IBM® Field Engineering

Theory of Operation

2501 Card Reader Model A

PREFACE

This manual explains the operation of the IBM 2501 Card Reader Model A. Maintenance information is in the IBM 2501 Field Engineering Maintenance Manual, Form Y31-0069. Attachment circuits are explained in the Attachment Manual, Form Z26-5974.

Third Edition

This is a major revision of, and obsoletes, Y31-0068-1. The manual has been revised to incorporate changes to the 2501 logics and also to include information on the fiber optic read station.

Significant changes or additions to the specifications contained in this publication will be reported in subsequent revisions or FE Supplements.

This manual has been prepared by the IBM Systems Development Division, Product Publications, Department 245, Rochester, Minnesota 55901. A form has been provided at the back of this publication for reader's comments. If the form has been removed, send comments to the address above.

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The IBM 2501 Card Reader Model A provides punched card input for the IBM System/360 Model 20. Cards are read serially at a rate of 600 cards a minute by the Model A-1 or 1000 cards a minute by the Model A-2.

Cards in the IBM 2501 are fed from the hopper into a preread station, then serially through the fiber optic read station and into the stacker (Figure 1-1). Cards can be placed in the hopper or removed from the stacker while the machine is operating.

The Central Processing Unit (CPU) contains all logic circuits for the 2501. Circuits in the 2501 include amplifiers and pulse shapers for pulses sent to the CPU and high-current drivers for the various 2501 magnet coils.

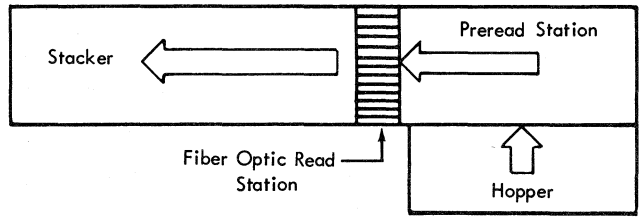


Figure 1-1. Card Path

FEEDING

Two card feed cycles are required to feed the first card from the hopper into the stacker. The first feed cycle is initiated by the Start key; the second cycle is initiated by the CPU.

The first feed cycle, initiated by the Start key, activates the pickerknives which move the first card from the hopper to the nudge rolls (Figure 1-2). The continuously-running nudge rolls feed the card into the preread station against the spring-loaded alignment rail. The nudge rolls also force the 12-edge of the card down to the card bed. As the 12-edge of the card moves toward the card bed, the alignment rail pushes the card against the front guide rail. The card remains clamped in this position until the next feed cycle is initiated.

A ready status is established as the card is sensed by the preread solar cell in the preread station.

The second feed cycle is initiated by a command from the CPU. This command activates both the pickerknives and the inject pressure roll. The inject pressure roll moves the card from the preread station into the read station. The card moves through the read station under control of the read feed wheel and is then fed into the stacker. As the first card moves from the preread station into the read station, another card is fed from the hopper into the preread station.

Further feed cycles are initiated by commands from the CPU and are identical in operation to the second feed cycle.

Feeding stops automatically when the hopper empties, the stacker fills, a card misfeeds, or the covers are opened.

The last card is run out of the preread station by pressing either the NPRO key or the Start key. The NPRO key causes the card to be fed into the stacker without being processed; the Start key restores ready and allows the CPU stored program to read the last

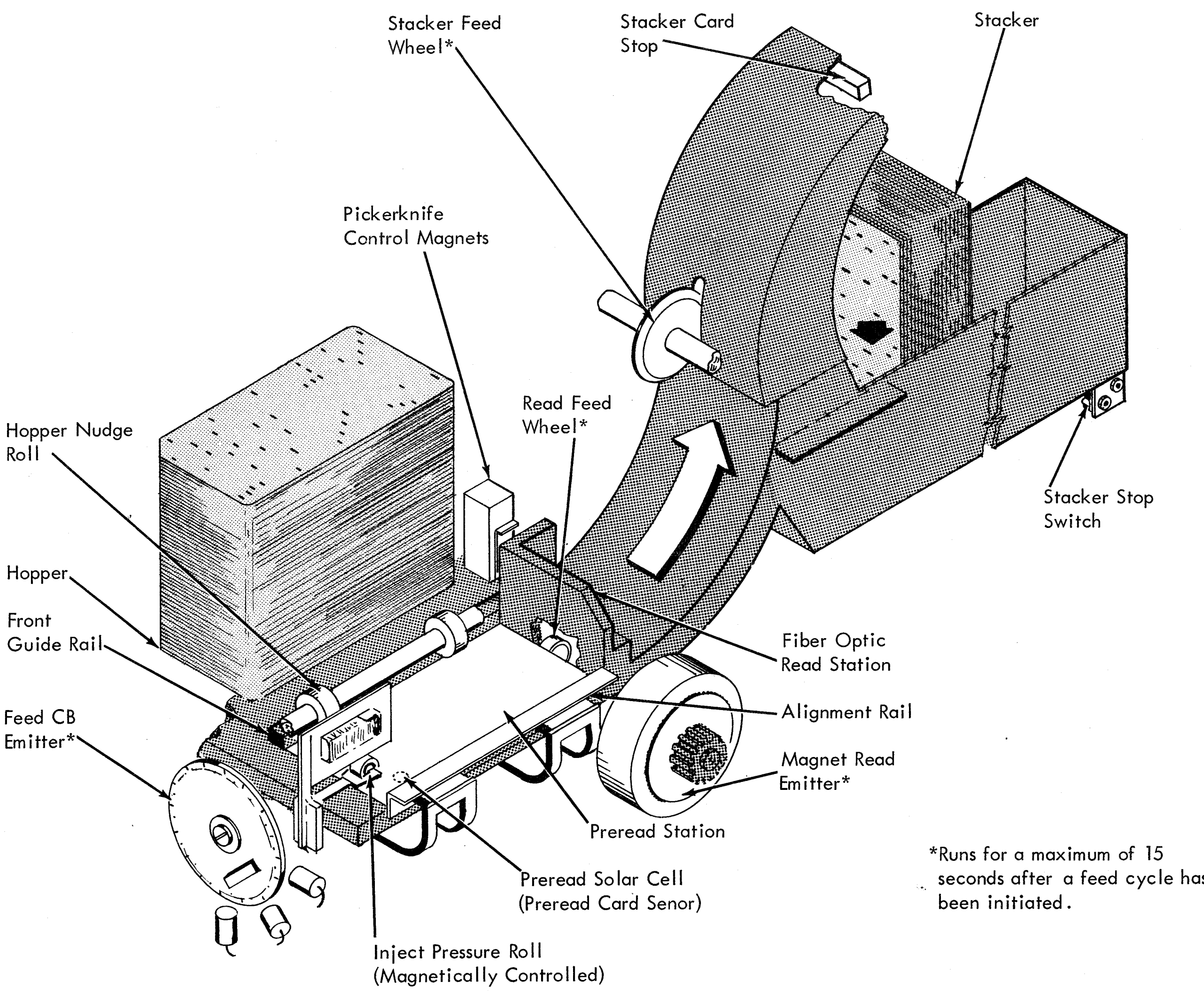


Figure 1-2. Card Path Components

card before the card is stacked.

A magnetic feed CB emitter (see Figure 1-2), which operates with the continuously-running mechanism, electrically signals the index time of the 2501 mechanism to the CPU.

READING

Reading is accomplished by a single light source and a fiber optic light distributor. The light distributor supplies light through 12 fiberglass bundles. This light is detected by 12 phototransistors mounted below the card path (Figure 1-3). The phototransistor outputs are shaped and sent to the CPU.

A magnetic read emitter on the read unit develops strobe pulses for the read data sensed by the photocells. The emitter contains a rotor on which magnetic spots are written, read, and erased by the CPU for each card. The strobe pulses are sent to the CPU along with the read data.

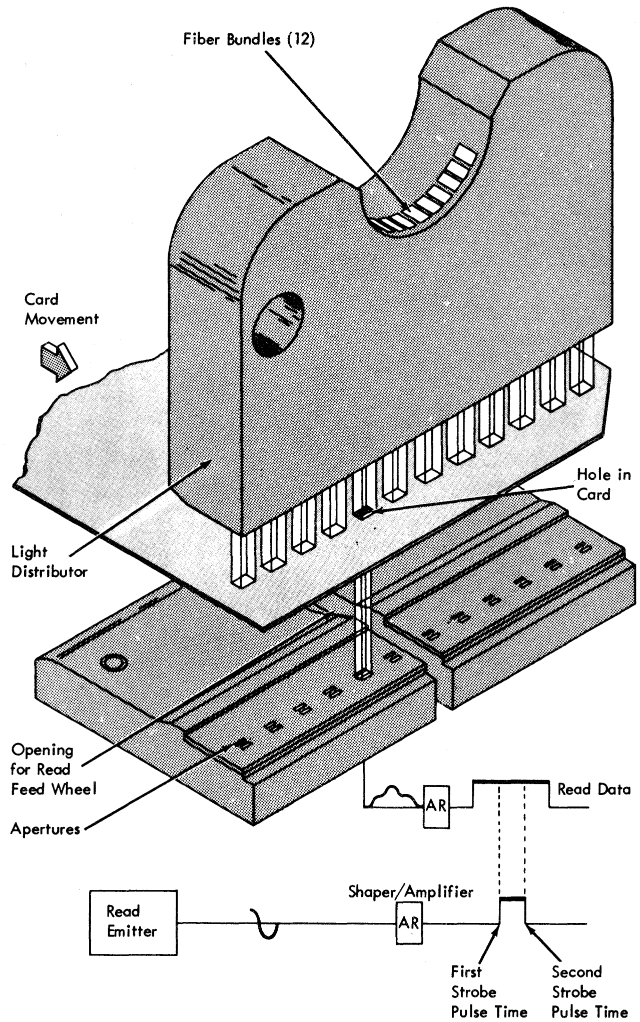


Figure 1-3. Fiber Optic Reading

This chapter explains the operation of the functional units in the 2501.

FEED CB EMITTER

- Three emitter coils provide electrical pulses timed to the machine index.
- Outputs of the coils are squared up and amplified in the 2501, then sent to the CPU.

Description

The feed CB emitter, at the right end of the hopper (Figure 2-1), generates timed pulses during each revolution of the continuously-running pickerknife camshaft. The pulses electrically inform the CPU as to the mechanical position of the 2501 mechanism.

The emitter consists of three coils and a revolving emitter index disk on which a permanent magnet is mounted. When the magnet passes an emitter coil core, an alternately positive- and negative-going voltage is developed by the coil. The negative part of the output is shaped, inverted, and amplified in the 2501, then sent to the CPU.

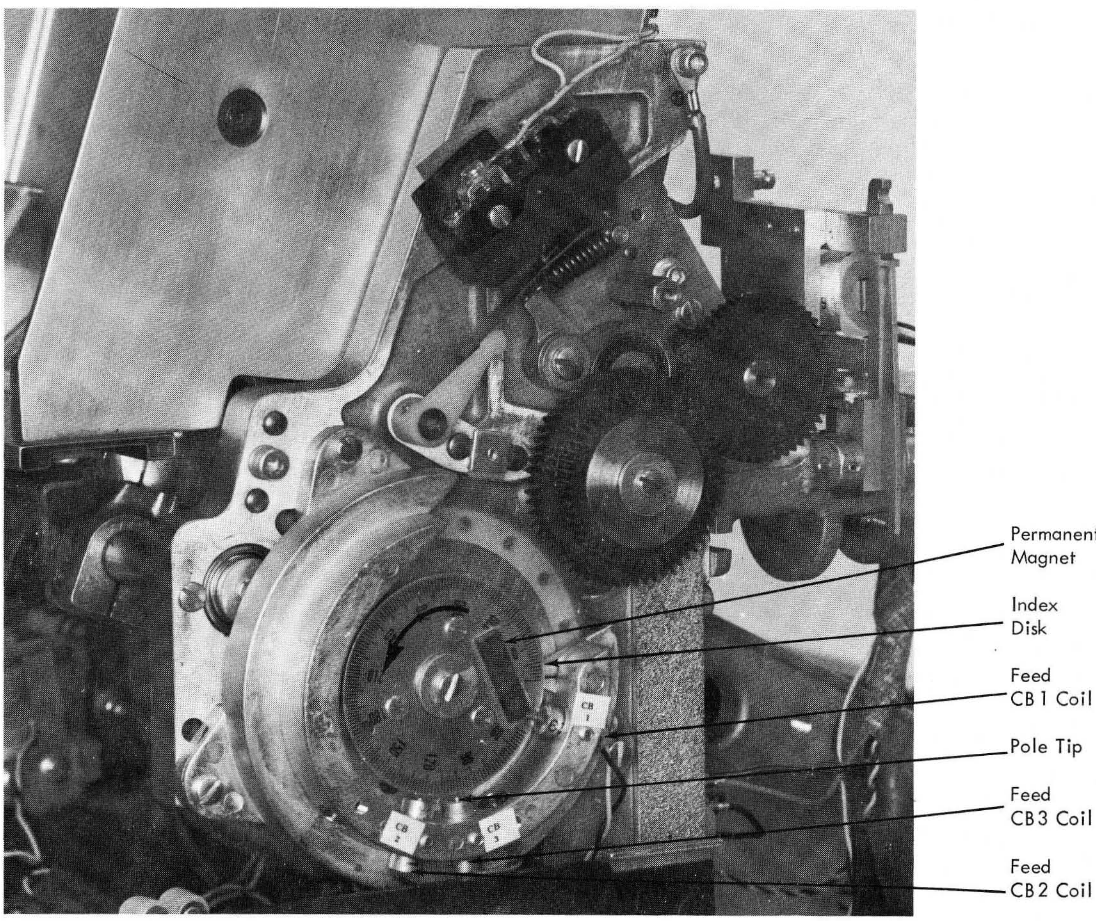


Figure 2-1. Feed CB Emitter

Electro-Mechanical Operation

The electro-mechanical operation of the feed CB emitter is shown in Figure 2-2. Note the difference in timing between the 600 cpm and 1000 cpm machines.

OPERATION:

1. The permanent magnet passes the coil pole tips.
2. A voltage is developed by the coils.
3. The coil outputs are shaped and amplified in the 2501, then sent to the CPU.

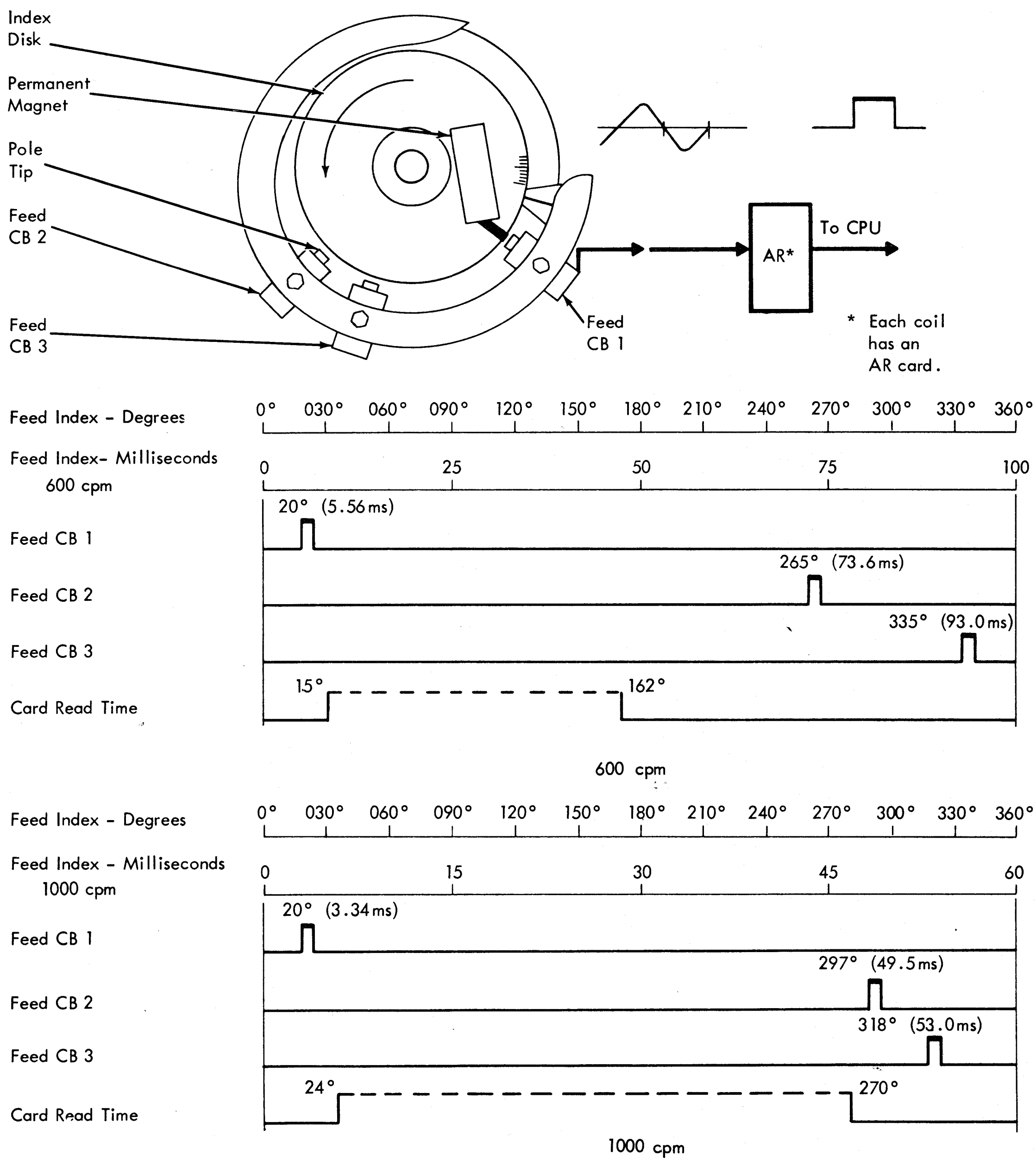


Figure 2-2. Operation of CB Emitter

PICKERKNIFE CONTROL MAGNET AND LATCH

- Control magnet contains a buck coil and a hold coil.
- Control magnet and latch magnet regulate pickerknife motion.

Description

The pickerknife control magnet at the left end of the hopper and the pickerknife latch under the hopper control card feeding from the hopper to the preread station (Figure 2-3). Both the control magnet buck coil and the latch magnet are energized by a command from the CPU at the rise of 'feed CB 3' time and de-energized at the rise of 'feed CB 1' time.

The pickerknife control magnet consists of a hold coil and a buck coil wound in opposite directions on the same core. The hold coil is energized continually when power is supplied to the 2501. The hold coil holds the cam follower away from the continuously-running pickerknife cam, preventing movement of the pickerknives. The buck coil and the pickerknife latch magnet, impulsed when the pickerknife cam is on high dwell, permit the cam follower to follow the cam. Movement of the cam follower operates the pickerknives and feeds a card. The magnetic pull of the hold coil is sufficient to restore the cam follower to the hold coil when the pickerknife cam reaches high dwell.

The purpose of the pickerknife latch is to prevent card feeding when power is removed from the 2501. Without the pickerknife latch, removing power from

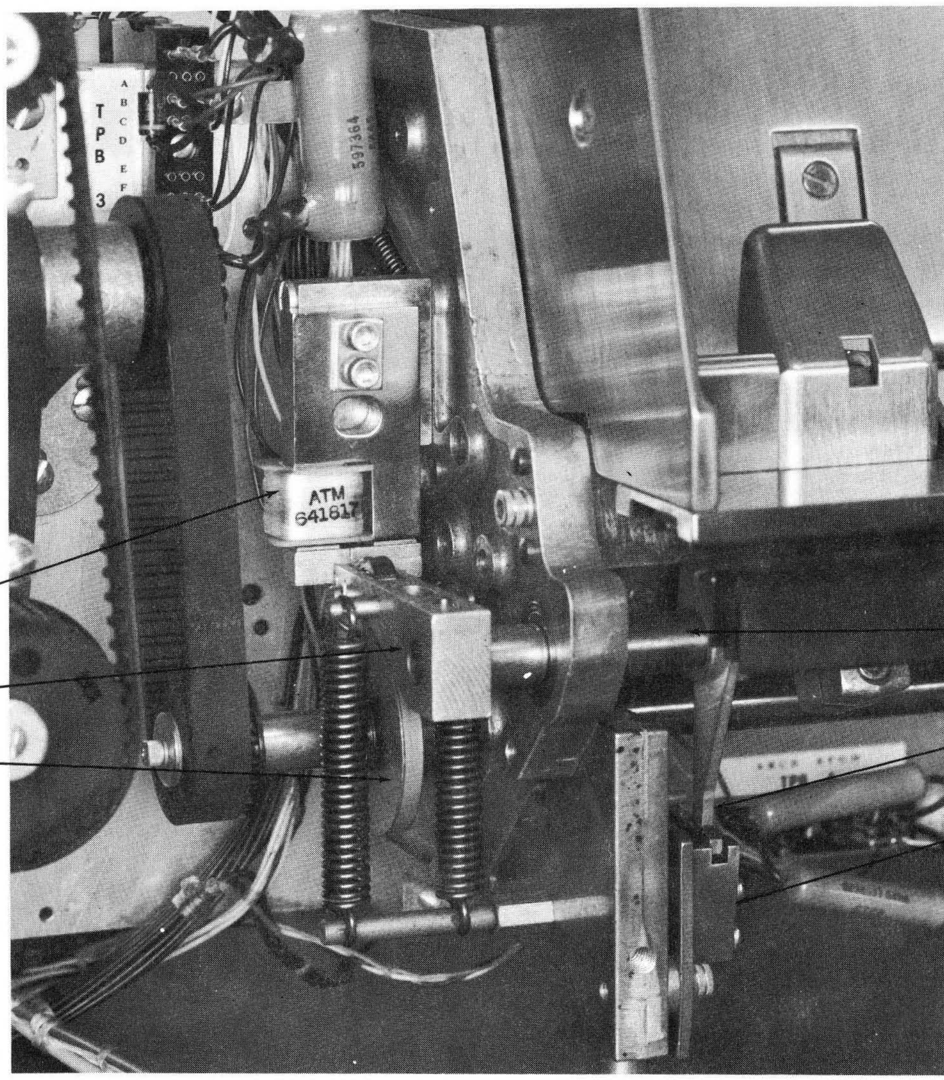


Figure 2-3. Pickerknife Control Magnet and Latch

the hold coil would allow the cam follower to follow the cam and operate the pickerknives as the machine coasts to a stop. The pickerknife latch magnet is impulsed for each feed cycle to permit the pickerknife shaft to turn when the cam follower is released by the control magnet.

Mechanical Operation

The mechanical operation of the pickerknife control magnet and pickerknife latch is shown in Figure 2-4.

Operation:

1. Buck coil and pickerknife latch magnet energized by a command from the CPU at leading edge of 'feed CB 3' time.
2. Pickerknife cam positioned, as shown, at 'feed CB 3' time.
3. Follower arm follows continuously running cam.
4. Pickerknives feed card from hopper into preread station.
5. Buck coil and pickerknife latch magnet de-energized at leading edge of 'feed CB 1' time.
6. Hold coil attracts follower arm when arm is on high dwell of cam (shaded area in illustration).

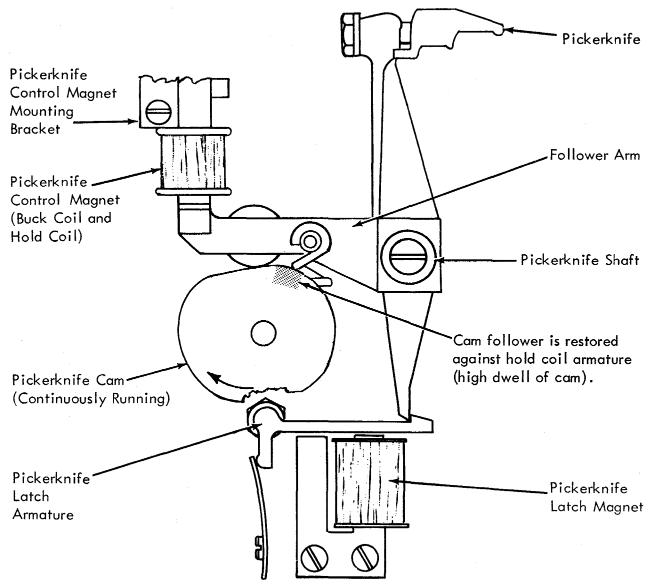


Figure 2-4. Operation of Pickerknife Control Magnet and Latch

READ UNIT

- Light from fiber optic read lamp is transmitted through fiber optic bundles.
- Light through punched holes in card is detected by phototransistors.
- Read data pulse is developed from amplified output of phototransistors.
- Read data is sent to CPU.

Description

The fiber optic read unit (Figure 2-5) consists of a single light source, a light distributor assembly, and a lower detector assembly.

The single lamp shines onto the top of the light distributor. The light distributor, which consists of 12 fiber optic bundles, transmits the light to the card path. The light, shining through the punched holes of a card, is detected by phototransistors by means of a double aperture optical mask. The phototransistor output is shaped and sent to the read circuits through the associated 'read data' line. A detailed explanation of the phototransistor output pulse, data pulse, and amplifier is in Appendix C, Data Pulse Controls.

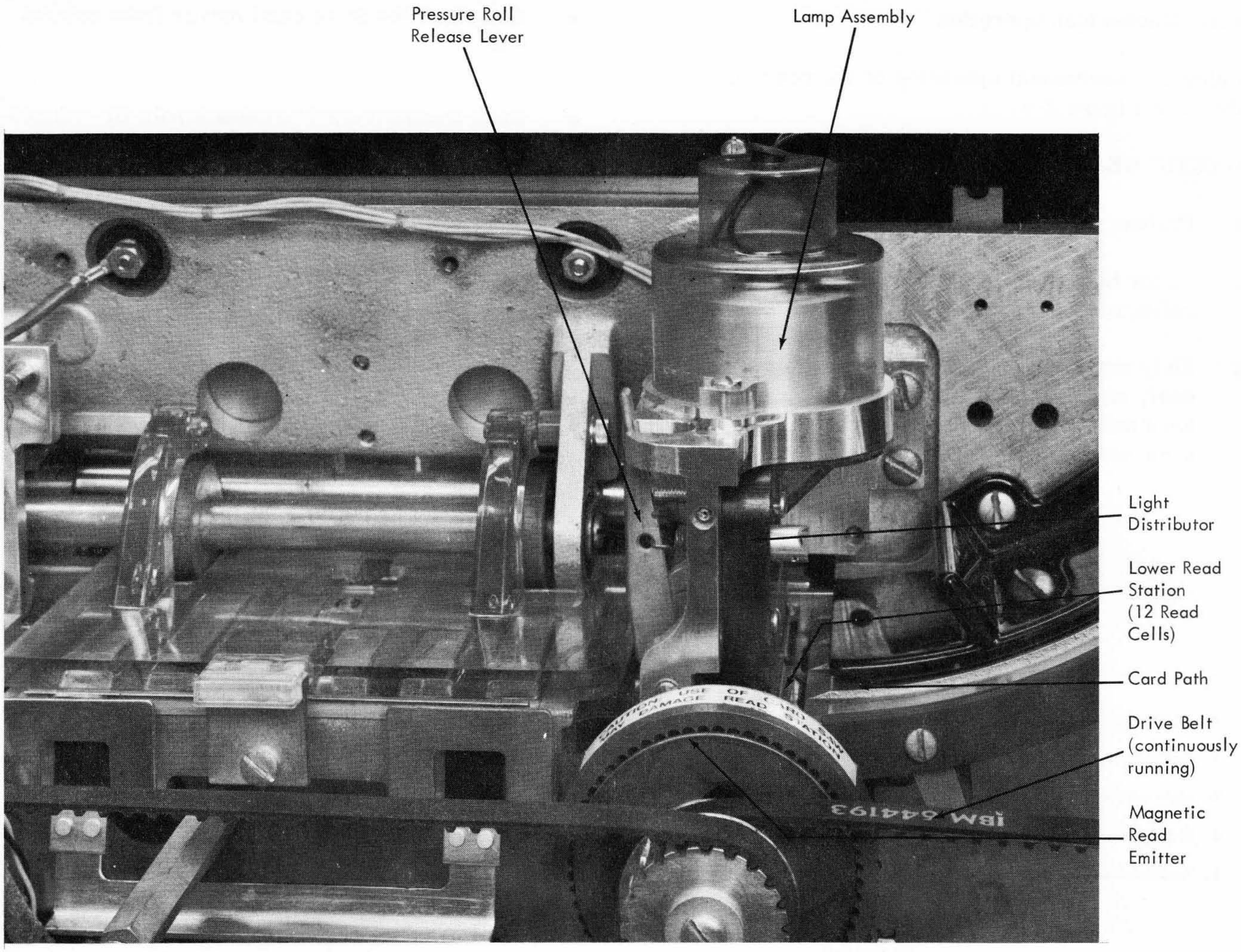


Figure 2-5. Read Unit

Electro-Mechanical Operation

The electro-mechanical operation of the read unit is shown in Figure 2-6.

MAGNETIC READ EMITTER

- Emitter consists of a stator and a rotor.
- Stator has 60 read/write pole tips and three coils; rotor is a magnetic drum.
- Sixty magnetic spots are written simultaneously on the rotor as the trailing edge of the card uncovers the preread solar cell (preread card sensor).
- Rotor rotates 6° as card moves from column 0 to 1.
- Each magnetic spot passing a pole tip induces a voltage into the read coil.
- Accumulated induced voltage develops a strobe pulse that is sent to CPU.
- Each card column is strobed as the card moves through the read unit.
- The erase coil is energized at 'feed CB 2 and 3' time.

Operation:

1. Inject pressure roll feeds card into read station.
2. Continuously-running read feed wheel feeds card through read station.
3. Light from lamp passes through punched hole in card and strikes phototransistor.
4. Phototransistor conducts.
5. Phototransistor output is amplified and sent to CPU.

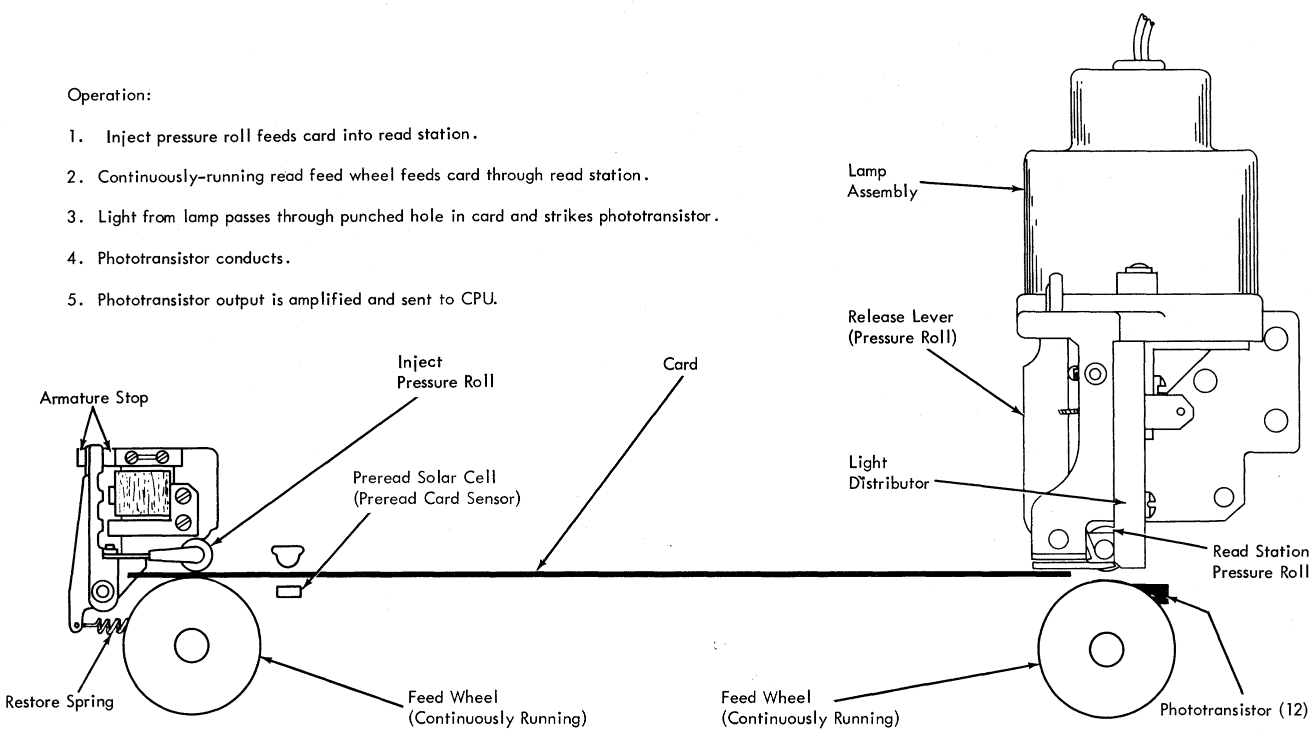


Figure 2-6. Operation of Read Unit

Description

The magnetic read emitter (Figure 2-7), which allows the machine to synchronize its circuits to the card, consists of a stator and a rotor. The emitter supplies pulses which are used to condition circuits in the CPU that strobe the read data from each card column.

The stator has three coils (write, read, and erase) and 60 pole tips. The space between adjacent pole tips on the stator corresponds to the distance between adjacent card columns.

The rotor is a magnetic drum on the continuously-running feed wheel shaft of the read unit. During the time a card moves one column, the rotor rotates 6°.

The write coil of the stator is energized when the trailing edge of the card passes the preread solar cell (preread card sensor) in the preread station. When the write coil is energized, a magnetic field is built up between the 60 pole tips and the rotor surface, causing 60 magnetic spots to be written on the rotor.

As the 60 magnetic spots on the rotor pass the 60 pole tips on the stator, a voltage is induced in the read coil. This voltage is shaped and amplified in the 2501, then sent to the CPU. The rotor turns 1 1/3 revolutions to read 80 card columns.

The 60 magnetic spots on the rotor are erased when the erase coil is energized by the CPU at 'feed CB 2 and 3'time.

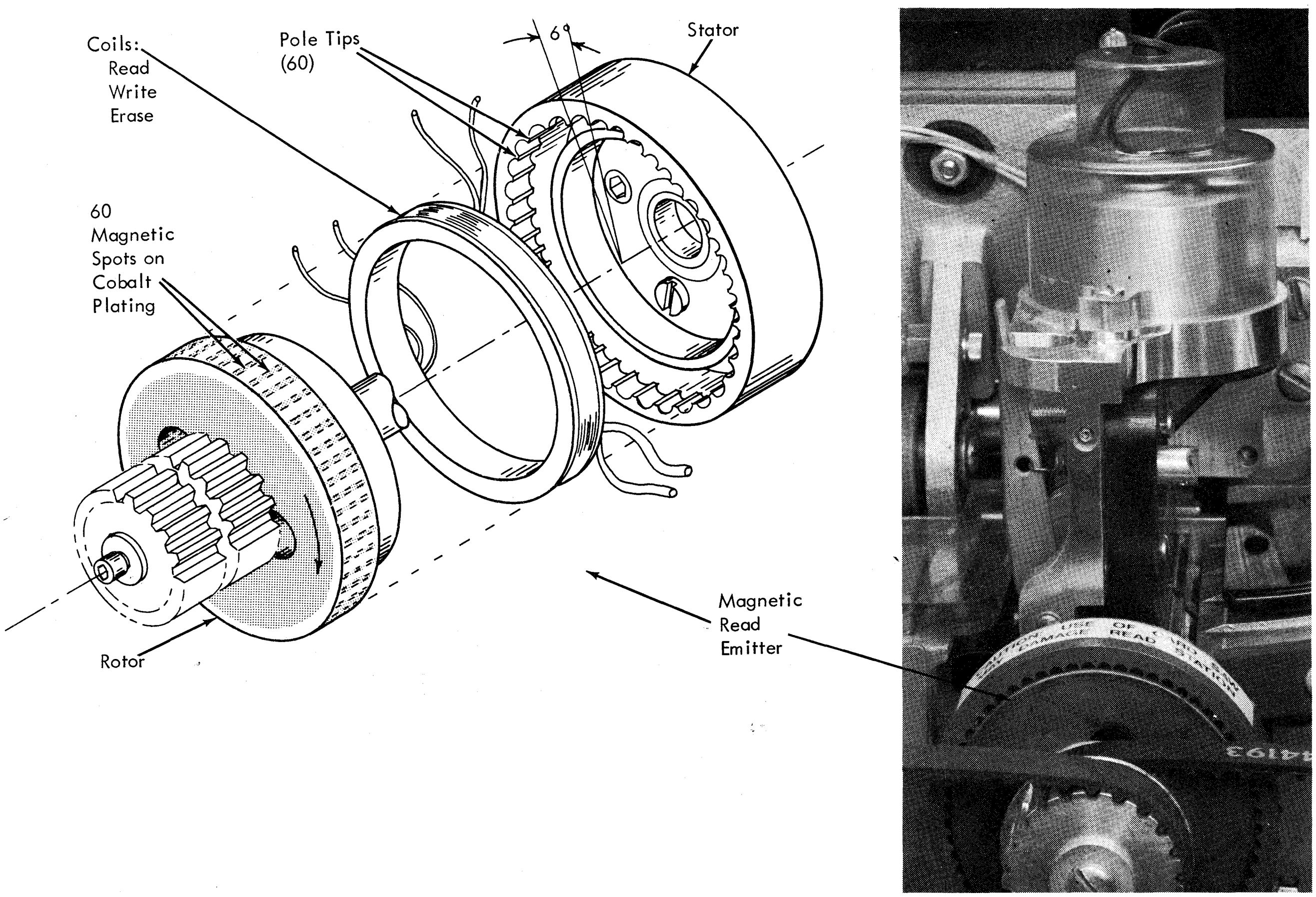


Figure 2-7. Magnetic Read Emitter

Mechanical Operation

The mechanical operation of the magnetic read emitter is shown in Figure 2-8.

Circuit Objectives

1. Card passing preread solar cell activates 'preread SC exp' line (Figure 2-9).

OPERATION

1. Sixty magnetic spots are written on rotor when moving card is registered in column 0 and preread solar cell (preread card sensor) is uncovered by trailing edge of card (Insert A).
2. Rotor advances 6°: card moves to column 1.
3. Each of 60 magnetic spots on rotor passes a pole tip on stator (Insert B).
4. Accumulated output from 60 pole tips induces voltage into read coil.
5. Rotor advances another 6°: card moves to column 2(Insert C).
6. Again each of 60 magnetic spots on rotor passes a pole tip on stator.
7. Accumulated output from 60 pole tips induces voltage into read coil.
8. The magnetic spots are erased after card is read.

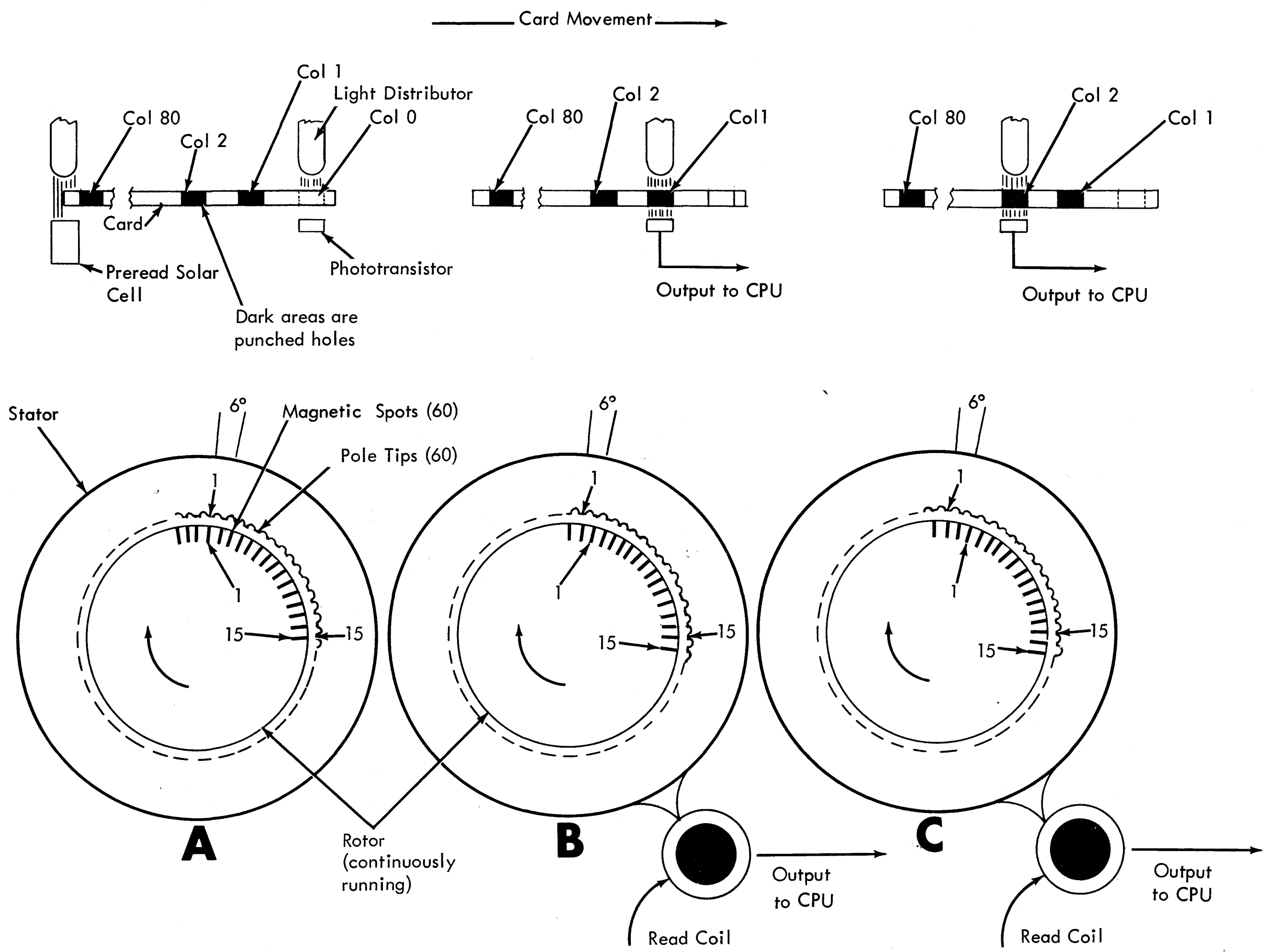


Figure 2-8. Operation of Magnetic Read Emitter

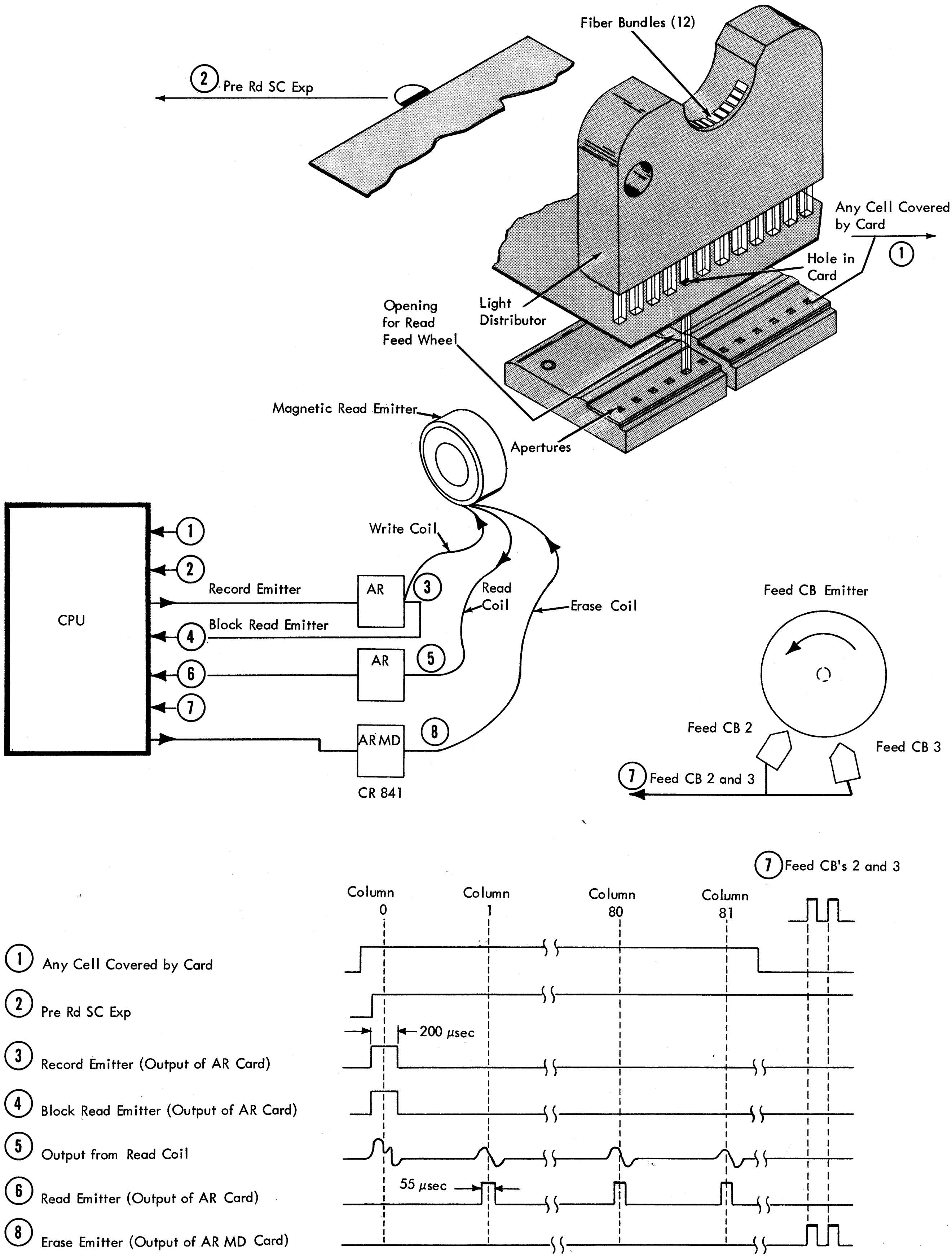


Figure 2-9. Electrical Operation of Magnetic Read Emitter

OPERATION:

1. Cards feed from read station along card path.
2. Card moves deflector from card path.
3. Card hits card stop and deflector returns to card path.
4. Card stop (compressed by card) forces card against deflector.
5. Card falls to card pusher slide.
6. Card pusher slide causes card to move to card deck support.
7. Card retaining lever prevents card from falling back into card path.
8. Stacker stop switch stops machine when stacker is full.

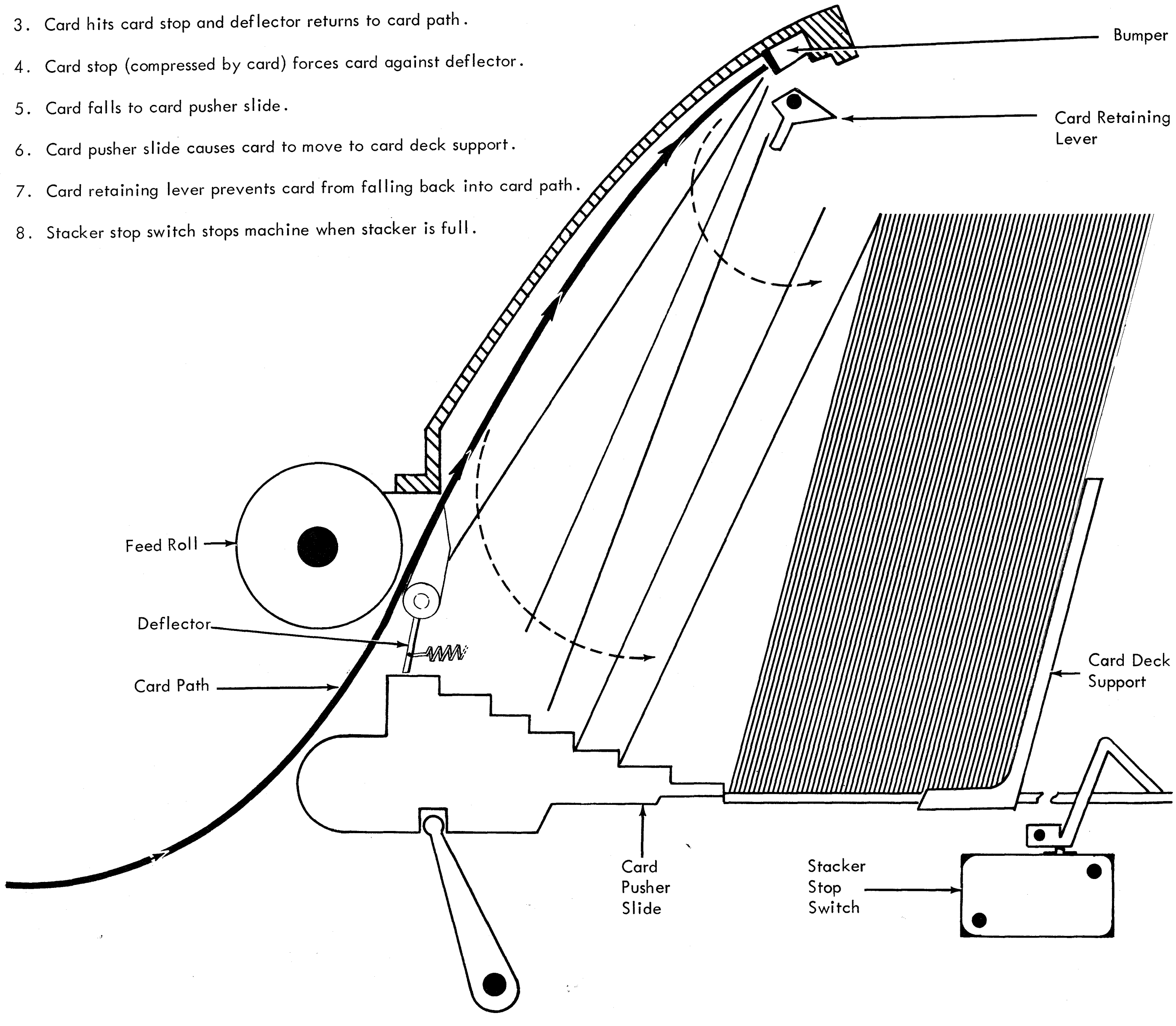


Figure 2-11. Operation of Stacker

This chapter contains a description of the combined operation of the various functional units used in the 2501. All line names used to describe the circuit operations appear as they do in the logics.

ESTABLISH READY

- Drive motor starts.
- Card feeds into preread station if no card is present.
- Ready light turns on.

Description

The 2501 must be in a ready status before read data can be sent to the CPU. Pressing the Start key activates the drive motor (through the CPU) and causes a card to feed into the preread station if the following conditions have been satisfied.

1. CPU power on.
2. Card path empty.
3. Cards in hopper.
4. Stacker not full.
5. No feed checks.
6. Covers closed.

The Ready light turns on as the card covers the preread solar cell in the preread station. The drive motor continues to run for 15 ± 3 seconds and then stops if no commands are received from the CPU.

Circuit Objectives

Figure 3-1 contains a description of the circuit objectives to establish ready.

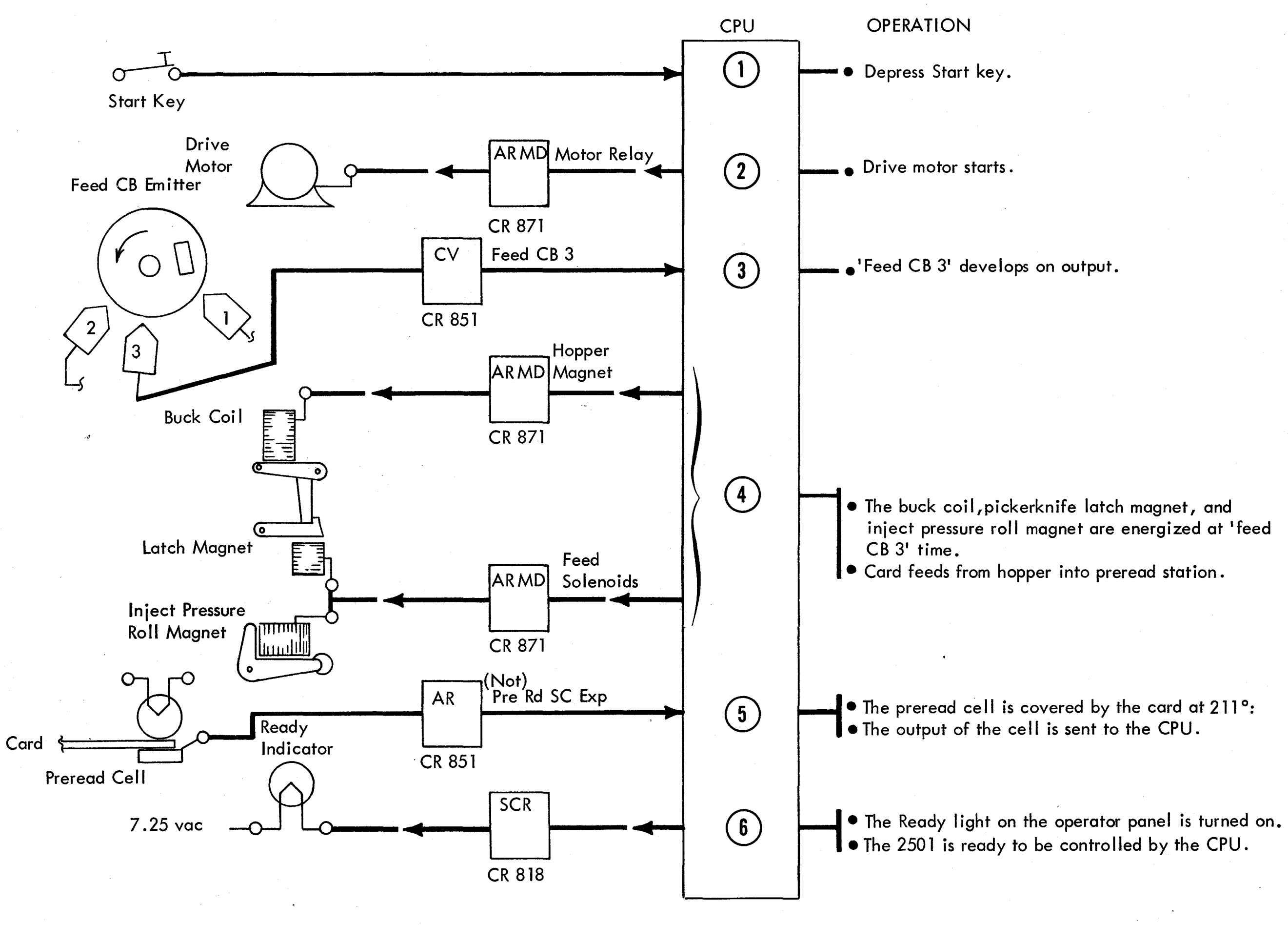


Figure 3-1. Establish Ready

FEED AND READ CYCLE, CPU INITIATED

- CPU activates 2501 drive motor (if stopped).
- Card feeds into the read station.
- Sixty magnetic spots are written on the rotor.
- The read data from the phototransistors and the output from the magnetic read emitter are sent to the CPU.
- The magnetic spots are erased at 'feed CB 2 and 3' time.

Description

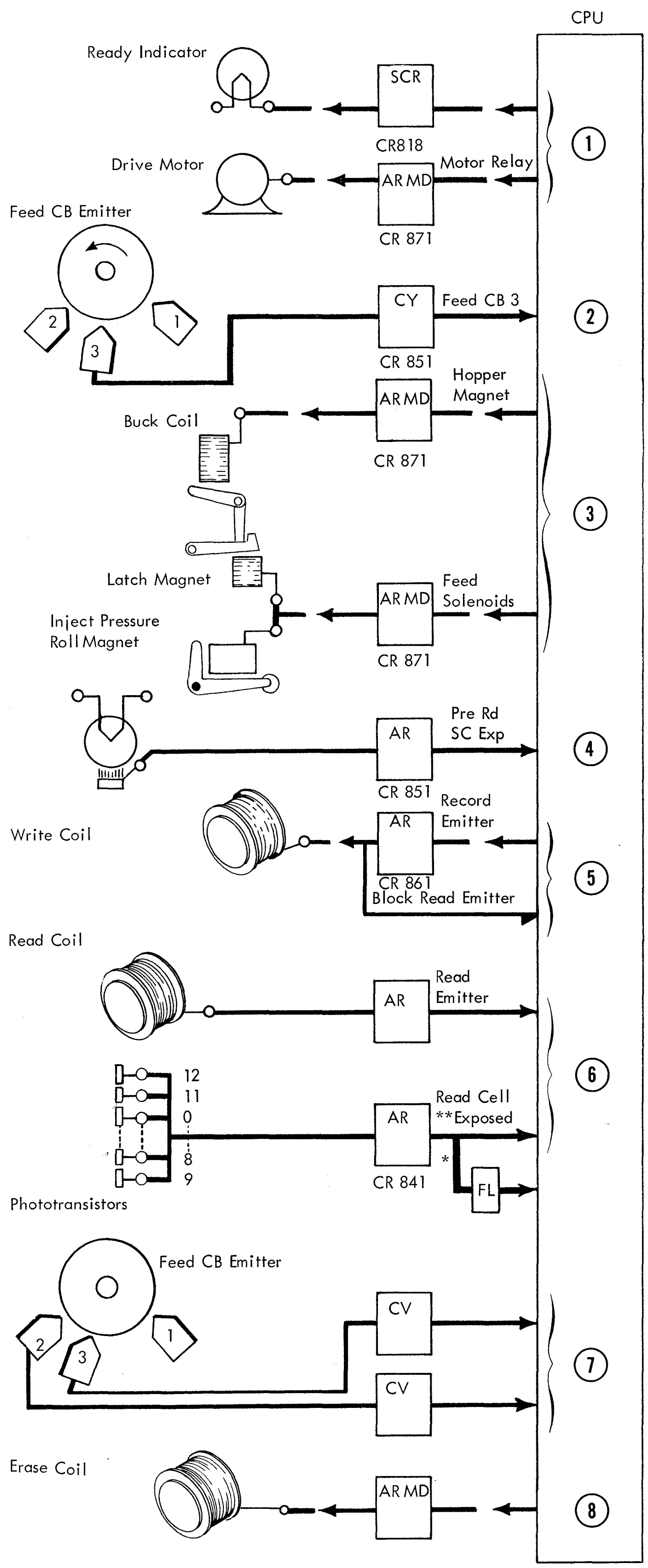
The CPU controls card feeding in the 2501 after ready has been established. The CPU sends pulses which activate the drive motor and inject pressure roll and cause the card in the preread station to feed into and through the read station. These same CPU pulses activate the pickerknives to feed a card from the hopper into the preread station.

As the card feeds into the read station, the preread solar cell is exposed. This signals the CPU to energize the write coil in the magnetic read emitter. The read data developed by the punched holes in the card and the output from the magnetic read emitter are sent to the CPU.

After the card has been read, the 60 magnetic spots on the rotor are erased at 'feed CB 2 and 3' time.

Circuit Objectives

Figure 3-2 contains a description of the circuit objectives to feed and read a card when the 2501 is controlled by the CPU.



OPERATION

- CPU activates drive motor when 2501 is in ready status.
- 'Feed CB 3' develops an output.
- The buck coil, pickerknife, latch magnet, and inject pressure roll magnet are energized at 'feed CB 3' time.
- The card in the preread station feeds into the read station.
- The 'preread SC exposed' line is activated as trailing edge of card uncovers preread SC cell.
- The write coil is energized: 60 magnetic spots are written on rotor.
- The 'block emitter' line is also activated.
- The read data and output from the read coil are sent to the CPU.
- The 'read check' latch (CPU) monitors the output of each read amplifier to see if it is functioning properly.
- 'Feed CB 2 and 3' lines are activated after the card has read.
- The erase coil is activated at 'feed CB 2 and 3' time; the 60 spots are erased.

* There is one AR logic block and one logic line for each cell.
**The line number for each cell is represented by the two asterisk: i.e., 'read cell 12 exposed' is the line associated with cell 12.

Figure 3-2. Feed and Read Cycle, CPU Initiated

The 2501 Model A has no special features.

+2.5 AND +24 VOLT DC SUPPLY

The 2501 receives +2.5 and +24 volts dc and 6 volts ac from a ferroresonant-regulated, full-wave, center-tapped power supply in the 2501. Ac power for the supply is received from the CPU. Refer to IBM Field Engineering Manual of Instruction, Solid Logic Technology, Power Supplies, Form 223-2799, for additional information about 2501 power supplies.

Voltage distribution is shown in the illustration (Figure 5-1).

SYSTEM SUPPLIED VOLTAGES

The CPU supplies the 2501 with +3, -3 and +6 volts dc. These voltages are available when dc is on in the CPU.

POWER SEQUENCING

Power On

Power on sequencing is controlled entirely by the CPU. Power in the 2501 is brought up when the processing unit supplies the 208/230 vac primary power to the power supply. The Power On light is activated when power is brought up in the CPU.

Power Off

Power off sequencing is normally controlled by the CPU. Power is dropped when the processing unit removes the 208/230 vac primary power to the drive motor and power supply. The Power On light turns off when 2501 Model A power is dropped.

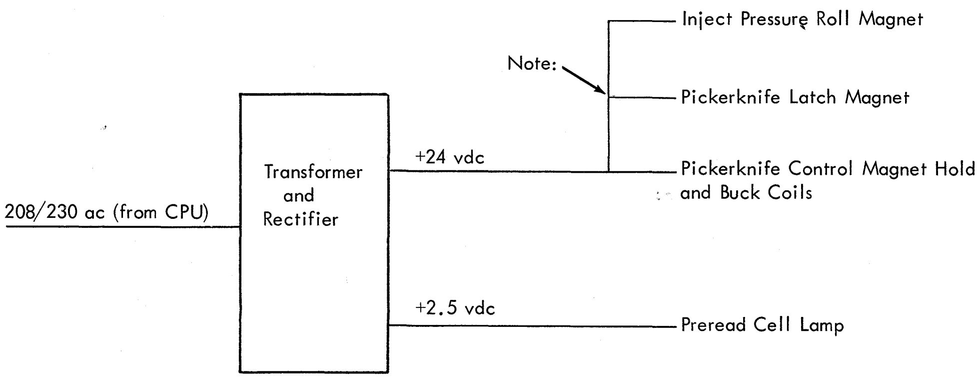
The CE switch on the power supply can also be used to remove power. Setting the switch at CE MODE drops the +2.5 and +24 vdc power supply. This prevents the drive motor from operating.

USE METER VOLTAGE SUPPLY

The 2501 use meter receives 41 vac from the use meter power supply in the 2501. Multiple primary taps are provided so the supply can be used with 208 or 230 vac.

The 2501 use meter runs simultaneously with the CPU meter after the 2501 has executed a Read command.

The meter stops and is removed from CPU control when the 2501 feed path is cleared of cards.



Note: This line supplies +24 volts to the logics for the components connected to the line.

Figure 5-1. DC Distribution

SECTION 1. CONSOLE

OPERATOR CONTROLS

Refer to Figure 6-1 for location of keys and lights on the operator panel.

Keys

Start: Pressing the Start key feeds the first card from the hopper to the preread station and places the 2501 in a ready status.

Stop: This key causes the 2501 to stop at the completion of the operation being performed and places the unit in a not ready status.

Nonprocess Runout (NPRO): Pressing this key with the hopper empty causes any cards in the preread station to be stacked without being read.

Lights

Power On indicates that dc power is being supplied to the 2501.

Ready indicates the 2501 is ready to feed and read when the following conditions exist:

1. Power on.
2. Card registered in the preread station.
3. Stacker not full.
4. No feed check condition.
5. No other error conditions.
6. Covers closed.

Feed Check indicates a card jam or improperly positioned card in the hopper, transport, or stacker. Normally, a feed check can be reset by emptying the hopper and pressing NPRO. Be careful not to damage nudge rolls. When a feed check cannot be reset in this way, the operator must manually remove the jammed cards from the transport or stacker area.

Read Check indicates that a card has not read properly, is off punched, or has not fed properly. The read check also indicates any electrical failure in the read station components.

Attention indicates that any of the following conditions exists in the 2501:

1. Stacker full.
2. Cover interlock active because of open cover.

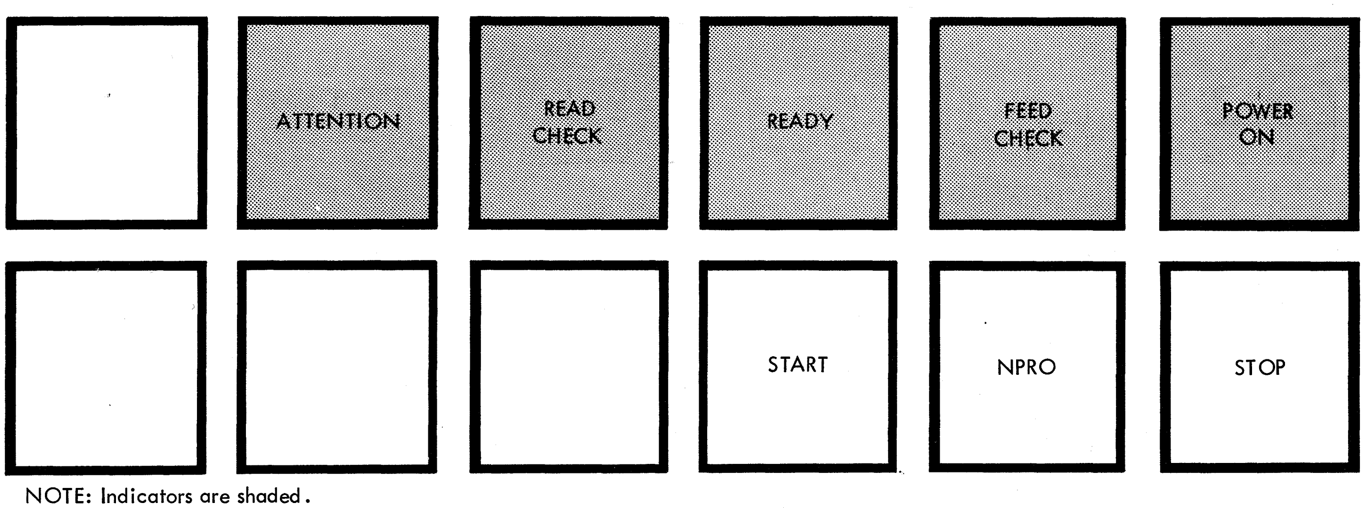


Figure 6-1. Operator Panel

CARD WEIGHT

The card weight used with the 2501 must contain two notches (Figure 6-2). The right notch allows the hopper switch lever to operate when cards run out of the hopper.

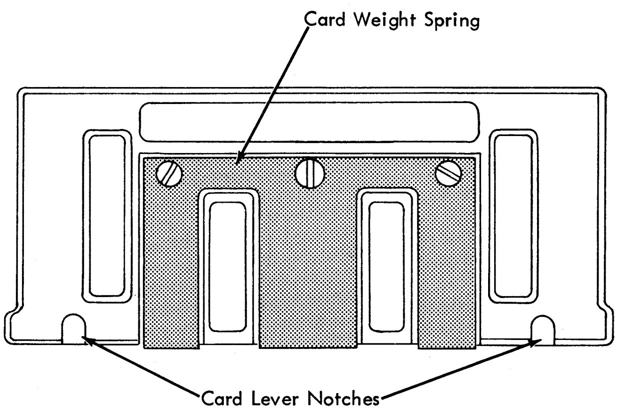


Figure 6-2. Card Weight, Bottom View

Dimensions

Weight: 150 pounds
Length: 30 inches
Width: 24 inches
Height: 43 inches

Power Requirements

The input ac voltage requirements are:
208/230 ac 60 cycles/second .3 KVA
195/220/235 ac 50 cycles/second .3 KVA
Tolerance on voltage input variations is ± 10%.
The allowable variation of cycles/second is ± 1/2 cycle.

Environmental Characteristics

Relative Humidity: Operating humidity is between 10% to 80%.

Temperature: Operating temperature is between 50° to 90° F.

Heat Dissipation: 1050 BTU/hr.

This appendix explains the SCR circuit operation as applied to the 2501. Additional information on SLT is found in: SLT Packaging, Tools, and Wiring Change, Form Z22-2800; and SLT Component Circuits, Form Z22-2798.

INDICATOR LAMP POWER MODULE

A silicon-controlled rectifier (SCR) module provides power to incandescent indicator lamps. These modules (Figure B-1) are individually packaged and are normally mounted near the indicator lamps they control.

When the SCR conducts, 7.25 vac is applied across the lamp. Two conditions must be satisfied before the SCR goes into conduction:

1. The polarity of the ac voltage must be such that pin G is minus and the lead to the indicator lamp is plus.
2. A positive control voltage must be applied to pin S through an externally provided resistor.

The SCR then stays in conduction until the polarity of the ac voltage reverses. If the voltage to pin S remains positive, the SCR will go back into conduction when the ac voltage reverses again. The negative-going signal at pin S is not enough to immediately extinguish the SCR. The SCR conducts until the ac voltage at the lamp goes negative.

Terminal T is the lamp test terminal. It is normally maintained at ground potential. If a positive voltage is applied to this terminal, the SCR will conduct.

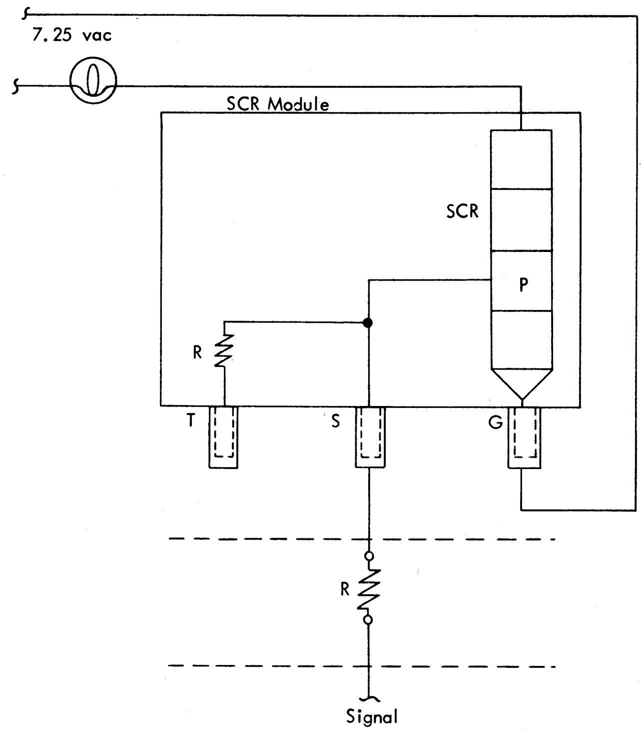


Figure B-1. Indicator Lamp Power Module

- Two apertures determine sharp rise and fall of data pulse.
- Switching level of amplifier is automatically adjusted between cards.

The read amplifier shapes the phototransistor output and supplies the required drive for the SLT logics.

As the punched hole of the card exposes the first aperture in the lower detector assembly, the phototransistor starts to conduct until it reaches a current output level of I_1 (Figure C-1). The output remains constant at I_1 until the punched hole begins to uncover the second aperture. With the second aperture uncovered, the phototransistor output current increases to a level of I_{peak}. This output (I_{peak}) remains constant until the first aperture is covered by the trailing edge of the punched hole. At this time, the phototransistor output current decreases to a level of I_2. I_2 is constant until the second aperture is covered. At this time, the level of I_{noise} (light detected through the card) is obtained.

The read amplifier switching level is automatically adjusted to 25% of the peak amplifier input drive current. The peak input drive current is established between cards. This is done when both apertures of the lower detector assembly permit light to be transmitted to the phototransistors. The switching level must occur between I_{noise} and I_1, and also between I_2 and I_{noise} in order to obtain a correct amplifier output pulse length of 485 ± 40 usec. This switching level is maintained for the entire duration of a card passing through the read station. After the card has passed the read station, the switching level is re-established before reading the next card.

A degree of symmetry must be maintained to the phototransistor output waveform in order to ensure that I_1 and I_2 both exceed 25% of I_{peak}.

Because the width of an aperture is .010" the relatively fast transition from I_{noise} to I_1, or from I_2 to I_{noise} causes the output pulse length (read data pulse to be nearly independent of the lamp voltage. The lamp voltage is adjustable however, to satisfy the minimum drive requirements of the amplifier and establish the switching level. If the lamp does not satisfy the minimum drive requirements of the amplifier, the amplifier input reverts to a logical one (positive level).

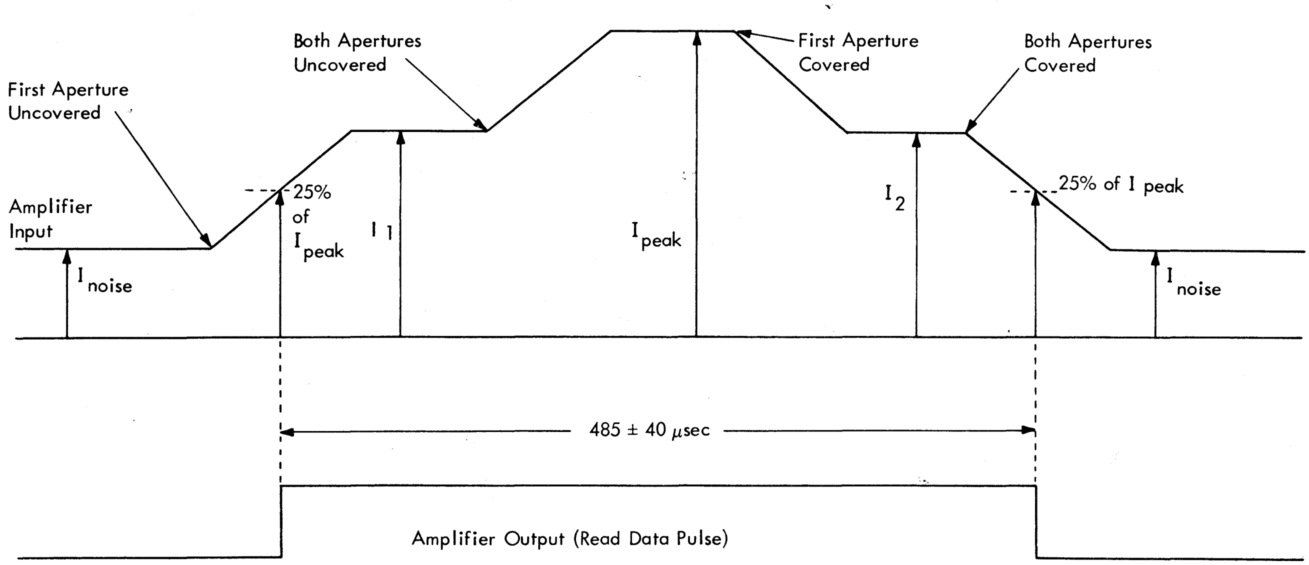


Figure C-1. Fiber Optic Read Amplifier