature of 32° to 121° fahrenheit (0° to 50° centigrade). Minimum storage temperature is -40° fahrenheit.

2. DESCRIPTION

BASIC UNIT

Mounting

2.01 The reader chassis is mounted on four rubber isolated mounting feet to facilitate mounting in a cabinet or self-contained model (Figure 1 and Figure 2).

Motor Unit

2.02 The motor unit consists of a permanent split capacitor type induction motor with fan, pulley, timing belt, and associated mounting hardware. The run winding and start winding with capacitor are interconnected to the 50-pin connector mounted at the rear of the unit (Figure 1).

2.03 External control is required to strap the run winding across the start winding with capacitor, electrically reversing the run winding with respect to the start winding, changing rotation direction.

2.04 Reversing the motor from one direction to another (at full speed) should take about 300 milliseconds under normal reader load conditions. The external logic circuitry should engage the retractor interlock switch, withdrawing the contacts below the top plate before the tape reverses direction.

Hysteresis Clutch

2.05 Motive power is supplied to the hysteresis clutch through a timing belt drive directly off the motor shaft pinion. An average speed of 1300 rpm is produced through the constant rotation of the magnetic clutch drivers. With the clutch follower coupled to the clutch driver by the permanent magnetic field of the drivers, the clutch follower torque and tape transport input torque is dependent on the adjustable air gaps between the face of the clutch drivers and the clutch followers (Figure 1 and Figure 2).

2.06 The smaller the air gap is between the clutch follower and clutch driver magnet, the more torque input is applied to the tape transport system. There is constant slipping between the clutch drivers and clutch followers when the unit is in idle condition.

2.07 When the unit receives a command to step, the clutch follower restores the torque storage spring (escapement drive spring) compensating for the energy used in moving the tape. The clutch operates in reverse as well as in forward, providing similar torque control in both directions.

Tape Stepper Assembly

2.08 With the unit in idle condition, torque is applied to the escapement wheel by the intermediate torque storage spring. Escapement wheel rotation is blocked by one side of the escapement pallet, while the escapement pallet is held in position by an armature attached to the pallet shaft, which is attracted to the pole face of the energized magnet (Figure 3).

2.09 A command to step is initiated by an input clock pulse into the electronic magnet driver which removes current from the energized coil and applies current to the opposite step coil, attracting the armature to the pole face (Figure 5). Since the armature and pallet are rigidly attached to the same shaft, motion of the armature causes motion of the pallet, releasing the escapement wheel (Figure 4).

2.10 Torque transferred through the torque storage spring is converted to rotary motion in the escapement wheel, which is allowed

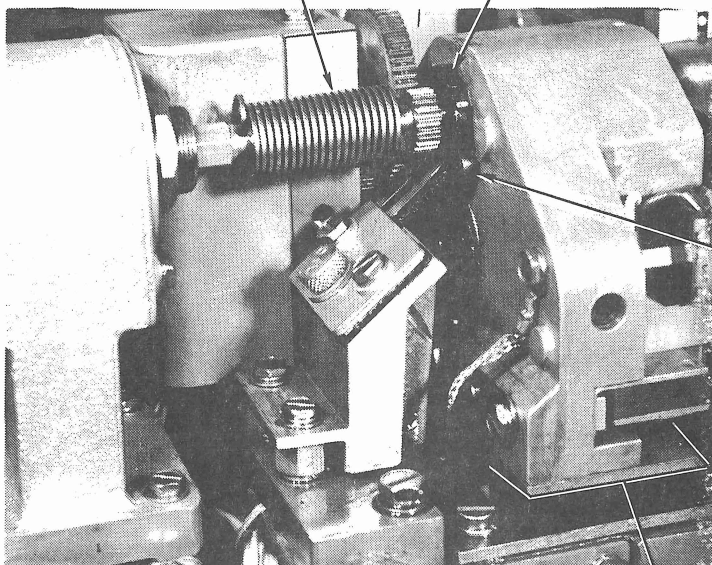

Figure 3 - Stepper Mechanism

to turn to its next position. Escapement wheel rotation is limited to 15° and tape motion to 0.1 inch. The same action takes place when the motor is reversed, providing operation of the unit in reverse direction.

READING HEAD

General

2.11 The tape sensing wires consist of cantilevered wire springs with formed sensing tips and integral electrical contact surfaces. In the idle condition without tape in the reading head, the sensing wires make contact with a common contact surface, providing a "mark" output, or contact closure for each sensing wire. The verify and code contact assemblies each have its own common contact surface.

2.12 With perforated tape in the reading head and tape lid closed, the tape hole pattern will be sensed by an electrical output. Nonperforated tape passing over the sensing wires or closing the tape lid over tape without holes, displaces the sensing wires and opens the contacts to provide a "space" output (Figure 6).

→ 2.13 When inserting tape in the reading head, provide at least 1 inch of lead tape over the feed wheel and the first character to be read before closing the tape lid.

2.14 The message tape determines the electrical output during the reading sequence. As the tape between adjacent characters passes over the sensing wires, all contacts are displaced to their open position producing a "space" output for all contacts. As the tape continues to move through the reading head, perforated holes of the next character permit the associated wires to be released by the open space to return to their normally closed position providing a "mark" output.

2.15 The sensing wires should be adjusted so that the wire tips are approximately in the center of the right two-thirds of the code and

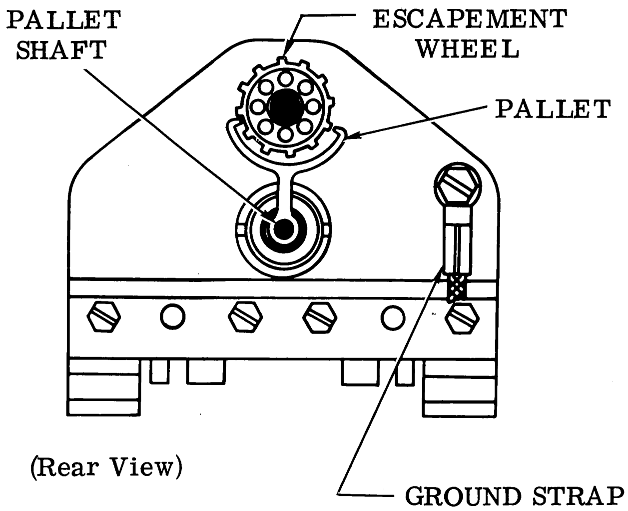

Figure 4 - Stepper Mechanism

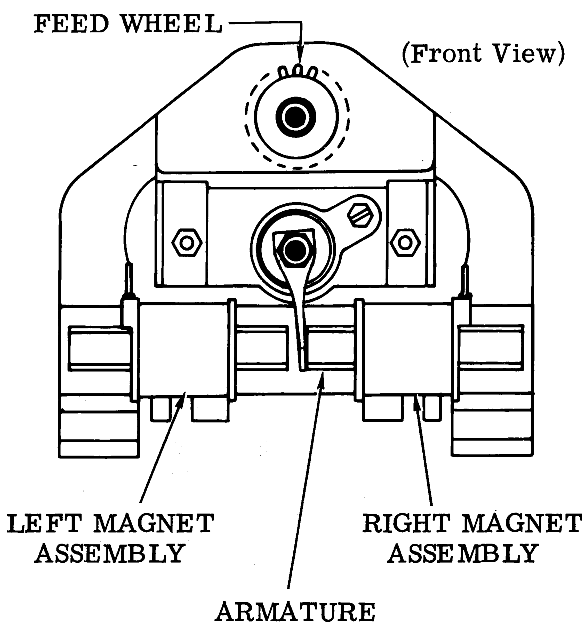

Figure 5 - Stepper Mechanism

feed holes when the tape reaches its stop position at the end of the step cycle.

TAPE READING CONTACTS

2.16 Code contacts — provide an electrical output corresponding to perforated holes in the tape as each character step is sensed. The external contact load must provide an open circuit of 3 to 8 volts dc, and a closed circuit of 3 to 8 milliamperes, resistive load (Figure 7).

2.17 Verify contacts — perform the same function as the code contacts, except each character is read one step after the code contacts have read the tape. The verify contacts are physically located 0.100 inch from the code contacts. The external circuit load should be the same type as used for the code contacts.

2.18 Feed contact — provides contact closure for each feed hole as the tape advances over its position. This information is used to indicate the command to step has been obeyed and the tape has been advanced. The feed contact assembly, between number three and number four sensing wires, and is identical in shape as the other sensing wires. The external circuit load should be the same type as used for the code contacts.

2.19 Tangled-tape/tape-out contacts — are located in the same contact pileup and operated by the tape-out contact insulator protruding through the top plate, motivated by the tangled-tape bail attached to the right of the tape lid. With no tape in the reading head the bail, being spring loaded, rests in a slot in the top plate. In this position (or with the tape lid up), the tape-out contact is normally open and the tangled-tape contacts are normally closed (Figure 8).

2.20 When tape is placed in the reading head and the tape lid closed, the bail is prevented from falling in the slot on the top plate, which keeps the tape-out contacts closed (Figure 9).

2.21 If the tape becomes tangled as it enters the reading head, the tangled-tape will raise the bail from the top plate, depress the tape-out and tangled-tape insulators, open the tangled-tape contacts and immediately stop tape transmission.

2.22 A minimum two-inch trailer on each tape is required to sense tape-out and still read the last character. The electrical load for these contacts must provide an open circuit voltage of 3 to 24 v dc and a closed circuit of 3 to 500 milliamperes resistive load.

RETRACTOR MECHANISM

2.23 Solenoid mechanism — used to lower the tape reading contact assemblies when operating the reader in reverse direction. The code and verify contact assemblies are mounted on a pivoted pedestal with two springs

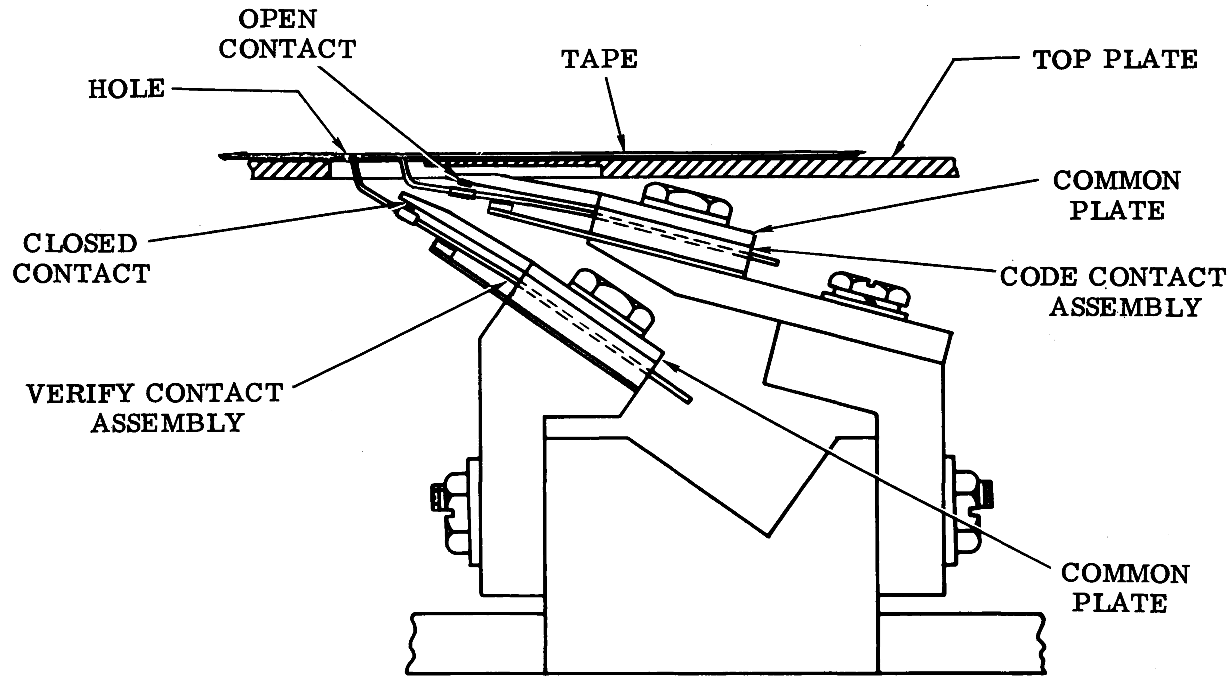

Figure 6 - Code and Verify Contact Assemblies

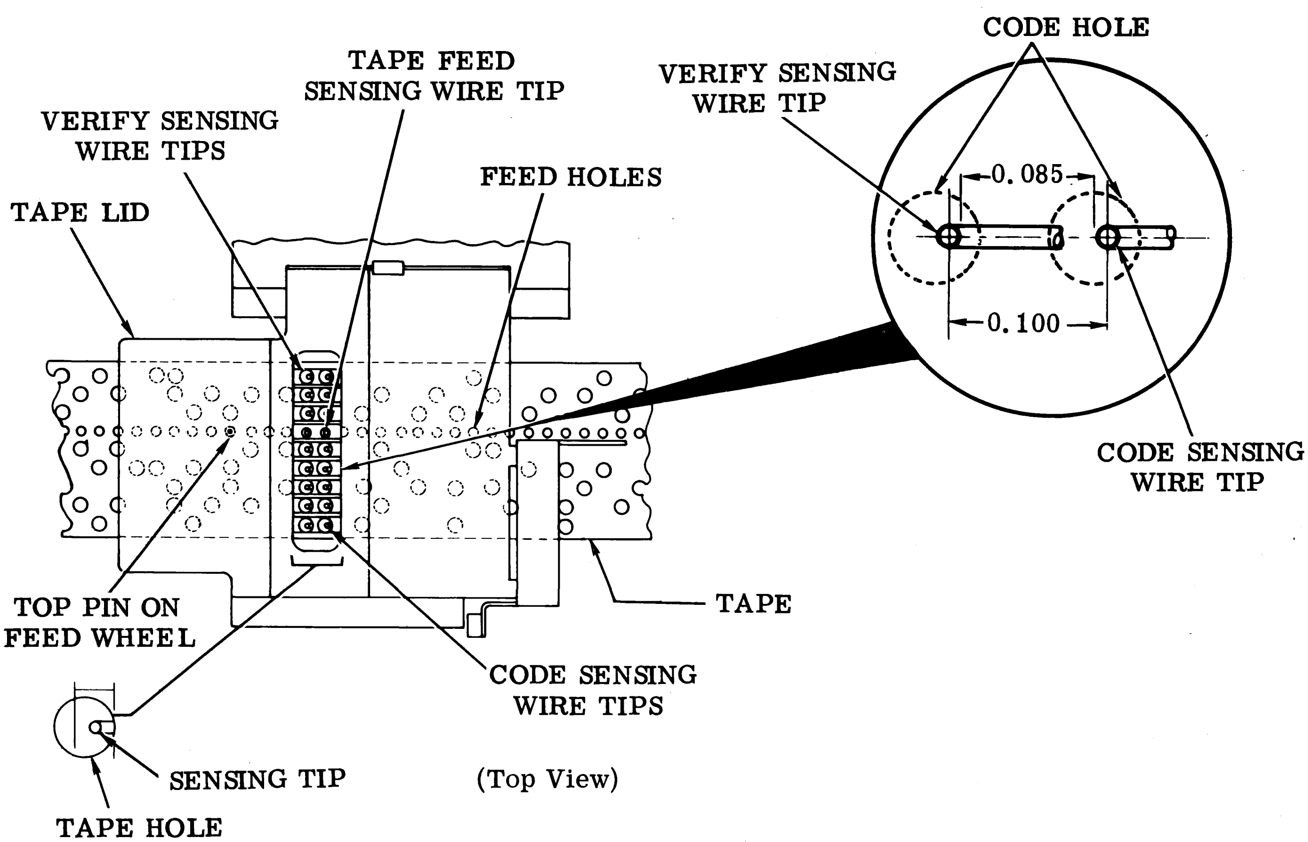

Figure 7 - Tape in Reading Head

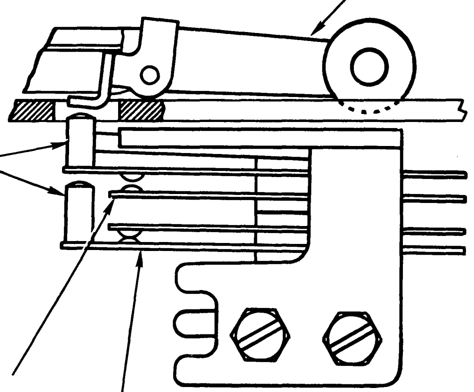

Figure 8 - Tangled-Tape/Tape-Out Contacts (With No Tape in Reading Head)

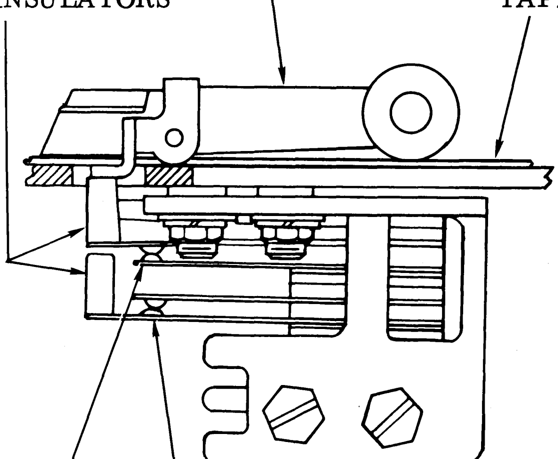

Figure 9 - Tangled-Tape/Tape-Out Contacts (With Tape in Reading Head)

at one end pulling the pedestal upward, allowing the tape reading contact sensing wires to protrude through the top plate, reading the tape passing over it in the forward direction (Figure 10 and Figure 11).

2.24 A solenoid mounted below the pivoted pedestal (with plunger attached to the pedestal) when actuated, pulls the pedestal down with the attached code and verify contact assemblies. This action lowers the contact sensing wire tips below the top plate surface, allowing the tape to be reversed without damaging the sensing wires or tearing the tape.

2.25 An adjustable stop controls the upper position of the pivoted pedestal, with the solenoid controlling the lower position. Maximum operating time of the solenoid is 30 milliseconds. The solenoid is intended for intermittent duty, incorporating a thermal cut-out switch designed to open the coil circuit at 194°F (90°c) should the circuit be left on continuously. After a reasonable length of time the coil will cool and service can be continued.

2.26 Retractor interlock switch — is mechanically engaged whenever the pivoted pedestal is actuated by the solenoid to its lower position. The interlock switch, when engaged, indicates the tape reading contact sensing wires have been retracted below the top plate surface and it is safe to reverse direction of the tape (Figure 10).

CAUTION: UNDER NO CIRCUMSTANCES SHOULD THE MOTOR BE REVERSED UNTIL THE RETRACTOR INTERLOCK SWITCH IS ENGAGED.

2.27 The switch is electrically integrated in the circuits through separate normally open and normally closed contacts interconnected through the connector mounted at the rear of the reader.

2.28 Spliced tapes — may be used in the reader for testing purposes. Splices (splicing material and tape) should not exceed 0.0075 inch, which necessitates a butt rather than overlap splice. Splicing tape should be applied to only one side of perforated tape. Splicer and splice part numbers can be found in Section 592-804-700.

2.29 The fast nonsynchronous tape motion will cause some burring of the tape feed hole. Standard 8-level, fully perforated tape can be reliably used for a minimum of ten times bidirectionally.

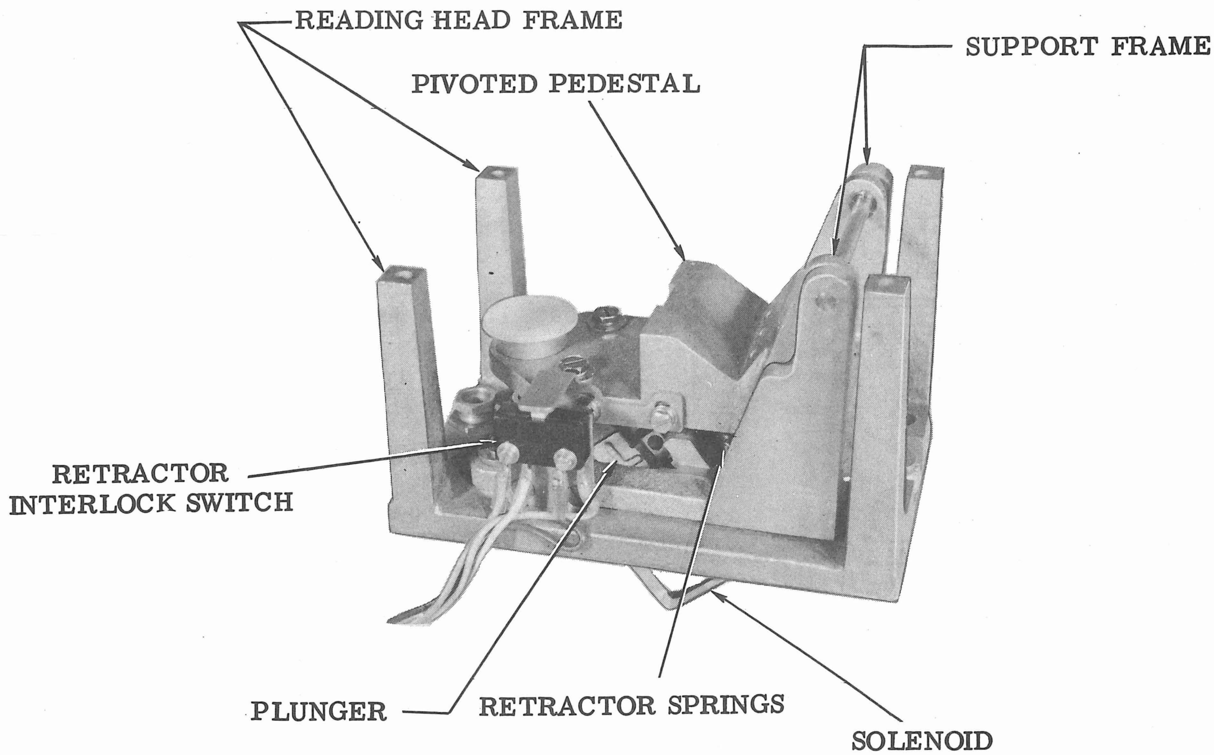

Figure 10 - Retractor Mechanism (Without Code and Verify Contact Assemblies)

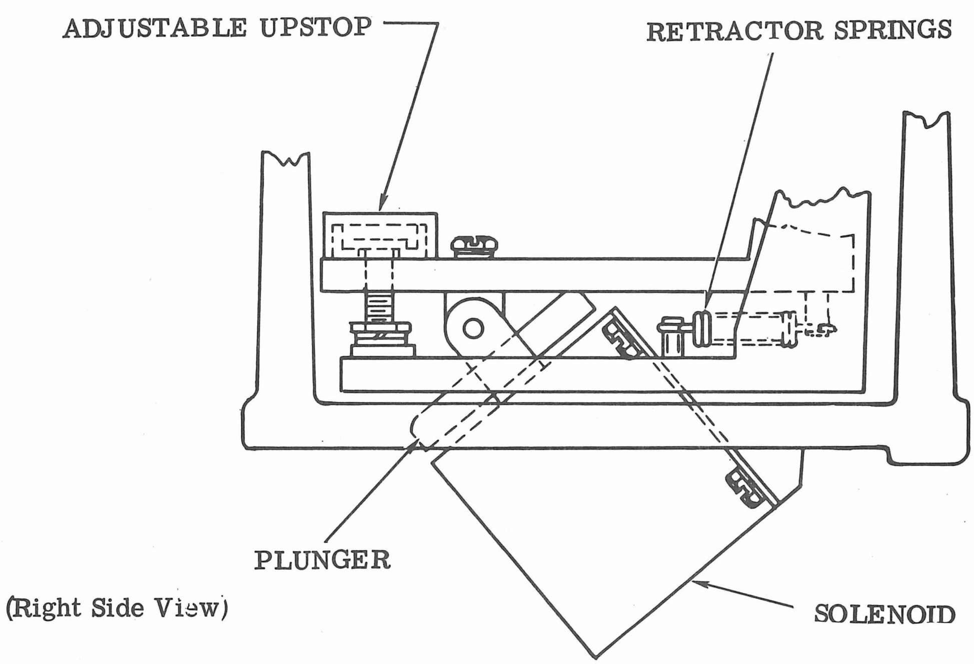

Figure 11 - Solenoid Mechanism

EDC BLOCK COUNTER MECHANISM

General

2.30 The block counter mechanism is a control device used in conjunction with the error detection and correction system. The tape is read in blocks, checked for errors and reread if an error should occur (Figure 12).

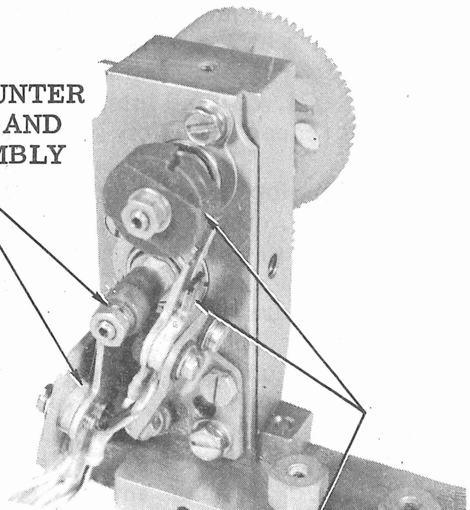

Figure 12 - EDC Block Counter Mechanism

2.31 End-of-block contacts and cam — driven by a spur gear on the escapement shaft rotating the upper end-of-block shaft once every 80 steps of the escapement shaft. The two cams mounted on the shaft control contacts which operate once every revolution. The front cam controls the forward contact which closes once every 80 steps in the forward direction. The rear cam controls the reverse contact which closes once every 80 steps in the reverse direction (Figure 13).

2.32 Timing between the forward and reverse contacts is adjusted to close on the 79th character of every 80-character block. When reading tape in the forward direction, with an error recognized in a block of 80 characters, the forward contact will close on the 79th character requiring one more clock pulse to step the reader to the 80th character.

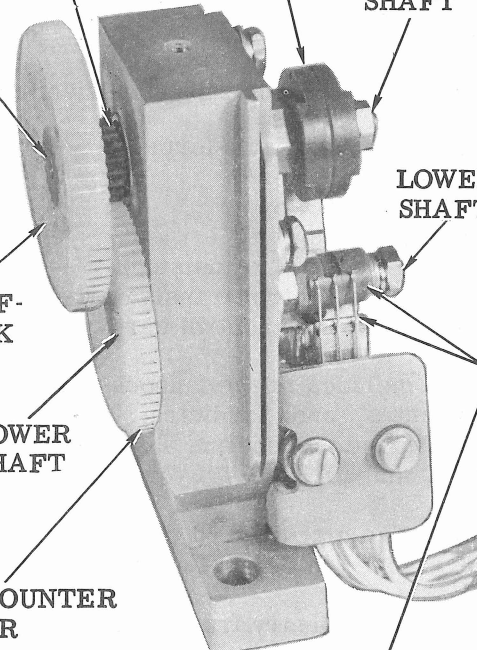

Figure 13 - Block Counter Gear Arrangement

2.33 When retractor solenoid is energized, the code and verify sensing wires are withdrawn, and the motor and tape are reversed. Clock pulses step the reader in the reverse direction. On the 79th step the reverse contact will close requiring one more clock pulse to step to the 80th character. The retractor solenoid is released and the motor direction changed to forward with clock pulses reapplied to reread the block of 80 characters which contained the error.

2.34 Block counter contacts and cam — driven by the upper shaft, rotating once for every three revolutions of the upper shaft. The cam mounted on the lower shaft controls three block counter contacts, which are operated in sequence. Any one of these contacts should be closed when either the forward or reverse contact is closed.

2.35 The block counter contacts are numbered front to rear; one, two, and three. The external load provided for these contacts should be 3 to 8 volts and 3 to 8 milliamperes resistive load.

ELECTRONIC MAGNET DRIVER

General

2.36 The electronic magnet driver consists of:

Power supply transformer	—	T1
Bridge rectifier	—	CR1-CR4
Filter capacitor	—	C1
Storage inductor	—	L1
Magnet control transistors	—	Q1 & Q2
Recharge control transistor	—	Q3
Magnet driver control card	—	TP318810

It also includes miscellaneous resistors, fuses, connectors, and hardware. Wiring diagrams can be found in Sections 592-804-400 for schematic, and 592-804-401 for actual.

2.37 The circuit card driver logic can be divided into four functional groups:

(1) Input binary transistors Q1 and Q2

(2) Output amplifier transistors Q3 through Q6

(3) Recharge driving and timing Q7 through Q9

(4) Components for biasing voltage for the recharge circuitry — bridge rectifier CR9 and filter capacitor C4.

Binary and Driver Operation

2.38 In the inactive condition, transistors Q1, Q3, and Q6 are on, while Q2, Q4, and Q5 are off. The saturated on action of Q1 holds Q2 off, grounding the base of Q2 through R15. Q4 is similarly held off through R1, allowing emitter-follower Q6 to supply +18 v base power to the chassis-mounted power transistor TP318822 which is saturated and holds the armature attracted to that side.

2.39 On the opposite leg of the circuit the off condition of Q2 allows Q3 to receive ±18 v base power and saturate. This action turns off emitter-follower Q5 cutting off its associated power transistor TP318822. Reverse action is initiated upon flip-flop operation of the binary circuitry.

2.40 In the binary circuitry (Q1 and Q2) flip-flop action occurs when a negative going pulse is received at input terminal T14. The signal should have the following characteristics:

(1) Amplitude - 6 v to 50 v

(2) Width 10 microseconds to 2.0 milliseconds

(3) Fall time - 6 v in 3 microseconds.

A pulse duration less than 10 microseconds will be rejected while a slower fall time will not create sufficient differentiation through coupling capacitors C1, C2, and integrators R9, C6, R6, and C5 to cause flip-flop action in either leg.

2.41 Flip-flop action occurs with transistor Q2 off, diode CR4 back-biased, and diode CR3 conducting. A negative going pulse from the input, through capacitor C2 drives the base of Q1 negative, turning Q1 off and releasing ground from resistor R15, allowing transistor Q2 to receive base current through resistors R22, R24 and R15. With transistor Q2 turned on (holding transistor Q1 off), the necessary drive for the chassis-mounted power transistor TP318822 is accomplished through inverters Q3, Q4 and emitter-followers Q5 and Q6.

Recharge Operation

2.42 The recharge circuit replaces energy taken out of the chassis-mounted storage inductor L1, during stepping operation. Timing the recharge circuit can be adjusted through an integrator type circuit by means of a strapping device consisting of resistors R29 through R33 and capacitor C3, to give a continuous recharge with the external input at 400 operations per second.

2.43 When transistor Q9 is off, transistor Q8 receives its base drive through the resistive portion of the integrator circuit. With transistor Q8 in the on condition, zener diode CR7 is held off by clamping the CR7 cathode at approximately 3.9 v, preventing base current from reaching transistor Q7. Any current leakage through CR7 is channeled to the ground side of 12.5 v supply through R12. Diode CR1 provides an additional current offset to the base of Q7 insuring that it remains off. Q7 in the off condition, holds the chassis-mounted recharge transistor 2N3055 off, while limiting the external stepper magnet coil to approximately 1.2 amperes.

2.44 When the externally supplied clock pulse enters the flip-flop circuit, one of the TP318822 transistors turns off while the other turns on. The collector of the off transistor will rise to a minimum of 325 v as the inductor goes into a back electromotive force condition. This positive voltage rise turns on transistor Q9 through diode CR5 or CR6 and the current limiting resistors R34 and R35. When Q9 turns on, capacitor C3 discharges holding ground on the capacitor as long as there is base circuit to Q9. The base current time is determined by the amount of time TP318822 transistor is conducting from coil energy.

2.45 When Q9 is turned on, Q8 is turned off and conducts through zener diode CR7 which is biased to the chassis-mounted recharge transistor 2N3055 from transistor Q7. The recharge transistor 2N3055 is shunted by two 5 ohm chassis-mounted series resistors to +18 v, increasing the driving potential to the storage inductor. This stored inductor energy is used to operate the stepper magnet coil in the same manner as a constant voltage source.

2.46 The recharging condition continues until capacitor C3 charges to a sufficiently high voltage level to drive the base of Q8 above the reference voltage level of its emitter which is set by zener diode CR8. Recharge time can be adjusted by cutting the wire shunting straps to the recharge circuit resistors (R29 through R33), adding more resistance to the circuit and increasing the recharge time constant.

3. PRINCIPLES OF OPERATION

READER TIMING

3.01 The reader timing concept consists of a contact signal output to a master clock pulse combined to make up the basic timing element.

STEPPER PULSE

3.02 The step pulse entering the reader drive circuit is channeled to one of the stepping coils. An oscilloscope may be used to monitor the voltage waveform at the stepping coils to determine the beginning of tape feed. Tape feed begins approximately the same time of armature impact against the energized coil pole base causing a slight inflection in the step coil voltage waveform at that instant (Figure 14).

TAPE FEED

3.03 The duration of the tape feed operation is dependent on the contact signal output. Shortly after beginning tape feed, all contacts open and remain open until approximately the end of the tape feed cycle. Reliable hole sensing and signal sampling occurs while the tape is stopped at the end of each tape feed cycle.

CONTACT CHARACTERISTICS

3.04 Reader adjustments and tape loading cause variations in individual signal outputs, a normally functioning reader will provide a minimum closure time 0.2 milliseconds on all contacts. Contact closure begins with an area of bounce followed by an area of steady signal.

3.05 The output signal is terminated at the beginning of the next feed cycle. The sampled steady 0.2 millisecond portion of the ← signal occurs 1.2 milliseconds after the clock pulse at operating speeds up to 240 operations per second. At operating speeds up to 300 operations per second, the steady portion of the signal occurs between 0.4 and 2.0 milliseconds after the clock pulse.

OPERATING CHARACTERISTICS

3.06 An oscilloscope may be used to view the relationship of the step coil voltage waveforms to sensing contact output. The timing diagram, Figure 14, shows the maximum repetition rate of 300 operations per second. The individual step characteristics of the reader are essentially the same for all speeds. The contacts remain closed proportionately longer at slower speeds.

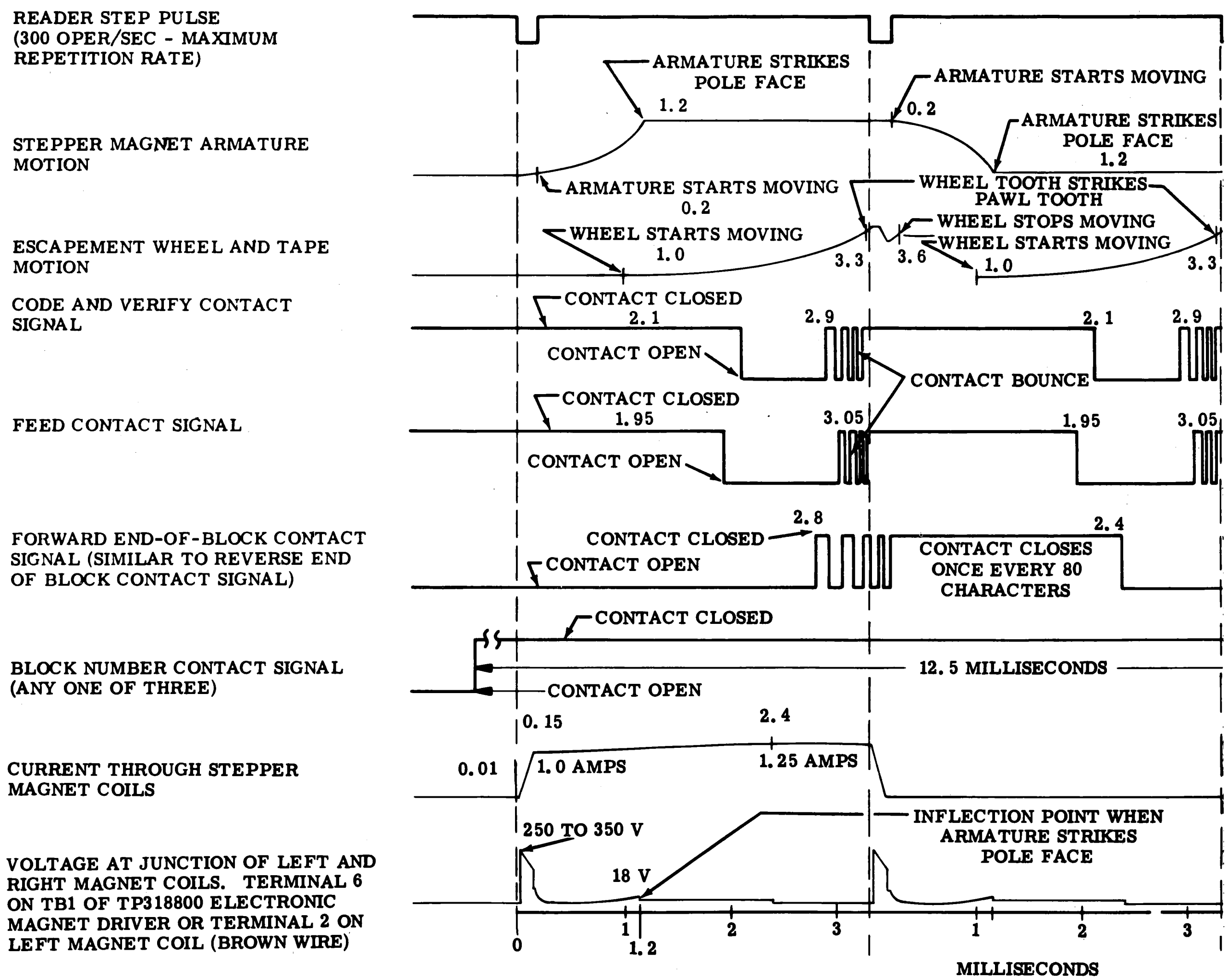

Figure 14 - Tape Reader Timing Diagram