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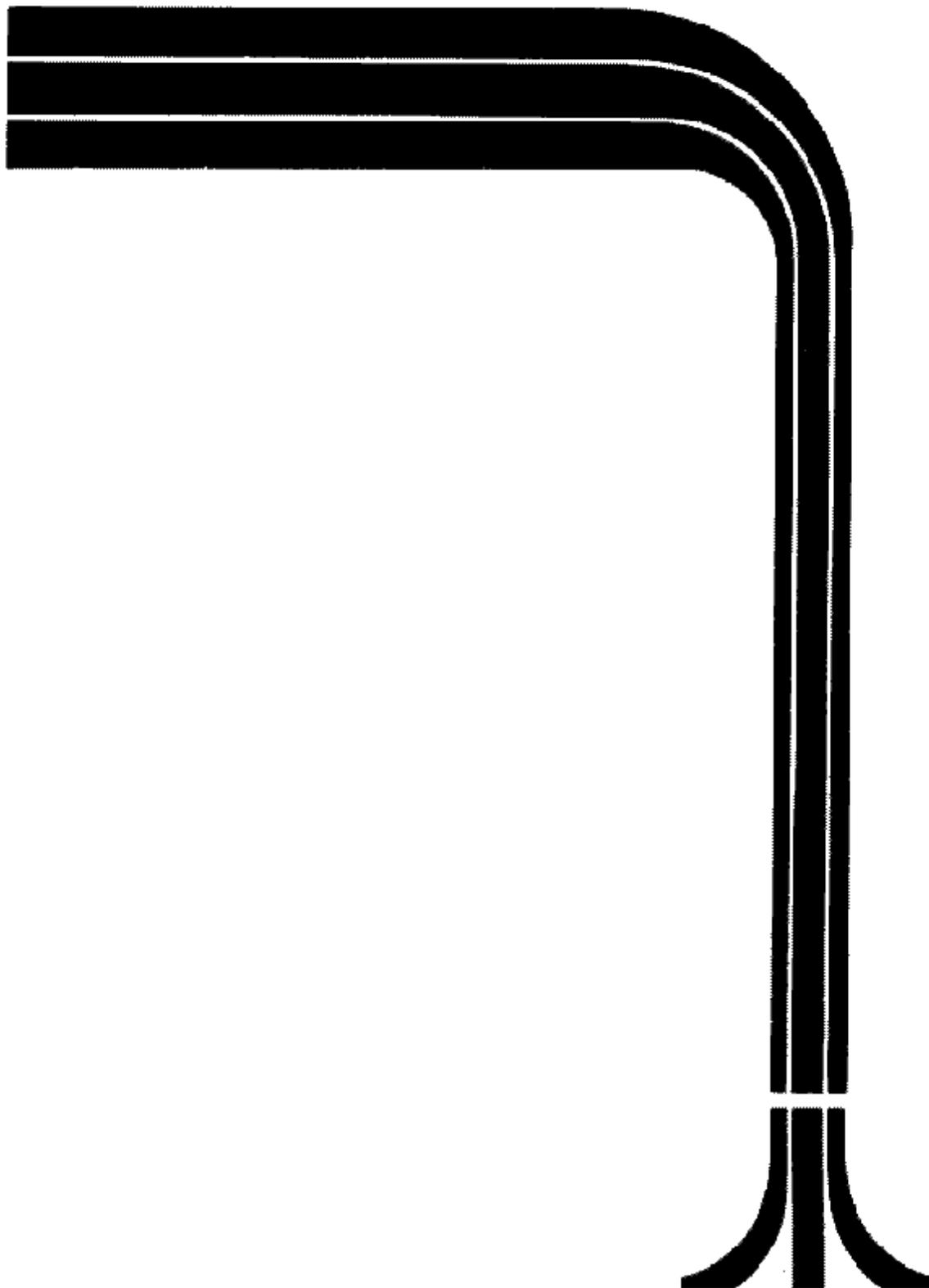
AIRBORNE AVENGER™

Operation, Maintenance
and Service Manual



Airborne Avenger
Operation, Maintenance and Service Manual

ATARI INC
1265 BORREGAS AVENUE
P.O. BOX 9027
SUNNYVALE, CA 94086
408/745-2000 • TELEX 35-7488



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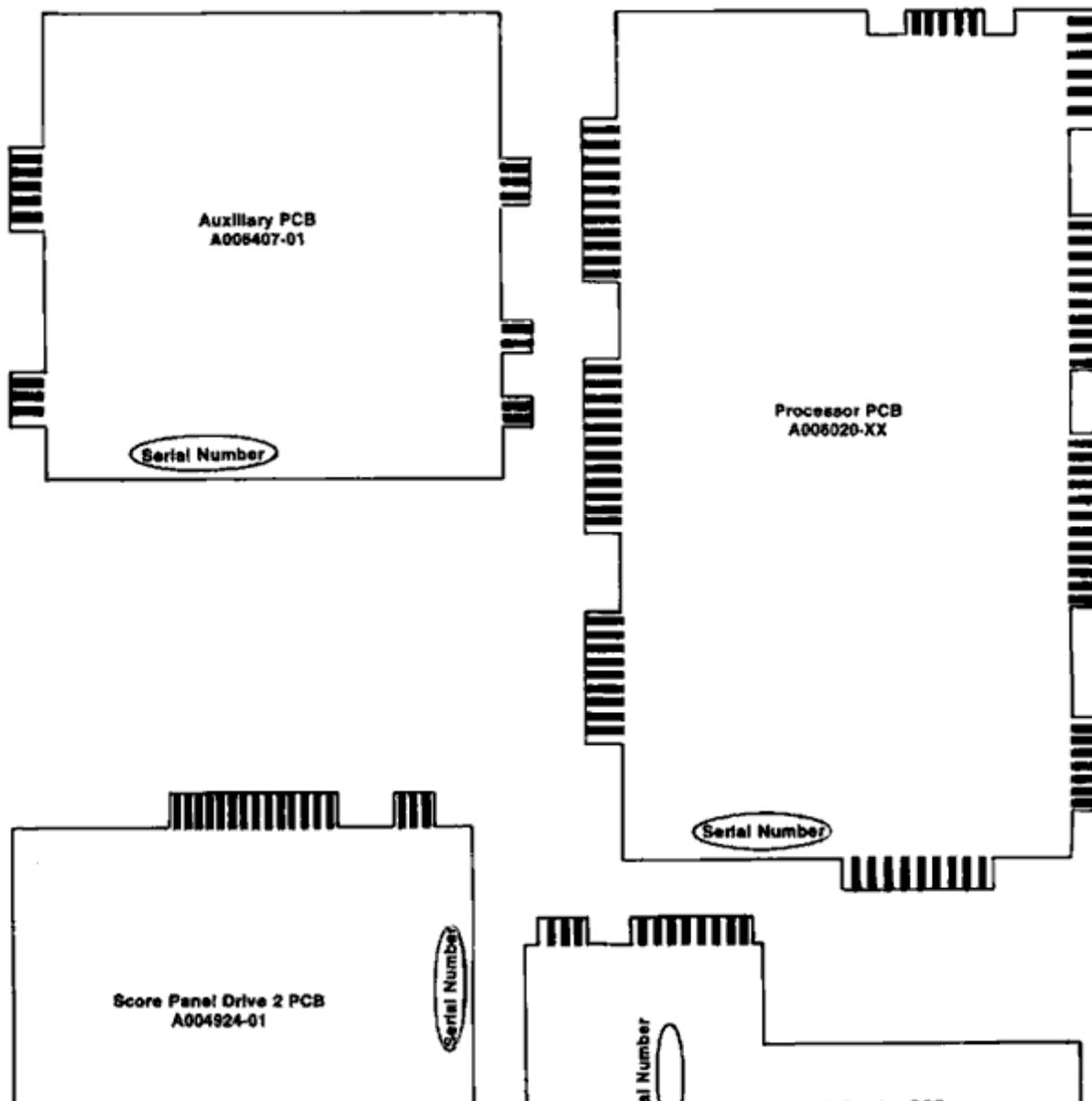
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ATARI INC
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SUNNYVALE, CALIFORNIA 94086

Location of Serial Numbers

Your game's serial number is stamped on all four printed circuit boards, in the locations shown below. The same number is also stamped on the label located on the rear of the back box. Please mention this number whenever calling your distributor for service.





Location of Serial Numbers

WARRANTY

Seller warrants that its printed circuit boards and parts thereon are free from defects in material and workmanship under normal use and service for a period of ninety (90) days from date of shipment. Seller warrants that its television monitors (in games supplied with monitors) are free from defects in material and workmanship under normal use and service for a period of thirty (30) days from date of shipment. None of the Seller's other products or parts thereof are warranted.

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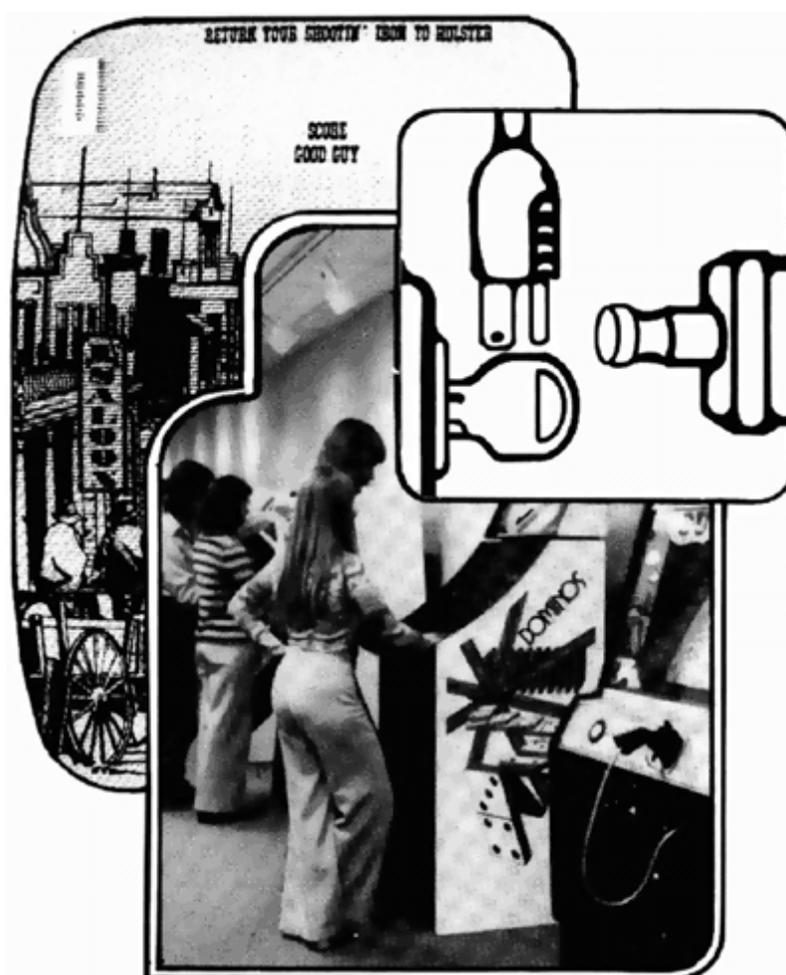
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Chapter 1: LOCATION SETUP

NOTE: If reading through this manual does not lead to solving your specific problem, you can reach Atari's Customer Service Department by telephone (open Monday through Friday, 7:30 a.m. to 4:00 p.m. Pacific Time); From inside California, Alaska or Hawaii: (408) 984-1900 From the remaining 47 states, toll-free: (800) 538-6892

A. INVENTORY OF PARTS IN SHIPPING CARTONS

As you already know, Atari's Airborne Avenger(TM) came to you packaged in one big carton containing 1) game cabinet 2) back box carton, and 3) accessories carton. Contained in the accessories box were the game cabinet legs, cash box, and this manual. Keys to the coin door are taped to the top back of the game cabinet. Keys to the back box are taped to the bottom of the back box.

Open the cash box and take an inventory of accessories as shown in Figure 1.

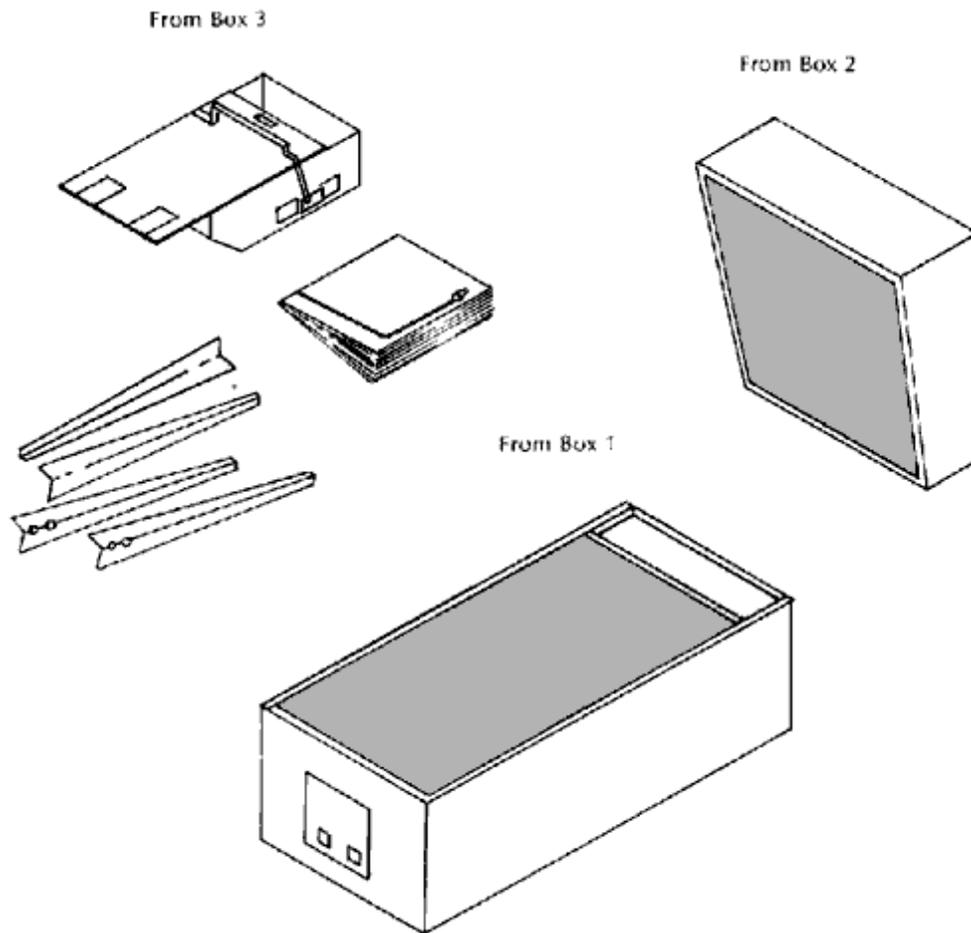


Figure 1: Inventory of Accessories

WARNING: Do not apply power to game until you have inspected inside of cabinet.

B. ASSEMBLY OF GAME

1. Assembly of Legs and Back Box

First, screw leg levelers (from cash box) into the bottom of each leg. Screw the leg leveler locking nuts onto the leg levelers.

If you have a Pin jack-

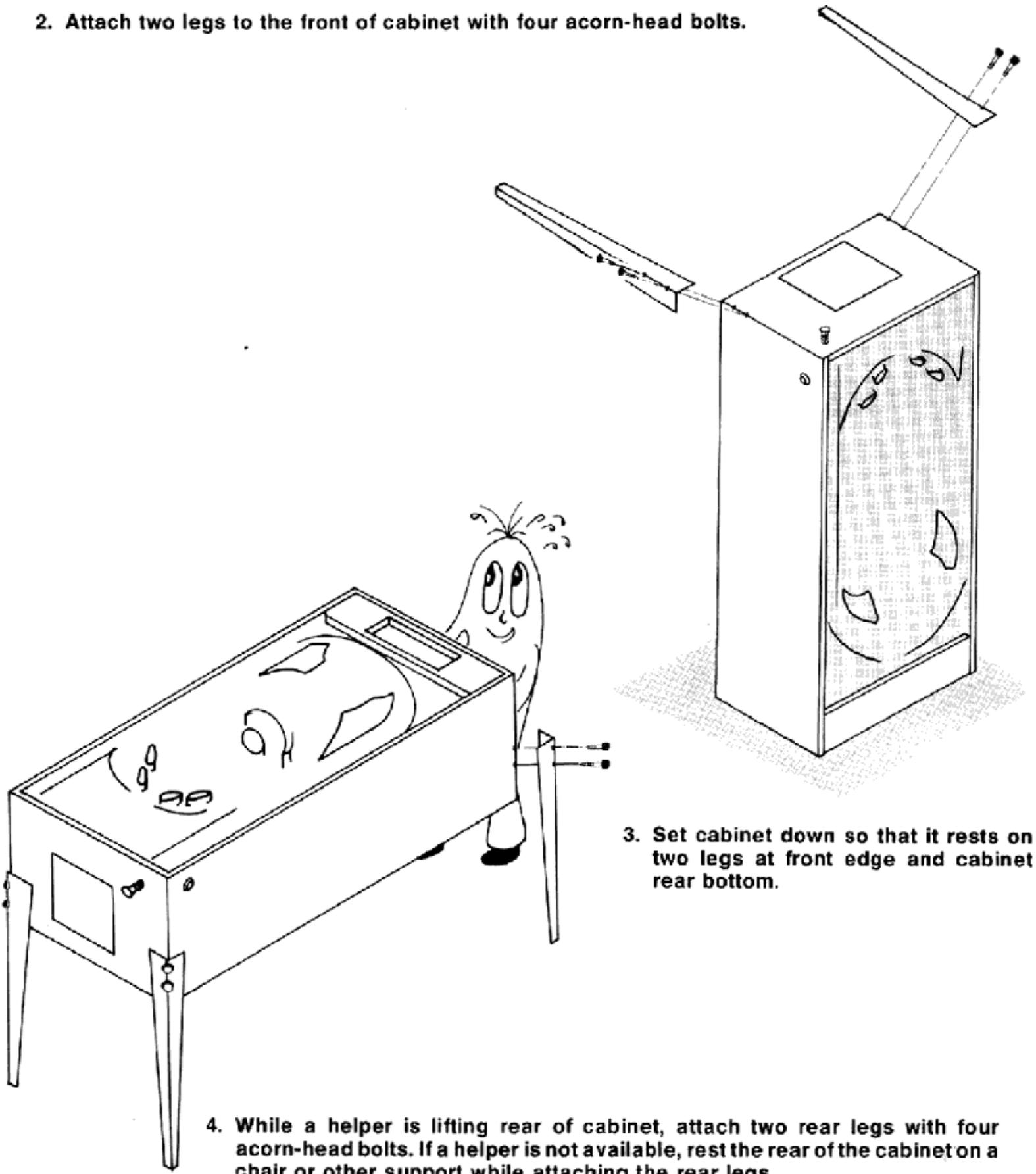
Place cabinet onto pin jack and raise cabinet at least 2 feet from floor. Then attach all four legs with eight acorn-head bolts.

If you don't have a Pin jack-

Refer to Figure 2 and follow the instructions.

1. Tilt cabinet and set it on its back on a padded surface (shipping carton works great).

2. Attach two legs to the front of cabinet with four acorn-head bolts.



3. Set cabinet down so that it rests on two legs at front edge and cabinet rear bottom.

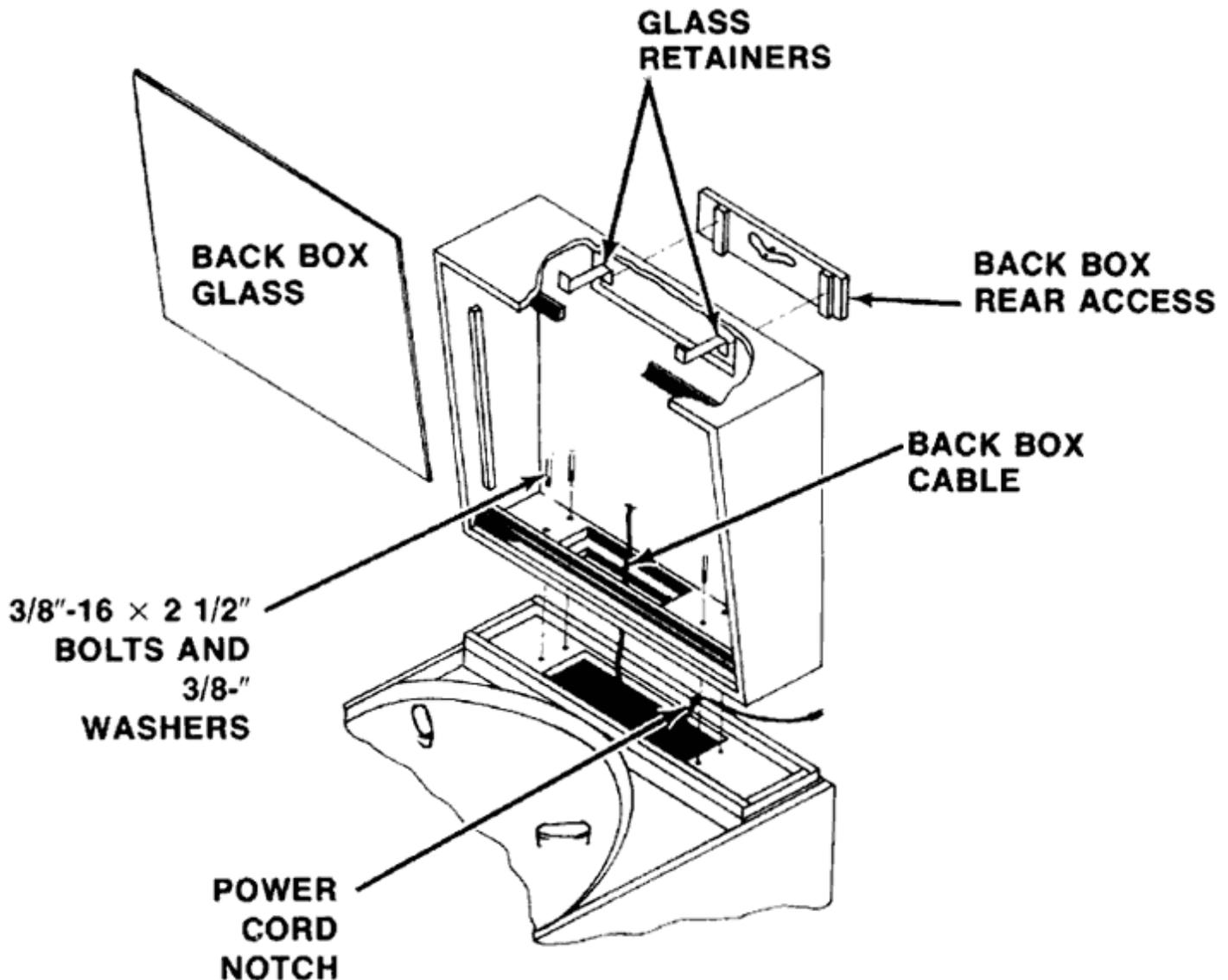
4. While a helper is lifting rear of cabinet, attach two rear legs with four acorn-head bolts. If a helper is not available, rest the rear of the cabinet on a chair or other support while attaching the rear legs.

Figure 2: Attaching Legs without a Pin Jack

2. Attach Back Box

CAUTION: Back Box carton is labeled "THIS SIDE UP" Set the Back Box carton as labeled before removing the Back Box from the carton. This will prevent the Back Box glass from failing out and breaking.

Remove the Back Box and Back Box Key Envelope from the Back Box carton and attach the Back Box to the pin cabinet as instructed in Figure 3.



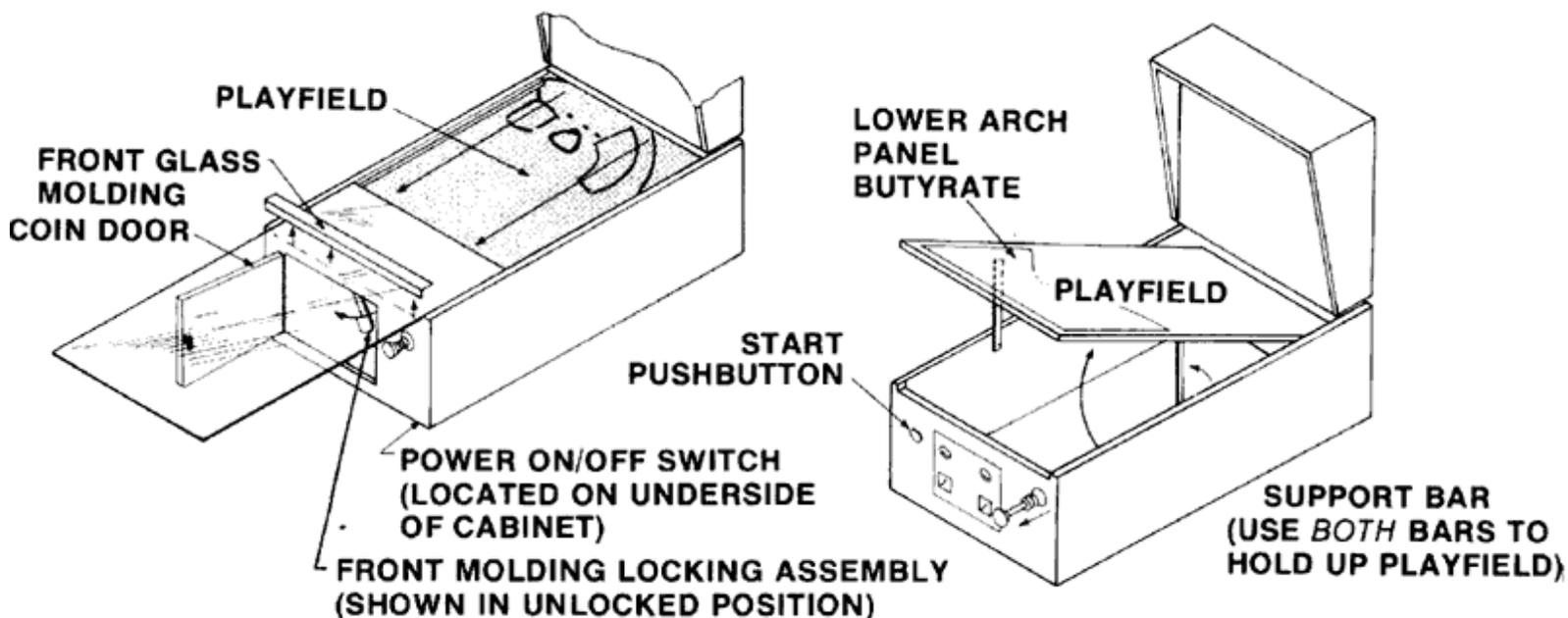
1. Reach into hole at the back of the cabinet and pull out the power cord. Insert the cord into the notch at the back of the cabinet.
2. Remove the key envelope from the top rear of the cabinet.
3. Unlock and remove Back Box rear access.
4. Pull (about 1/2 inch) on both glass retainers.
5. Push up on glass and lift up and out of Back Box.

6. **Attach Back Box to the cabinet with four 3/8"-16 × 2-1/2" bolts and four 3/8" flat washers. (Place power cord into the power cord notch.)**
7. **Unwind Back Box cable and feed down through hole in Back Box and into the cabinet. Plug the cable connector into the two pin connector receptacle on the lower left front of the Power Supply.**
8. **Snug all lamps, then reinstall Back Box glass.**
9. **Install and lock Back Box rear access.**

Figure 3: Attaching Back Box

3. Final Inspection

Refer to Figure 4 and follow the instructions.



1. **Unlock and open the coin door.**
2. **Move the playfield Front Molding Locking Assembly to the left and remove the playfield Front Molding.**
3. **Remove mounting screws from the lower Arch Panel Butyrate. Pull out and discard the foam packing from above the Score Display. Check that the edge pins of the Score Display are aligned with the pins of the interfacing connector. Remount the Lower Arch Panel Butyrate.**
4. **Lift the front of the playfield and rest it on *both* support bars.**
5. **Locate two loosely tied large nylon cable ties, one mounted on each side of the cabinet, that secure the connectors during shipping. Cut these cable ties.**
6. **Temporarily lift the black plastic cover from above the Processor PCB by removing the two front cover mounting screws.**
7. **Connect the connectors to the Processor PCB by matching the color dots on the connectors to the color dots on the PCB. Make sure that each connector's side marked "This Side Up" is up.**
8. **Thoroughly inspect the game as follows:**
 - Cabinet Inspection**
 1. **Check that all connectors are properly seated.**
 2. **Check that all fuses are properly seated.**
 3. **Check that there are no disconnected wires.**
 4. **Check entire cabinet for loose or foreign objects that may cause**

short circuiting.

5. Check that the contacts of the vertical slam switch, located on the bottom of the cabinet, and the coin door slam switch contacts are both open.

6. Check to ensure that the black plastic cover over the Processor PCB is attached with all four screws.

Playfield Inspection

Check that all harness wires on the underside of the playfield are out of the way of all moving parts and free from being pinched when the playfield is lowered.

Figure 4: Final Assembly and Inspection

4. Final Assembly

NOTE: The tilt bob is made of a soft material, carbon: don't overtighten.

1. Install the tilt bob (from cash box) onto the pendulum wire at the right front side of the pin cabinet. Tighten the thumbscrew lightly and leave it pointing toward the coin door. This way it will be accessible from the coin door for fine tuning after the playfield is lowered.
2. Place one ball onto the playfield and the other ball (both from cash box) into the captive ball area (located in the center of the playfield).
3. Choose the proper instruction cards (from cash box) and attach to the lower arch panel butyrate as illustrated in Figure 5.
4. Install the cash box.
5. Lower the playfield and install the playfield glass (for help, refer to Figure 4).
6. Level the playfield for a 3 $\frac{1}{4}$ slope from the rear to the front of the playfield.
7. Insert the power plug into a 115 VAC power source.

C. DESCRIPTION OF GAME OPTIONS

Several options are available for structuring Airborne Avenger(TM) for maximum returns at your location. The following is a list of these options:

1. Sixteen coin/credit settings for each coin chute
2. Four maximum credit levels
3. Automatic double bonus for last ball or not
4. Match or no match
5. Four different choices for "special" (20,000 points, 30,000 points, free game or extra ball)
6. Three- or five-ball game
7. Add-a-ball or not
8. Replay or no replay
9. Extra ball or 20,000 points for spellout of AIRBORNE AVENGER

D. SETTING THE OPTIONS

WARNING: Power should never be on while setting the options. Dangerous voltages are present inside the game cabinet.

All the options are selectable by merely flipping a switch. Refer to Self-Test Procedure in Table 1. Tables 2, 3, and 6 through 10 list all the options and the switches necessary to set those options. In these tables, all manufacturer suggested settings are marked with asterisks. Figure 5 shows the location of each switch on the Processor PCB (printed circuit board). To set the switches, lightly press down on the selected switch toggles with a small pointed object. To set the toggle to on, press on the switch side toward the closest end of the Processor PCB.

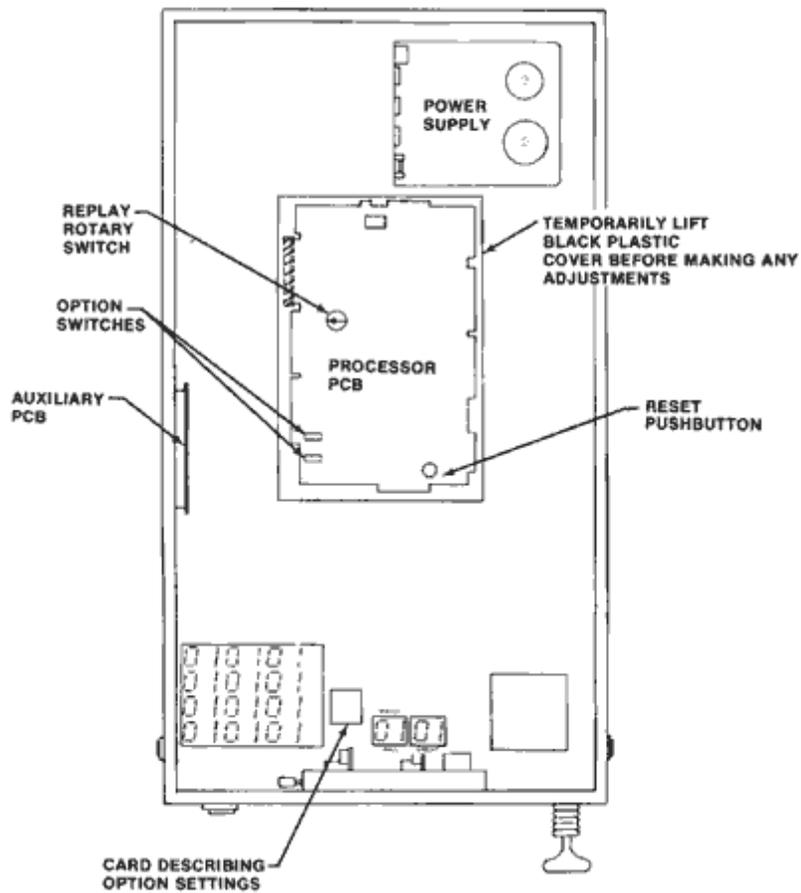


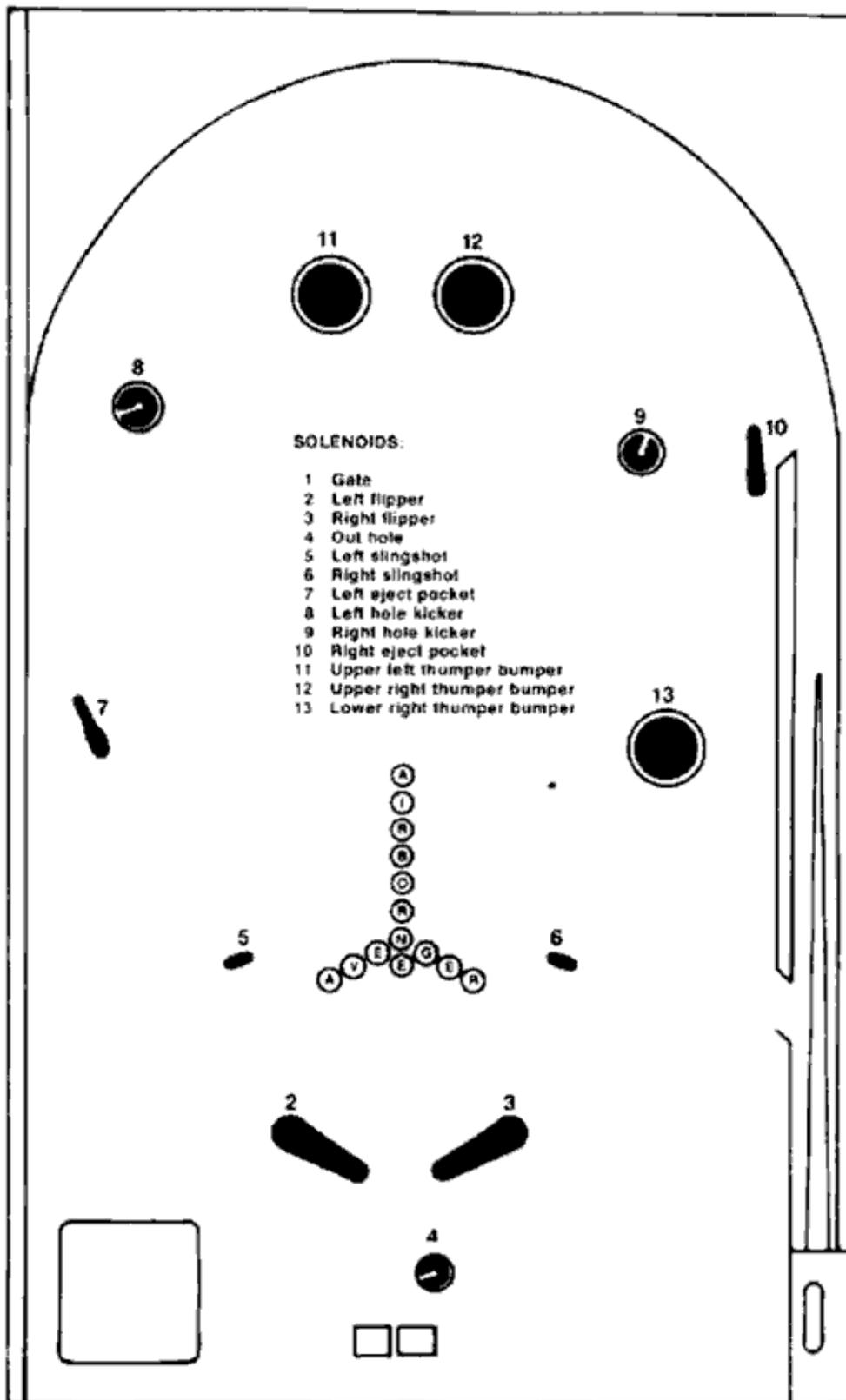
Figure 5: Location of Option Switches

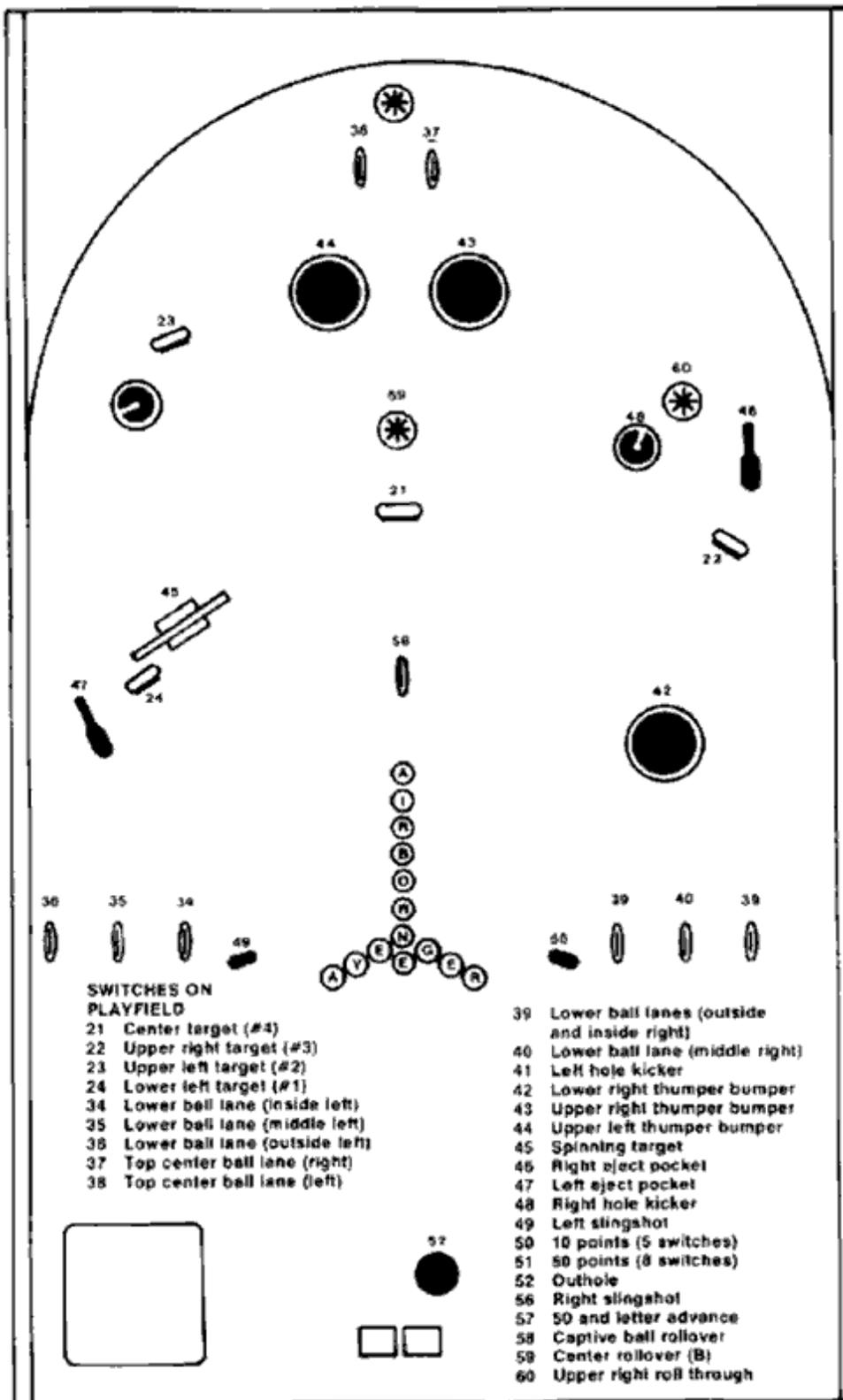
E. SELF-TEST

Self-Test is activated by pressing the TEST pushbutton. The TEST pushbutton is located at the inside top middle of the coin door. Pressing the pushbutton once, begins the lamp test pressing the pushbutton twice, begins the switch test; and the third time, the solenoid test. Pressing the pushbutton the fourth time causes the game to exit the Self-Test mode and enter the attract mode of operation,

Please read the following Suggestions, then perform the Self-Test Procedure described in Table 1.

As an aid for locating the playfield switches and solenoids, see Figure 6.





NOTE: Star rolover at top center of playfield is connected to switch 51 (50 points), except in German games rolover is connected to switch 23 (target #2).

Figure 6: Location of Playfield Switches and Solenoids

NOTE: Toggle 1 of PROG SW1 on Processor PCB should always remain in off position. For bench test purposes, Self-Test mode may be activated by setting PROG SW1 toggle 1 to on then off. This simulates pressing the TEST pushbutton.

SUGGESTION: Perform Self-Test no less than each time the cash box is collected. Machines in good operating condition have been proven to earn more money.

SUGGESTION: While performing Self-Test, inspect the playfield for worn rubbers or dirt. Clean the playfield glass and outside of the cabinet regularly. Clean games attract more players and therefore earn more money

F. VOLUME ADJUSTMENT

The volume control for all game sounds is located inside the cabinet above and to the right of the game speaker To adjust the volume, turn the volume control clockwise to increase the volume and counter-clockwise to decrease the volume.

A second volume control is located inside the cabinet on the Auxiliary PCB (labeled VOL). This volume control should only be adjusted by a qualified technician. Technicians may learn the proper adjustment of this control by reading the instructions in the Maintenance chapter (Chapter 3) of this manual.

Table 1: Self-Test Procedure

Test Name	Test Instruction	Indication of of Test Mode	Test Results	Operator Action
Lamp Test	Press and release (once only) the TEST pushbutton. (The TEST pushbutton is located on the inside top middle of the coin door.)	(Test number) 1 appears in 4TH UP player score display.	All lamps are lighted (ignore back boxlamps).	Check to ensure that all lamps are lighted.
			High replay level is displayed in 1ST UP player score display.	To change, adjust Replay Rotary switch and PROG SW1 toggle 4 for the results as listed in Table 2.
			Medium replay level is displayed in 2ND UP score display.	
			Low replay level is displayed in 3RD UP player score display.	
			Number of balls per game is displayed in BALL display.	To change, set DIP switch PROG SW 2 toggle 1 to ON for 3 balls, OFF for 5 balls.
Maximum credits is displayed in CREDIT display.	To change, set DIP switch PROG SW 1 toggles 5 and 6 as listed in Table 3.			
				NOTE: To exit Self-Test, press and release the TEST pushbutton three times.
Switch Test	Press and release (once only) TEST pushbutton.	(Test number) 2 appears in 4TH UP player score display.	Any activated or stuck switches are identified by a number in the CREDIT display. A pulsing tone is heard when a switch is activated or stuck.	Identify activated or stuck switches as listed in Table 4. NOTE: To exit Self-Test, press and release the TEST pushbutton two times.
Solenoid Test	Press and release (once only) TEST pushbutton.	(Test number) 3 appears in 4TH UP player score display.	Each solenoid is individually energized and identified by a number in the CREDIT display.	Press left flipper button to activate solenoid. Press right flipper button to change to next solenoid. Identify each solenoid with number in CREDIT display as listed in Table 5. NOTE: To exit Self-Test, press and release the TEST pushbutton one time.

Table 2 Replay Level Settings

Rotary Switch Setting	PROG SW1 Toggle 4	Low Replay Level	Medium Replay Level	High Replay Level
0	OFF	50,000	70,000	90,000

1	OFF	60,000	90,000	120,000
2	OFF	70,000	100,000	130,000
3	OFF	80,000	120,000	160,000
4	OFF	90,000	130,000	170,000
*5	OFF	100,000	150,000	200,000
6	OFF	110,000	160,000	210,000
7	OFF	120,000	180,000	240,000
8	OFF	130,000	190,000	250,000
9	OFF	140,000	210,000	280,000
10	OFF	150,000	220,000	290,000
11	OFF	160,000	240,000	320,000
12	OFF	170,000	250,000	330,000
13	OFF	180,000	270,000	360,000
14	OFF	190,000	280,000	370,000
15	OFF	200,000	300,000	400,000
0	ON	210,000	310,000	410,000
1	ON	220,000	330,000	440,000
2	ON	230,000	340,000	450,000
3	ON	240,000	360,000	480,000
4	ON	250,000	370,000	490,000
5	ON	260,000	390,000	520,000
6	ON	270,000	400,000	530,000
7	ON	280,000	420,000	560,000
8	ON	290,000	430,000	570,000
9	ON	300,000	450,000	600,000
10	ON	310,000	460,000	610,000
11	ON	320,000	480,000	640,000
12	ON	330,000	490,000	650,000
13	ON	340,000	510,000	680,000
14	ON	350,000	520,000	690,000
15	ON	360,000	540,000	720,000

*Indicates manufacturers suggested setting

Table 3: Maximum Credit Settings

Maximum Credits	Prog Sw1 Toggle 5	Prog Sw1 Toggle 6
*8	OFF	OFF
12	ON	OFF
15	OFF	ON
20	ON	ON

*Indicates manufacturers suggested setting

Table 4: Switch identification

Credit Number	Location
1	Left coin switch
2	Right coin switch
3	START pushbutton
4	Coin door slam switch
17	Cabinet slam switch
18	Tilt pendulum
19	Left flipper

20	Right flipper
21	Center target (#4)
22	Upper right target (#3)
23	Upper left target (#2)
24	Lower left target (#1)
34	Lower ball lane (inside left)
35	Lower ball lane (middle left)
36	Lower ball lane (outside left)
37	Top center ball lane (right)
38	Top center ball lane (left)
39	Lower ball lanes (outside and inside right)
40	Lower ball lane (middle right)
41	Left hole kicker
42	Lower right thumper bumper
43	Upper right thumper bumper
44	Upper left thumper bumper
45	Spinning target
46	Right eject pocket
47	Left eject pocket
48	Right hole kicker
49	Left slingshot
50	10 points (5 switches)
51	50 points (8 switches)
52	Outhole
56	Right slingshot
57	50 and letter advance
58	Captive ball rollover
59	Center rollover (B)
60	Upper right roll-thru

Table 5: Solenoid Identification

Credit Display Number	Solenoid
1	Gate
2	Left flipper
3	Right flipper
4	Outhole
5	Left slingshot
6	Right slingshot
7	Left eject pocket
8	Left hole kicker
9	Right hole kicker
10	Right eject pocket
11	Upper left thumper bumper
12	Upper right thumper bumper
13	Lower right thumper bumper

Table 6: Coin/Credit Mode Switch Settings

Coin/Credit For:		PROG SW2 Toggles			
Left Coin Chute	Right Coin Chute	3	4	5	6

*1 coin, 1 credit	*1 coin, 1 credit	OFF	OFF	OFF	OFF
1 coin, 2 credits	1 coin, 2 credits	ON	OFF	OFF	OFF
1 coin, 3 credits	1 coin, 3 credits	OFF	ON	OFF	OFF
1 coin, 4 credits	1 coin, 4 credits	ON	ON	OFF	OFF
2 coins, 1 credit	2 coins, 1 credit	OFF	OFF	ON	OFF
**2 coins, 3 credits	**2 coins, 3 credits	ON	OFF	ON	OFF
**2 coins, 5 credits	**2 coins, 5 credits	OFF	ON	ON	OFF
2 coins, 1 credit	1 coin, 1 credit	ON	ON	ON	OFF
1 coin, 1 credit	1 coin, 2 credits	OFF	OFF	OFF	ON
1 coin, 2 credits	1 coin, 4 credits	ON	OFF	OFF	ON
1 coin, 3 credits	1 coin, 6 credits	OFF	ON	OFF	ON
**2 coins, 3 credits	**2 coins, 7 credits	ON	ON	OFF	ON
**2 coins, 5 credits	1 coin, 5 credits	OFF	OFF	ON	ON
**2 coins, 7 credits	1 coin, 7 credits	ON	OFF	ON	ON
***3 coins, 1 credit	1 coin, 1 credit	OFF	ON	ON	ON
1 coin, 1 credit	1 coin, 3 credits	ON	ON	ON	ON
*Indicates manufacturers suggested setting					
**Indicates second coin gives 1 more credit than first coin, provided no scoring is achieved between coins.					
***Indicates no credit until third coin is accepted					

Table 7: Replay/Add-A-Ball Switch Settings

Replay/Add-A-Ball for Exceeding Replay Score	PROG SW1 Toggle 7	PROG SW1 Toggle 8
No replay, no add-a-ball	OFF	OFF
Add-a-ball	ON	OFF
*Replay	OFF	ON
Replay	ON	ON
*Indicates manufacturers suggested setting		

Table 8: Match Switch Setting

Match	PROG SW2 Toggle 2
Match off	OFF
*Match on	ON
*Indicates manufacturers suggested setting	

Table 9: Ball Setting

Balls Per Game	PROG SW2 Toggle 1
3 Balls	ON
5 Balls	OFF

Table 10: "Special" Mode Switch Settings

"Special Mode"	PROG SW2 Toggle 7	PROG SW2 Toggle 8
Extra ball for <i>Special</i>	OFF	OFF
*Replay for <i>Special</i>	ON	OFF

20,000 points for <i>Special</i>	OFF	ON
20,000 points for <i>Special</i>	ON	ON
*Indicates manufacturers suggested setting		

Table 11: AIRBORNE AVENGER Spellout Setting	
Spellout Reward	PROG SW1 Toggle 2
Extra Ball Awarded for Spellout	OFF
20,000 Points Awarded for Spellout	ON

Table 12: Last Ball Bonus Setting	
Last Ball Reward	PROG SW1 Toggle 3
No Double Bonus for Last Ball	OFF
Double Bonus for Last Ball	ON

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Chapter 2: GAME PLAY

The game has three modes of operation: attract, play, and Self-Test. The attract mode serves to attract players to the game. The play mode is active when the game is being played. Self-Test is used by the operator for game maintenance.

A. ATTRACT MODE

The attract mode is initiated by game power-up, exit from Self-Test, or by the end of the previous game. If entered from power-up or Self-Test, the score and match/credit displays will indicate all eights. If the attract mode follows a game, the score will indicate the final score of that game. In any case if the game is untouched, within approximately two minutes the score display will go blank to conserve energy.

In the attract mode, the playfield lamps blink on and off in an exotic light show that attracts potential players to the game. The game remains in this mode unless a player presses the START pushbutton (if there are sufficient accumulated credits) or by the operator entering the Self-Test mode by pressing the TEST pushbutton.

B. PLAY MODE

After a player has depressed the START button, the game responds as follows:

1. The uppermost row in the Score Panel will indicate two zeros, and the words 1ST UP to the right of the zeros will start to blink on and off.
2. The number in the Credit Display decreases by 1.
3. The Match Display will now become the Ball Display and will indicate 01, meaning that the first game ball is in play.
4. The ball is ejected from the outhole and rolls over to the ball shooter.
5. The playfield lamps will stop blinking, and 1000 and BALL IN PLAY lamps will be constantly lighted. All other score-related lamps remain unlighted.
6. The flipper controls are enabled.
7. On the player panel just above and beside the ball shooter, the lamp behind the numeral 1 (surrounded by yellow) will light, indicating that so far one player is playing.

Up to this point and even up until the ball hits the first score point object, additional players may be added to the game. They do this by depositing money (if necessary), and by then depressing the START pushbutton. Each time the game responds by adding another row of two zeros in the Score Panel, decreasing the Credit Display by 1, and lighting another lamp just above the ball shooter.

If a ball rolls all the way down to the outhole without achieving any score whatsoever, the outhole kicker will then eject the ball so that the player can shoot again. But if a ball achieves any score it is counted as one of the play balls.

As soon as the first score points are earned, the lock-out coil on the coin door is de-energized and the

coin mechanisms will not accept any coins until after the play sequence ends. The game's speaker also produces sounds when score points are earned, as follows:

1. For 3000 points, a high-pitch, medium-duration tone, immediately followed by a high-pitch, medium-duration tone.
2. For 2000 points, a low-pitch, short-duration tone.
3. For 1000 points, a low-pitch, short-duration tone.
4. For 500 points, a high-pitch, long-duration tone.
5. For 100 points, a high-pitch, medium-duration tone.
6. For 50 points, a high-pitch, medium-duration tone.
7. For 10 points, a high-pitch, short-duration tone.

Game Play and Scoring

1. **Bonus:** Bonus advancement is achieved by hitting the various bonus advance targets, rolling the ball through one of the two triple bonus advance lanes (when lit), or rolling the ball over one of the 3 single bonus advance lanes (when lit) or by placing the ball into the left eject pocket where the player receives 2000 pts. and 2 bonus advances for each of "A", "B", and/or "C" lit. The bonus has a maximum advancement of 29,000 points, and is collected at the end of each ball. When double bonus is achieved, the player collects twice the bonus value he has achieved.
2. **Double Bonus:** Double bonus is achieved by lighting A, B, and C in the double bonus accumulator. "A" is lit by shooting the ball into the left hole kicker or the "Lites A" ball lane, "B" is lit by rolling the ball over the "lites B" rollover or the "lites B" ball lane. "C" is lit by shooting the ball into the right hole kicker, or by rolling the ball through the "Lites C" ball lanes.
3. **Gate:** The ball gate is opened by hitting either stand-up target #3 (upper right) or stand-up target #1 (lower left). The gate remains open until the ball goes through the gate or the ball drops into the outhole.
4. **Top Center Ball Lanes:** The left and right top center ball lanes are alternately lit, and are changed by hitting any 50 point switch. Each lane will yield 500 points when not lit, or 3000 points and 3 bonus advances when lit. Rolling through the left lane will light all 3 lower left lanes, and rolling through the right lane will light all 3 lower right lanes, Rolling through either top center ball lane will light the captive ball rollover and the "lites B" rollover.
5. **Spinner:** The spinner target yields 100 pts per rotation or 1000 points per rotation when lit. The spinner is lit by hitting either the captive-ball target (#4) or the upper left target (#2). The spinner light goes out when the ball lands in the left eject pocket.
6. **A, B, C Bonus:** When the ball lands in the left eject pocket, the player collects 500 points plus 2000 points and 2 bonus advances for each of "A", "B", and "C" he has lit in the left eject pocket. Upon collection, each light is turned out, and the player must relight the letters by achieving the appropriate rollovers or hole kickers in order to collect them again.
7. **Special:** The Alternating special is lit when the player lights targets 1 through 4 on a single ball. The special alternates between the lower left drain, lower right drain, and the upper right roll through. Both sling shots and the fifty point switches rotate the special. To achieve the special, the ball must roll over the rollover where the special light is lit.

8. Spell-Out: Completing the Spell-out of AIRBORNE AVENGER can result in either an award of an extra ball or 20,000 points (see switch options in Table 11). The spell-out is advanced by letter advance hole kickers, ball lanes, and the triple letter advance roll-thru.

Tilt Condition

The game is provided with a pendulum tilt switch, a slam tilt switch on the coin door, and another slam-type switch on the floor of the cabinet. If the microcomputer senses any closure of the above switches, it will put the game into a "tilt" condition and light the TILT lamp. A sound is produced when the game is tilted.

Match Option

If this option is selected, after the last player's last ball has reached the outhole the Ball Display changes into a Match Display (the lamp behind the word BALL will be unlighted and the lamp behind the word MATCH will light). A random number is selected by the microcomputer. That number is displayed in the MATCH display.

The microcomputer then compares the match number with the two least significant digits in each player's score. One game credit will be awarded for each match-up. Therefore a maximum of four matches are possible after a four-player game has ended.

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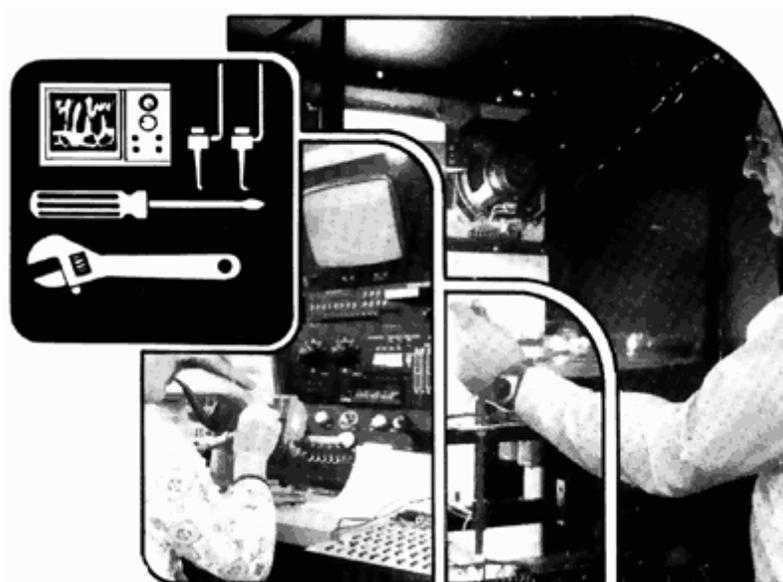
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CHAPTER 3: MAINTENANCE AND ADJUSTMENTS

Due to its solid-state electronic circuitry, this Atari game should require very little maintenance and only occasional adjustment. Information given in this chapter and elsewhere in the manual is intended to cover most servicing situations that may be encountered at the game site. The procedures given are in sufficient detail to be understood by a person with moderate technical ability.

A. CLEANING

Game Cabinet Exterior

The exterior parts of the game cabinet and glass may be cleaned with any non-abrasive household cleaner. If desired, special coin machine cleaners which leave no residue can be obtained from distributors.

Playfield

The surface of the playfield has a finish chosen for its long-wearing property. Check the surface periodically to make sure that it is both clean and free of foreign material. Also, periodically check the ball to make sure that it also is smooth and clean. Immediately replace any ball that is chipped, burred, corroded, or pitted. A defective ball will cause damage to the playfield surface in a very short time.

Much of the player appeal in pinball games depends on smooth ball travel over the entire playfield. To keep the playfield and ball from wearing out prematurely, Atari recommends using only a nonabrasive cleaner.

Do not use such products as "Formula 409" or "Windex," kitchen cleansers, soapy cleaning pads or steel wool, waxes or polishes, or great amounts of water. These products may easily scour and damage the silk-screened artwork, and/or cause buildup of gummy residue.

While cleaning the playfield, avoid getting foreign material into the bodies of the star rollovers. You might cover the switch body with a small amount of masking tape when cleaning around the switch body.

For replacement sizes of playfield rubbers, see Figure 7.

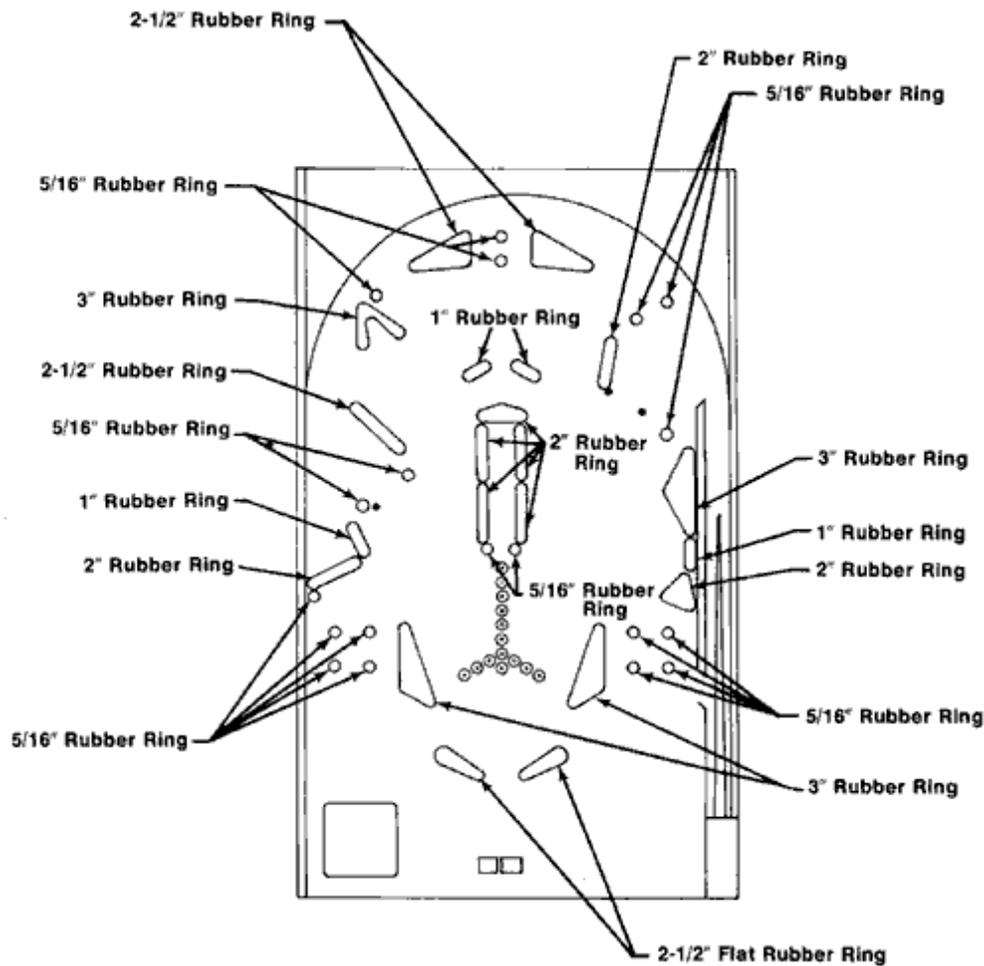


Figure 7: Playfield Rubber Sizes

B. FUSE REPLACEMENT

WARNING: As an additional safety measure when replacing fuses always unplug the power cord before opening the cabinet.

CAUTION: When changing fuses make sure that the replacement fuses have time ratings specified by Atari, and that the fuse is being replaced in the correct fuse holder.

Replacement fuse values are listed on charts near both the power supply fuse panel and service panel. In case these fuse value charts have been destroyed, refer to Tables 13 and 14 for the values.

Table 13: Fuses Located Near Ball Shooter

Position on Strip	Designation	Circuit Protected	Domestic Fuse Rating	Foreign Fuse Rating
Uppermost fuse	F7	Back Box	2 amps, 250 volts, fast-blo (3AG)	2 amps, 250 volts, fast-blo (3AG)
Middle fuse	F8	Line Power	7 amps, 250 volts, slo-blo (3AG)	2.5 amps, 250 volts, slo-blo (3AB)
Bottom fuse	F9	Service Outlet	2 amps, 250 volts, fast-blo (3AG)	2 amps, 250 volts, fast-blo (3AG)

Table 14: Fuses Located on Power Supply Assembly

Position on Strip	Designation	Circuit Protected	Rating
Uppermost fuse	F6	Audio	2 amps, 250 volts, fast-blo (3AG)
	F5	Displays	0.5 amps, 250 volts, slo-blo (3AG)
	F4	Displays	0.5 amps, 250 volts, slo-blo (3AG)
	F3	Lamps	15 amps, 250 volts, fast-blo (3AB)

	F2	Logic	7 amps, 250 volts, slo-blo (3AG)
Bottom fuse	F1	Solenoids	15 amps, 250 volts, fast-blo (3AB)

C. COIN MECHANISM

Components on Coin Door

Figure 8 shows the back side of the coin door assembly where the game's two coin mechanisms are mounted. Included is the lock-out coil assembly; the lock-out wires are connected to this assembly but are hidden behind the coin mechs. During the attract mode, the microcomputer energizes the lock-out coil, causing the lock-out wires to retract far enough to allow genuine coins to reach the coin box. During play mode (and also when AC power in the game has been turned off) the lock-out coil is de-energized, causing the lock-out wires to move out far enough to divert coins over to the coin return chute.

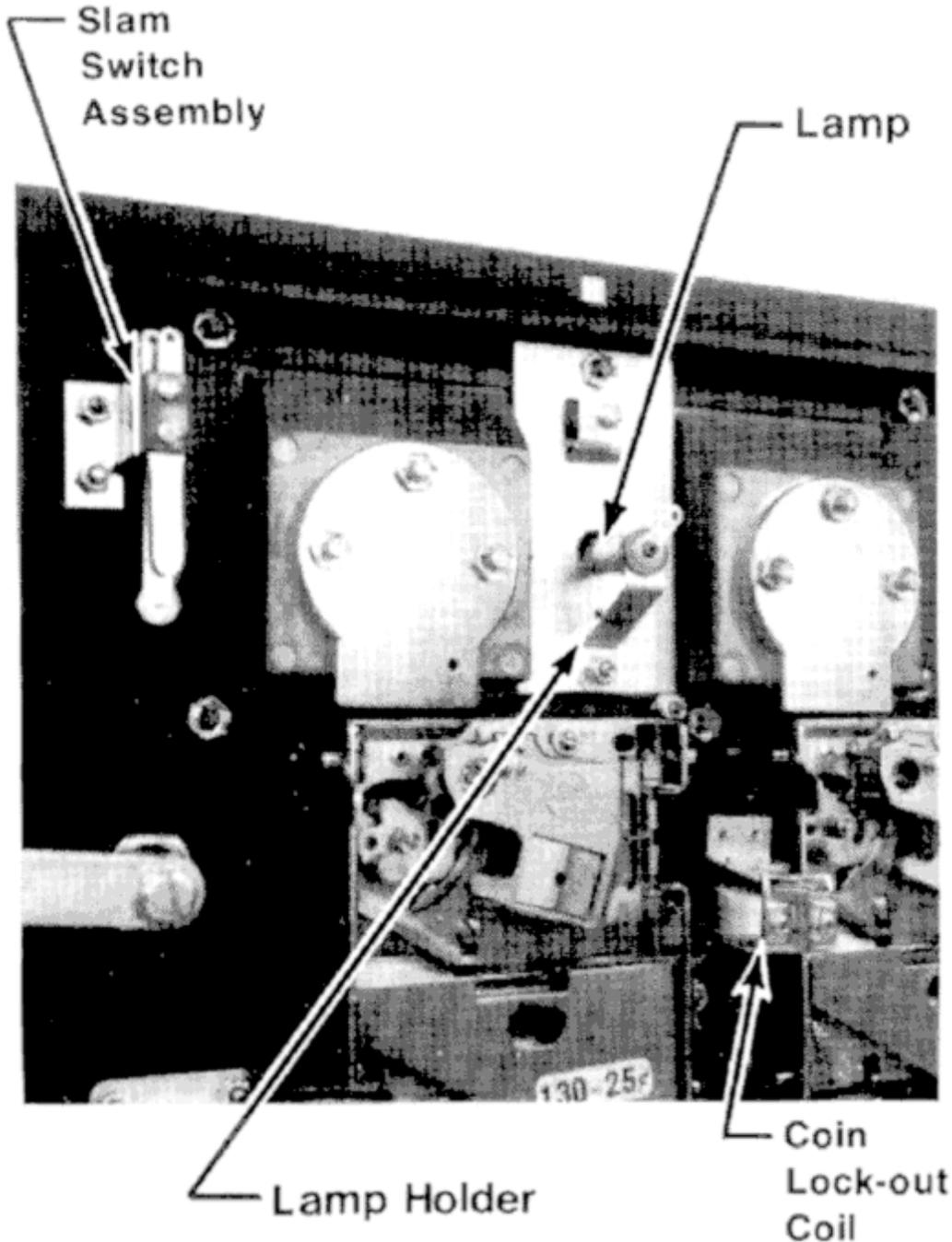


Figure 8: Coin Door Assembly

Directly below each coin mechanism is a secondary coin chute and a coin switch with a trip wire extending out to the front edge of the chute. When the trip wire is positioned correctly, a coin passing down the secondary chute and into the coin box will momentarily push the trip wire down and cause the switch contacts to close.

Also shown in the photograph is a slam switch assembly. It has been included to defeat any players who might try to obtain free credits by violently pounding on the coin door to momentarily close the contacts on a coin switch. The slam switch contacts connect to the microcomputer system, which will ignore coin switch signals whenever the slam switch contacts are closed.

Access to Coin Mechanisms

To remove jammed coins, and for maintenance cleaning, each magnet gate assembly can be hinged open without removing it from the door, as shown in Figure 9. Or, if necessary, each coin mechanism can be entirely removed from the door merely by pushing down on a release lever and simultaneously tilting the mechanism back, then lifting it up and out. This is shown in Figure 10.

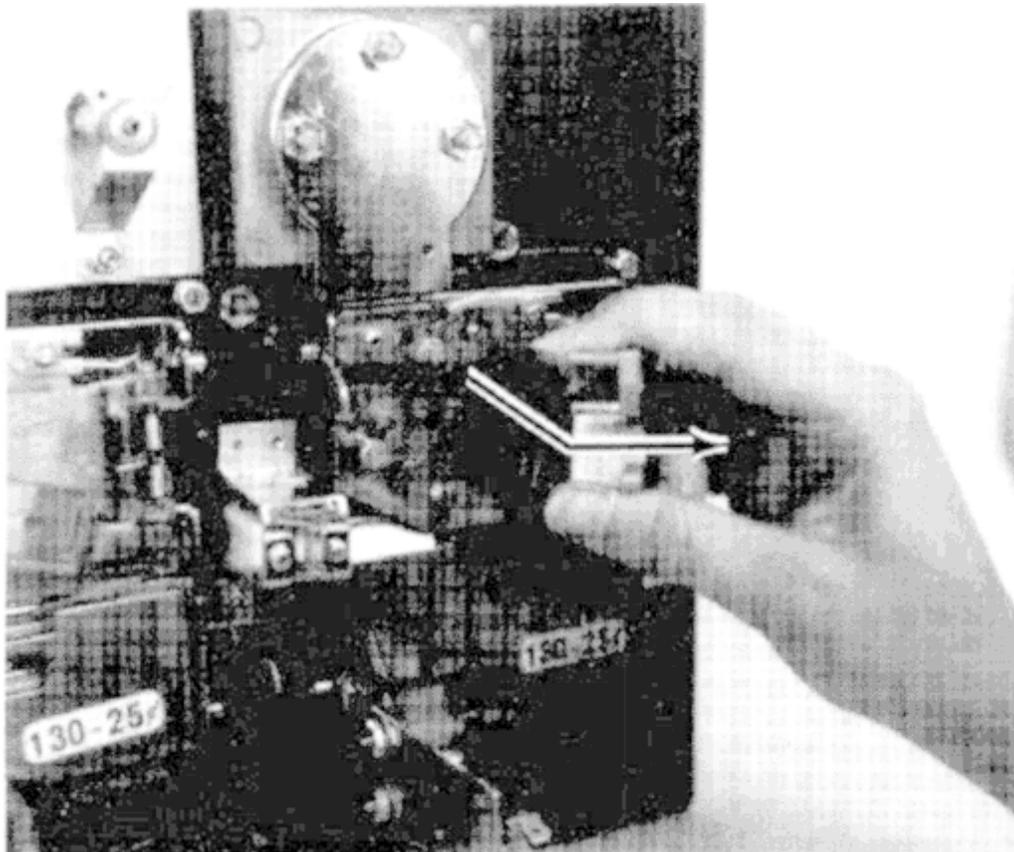


Figure 9: Hinging Open the Magnet Gate Assembly

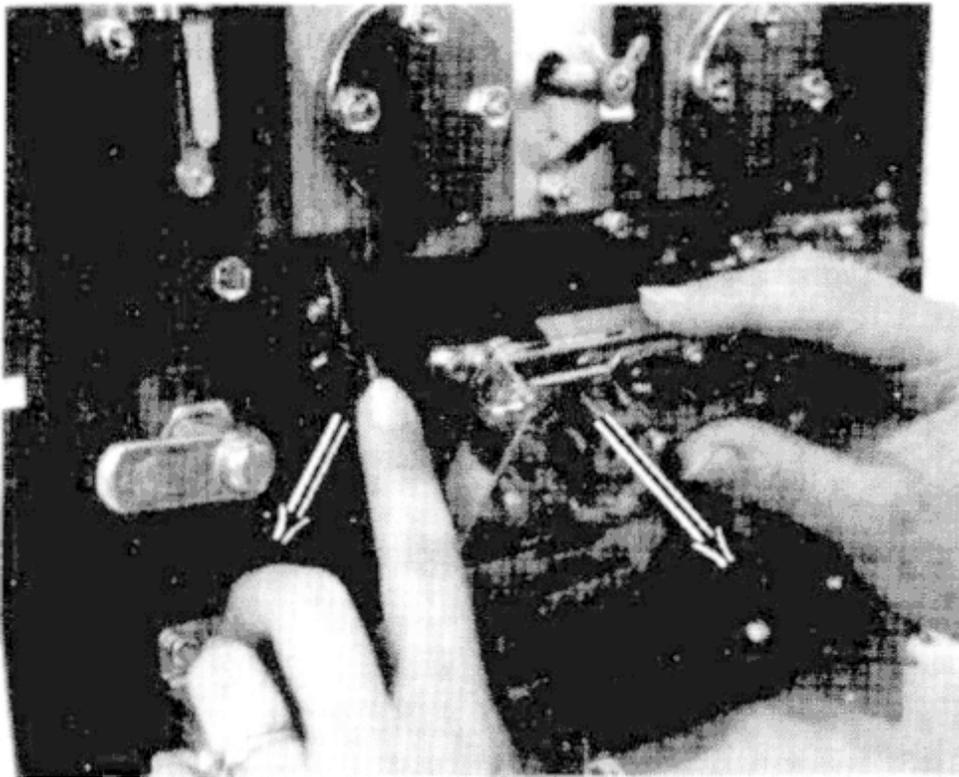


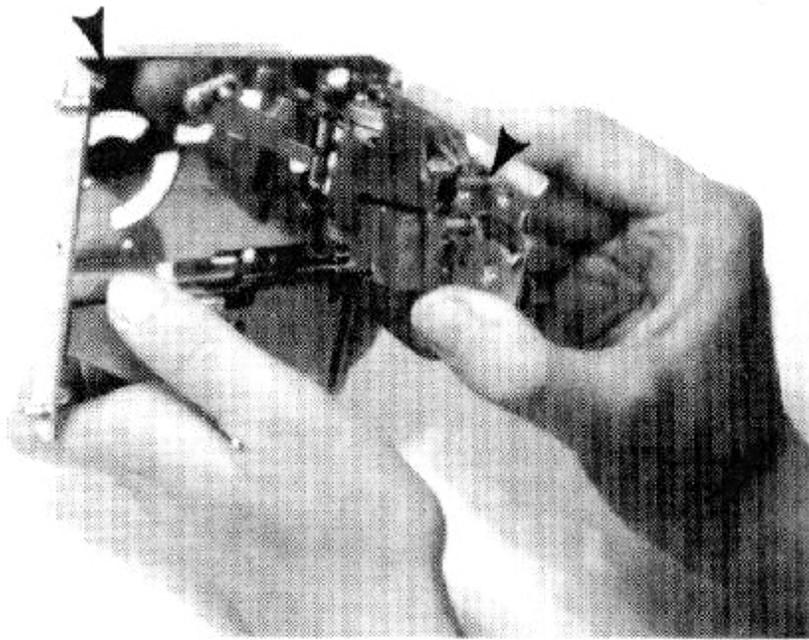
Figure 10: Removal of Coin Mechanism

Clearing of Coin Path

CAUTION: The use of an abrasive (such as steel wool or a wire brush) or a lubrication on a coin mechanism will result in a rapid buildup of residue.

By talking to many operators, we have found that the best method of cleaning a coin mechanism is by using hot or boiling water and a mild detergent. A toothbrush may be used for those stubborn buildups of residue. After cleaning, flush thoroughly with hot or boiling water, then blow out all water with compressed air.

Figure 11 shows the surfaces to clean inside the coin mechanism. These include the inside surface of the mainplate and the corresponding surface of the gate assembly. There may also be metal particles clinging to the magnet itself. To remove these you can guide the point of a screwdriver or similar tool along the edge of the magnet.



(Clean both surfaces where coin enters the mechanism, as well as the magnet)

Figure 11: Surfaces to Clean inside the Coin Mechanism

If coins are not traveling as far as the coin mechanisms, you will need to clean the channel beneath the coin slot. To gain access to this channel, use a 3/8-inch wrench and remove all three nuts that secure the cover plate (refer to Figure 12). Removing the plate will provide access to the entire channel.

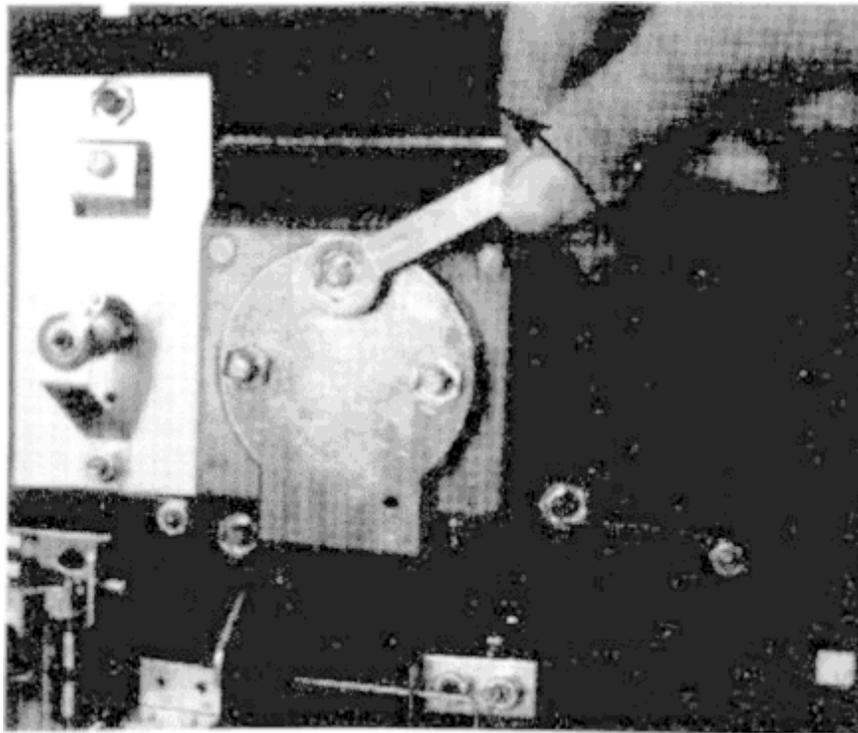


Figure 12: Removal of Plate Covering Rear of Coin Slot

Also clean the inside surfaces of the secondary coin chutes, but when doing this be careful not to damage or bend the trip wires on the coin switches.

Adjustment of Coin Switch Trip Wire

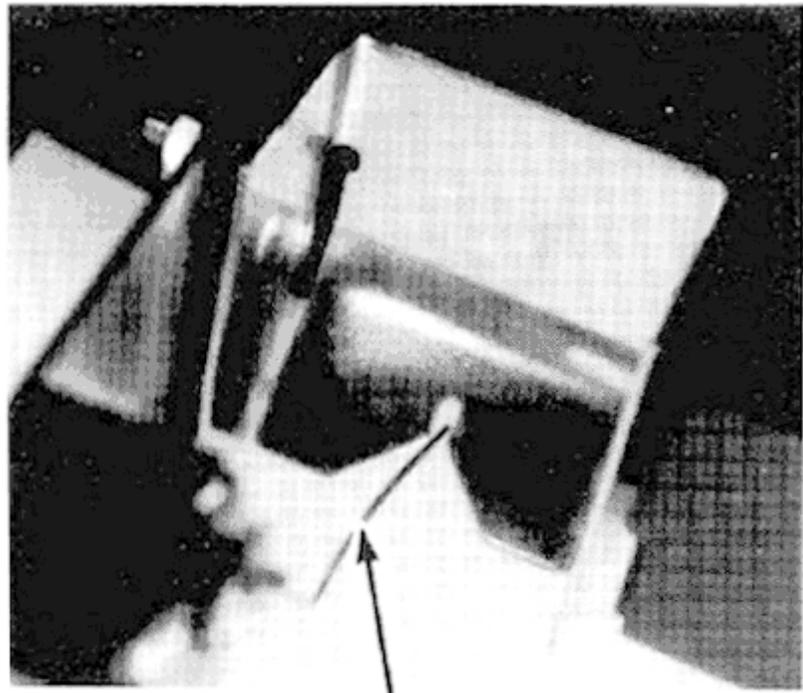
In order for a coin switch to operate reliably when a coin travels down the secondary coin chute, the rest position of the switch's trip wire should be as shown in Figure 13. Use extreme care when handling or touching these wires.

Three problems can occur with trip wires—they can be too long, too short, or become loosened and fall off.

With a too long wire you may have a problem of it catching on the opening in the cash box as a coin is accepted. You can cut off the end of the wire in small increments, making sure it still extends slightly through the "V" of the coin chute.

If the trip wire is too short (either by wrong adjustment or by being cut off too much), then coins may slip by the wire without tripping it, and no credits will be given. The solution is to carefully bend and somewhat straighten out the wire to lengthen it. If you cannot straighten it enough, then you will have to contact your distributor to order another trip wire.

If the wire is loose and falls off of its mounting stud, it will also cause no credits to be given. Secure the wire by crimping together both ends of the brass-colored mounting stud with a pair of pliers (also see Figure 13). If you should ever need to remove the trip wire, the two halves of the mounting stud can be separated with a small screwdriver.



Correctly adjusted trip wire

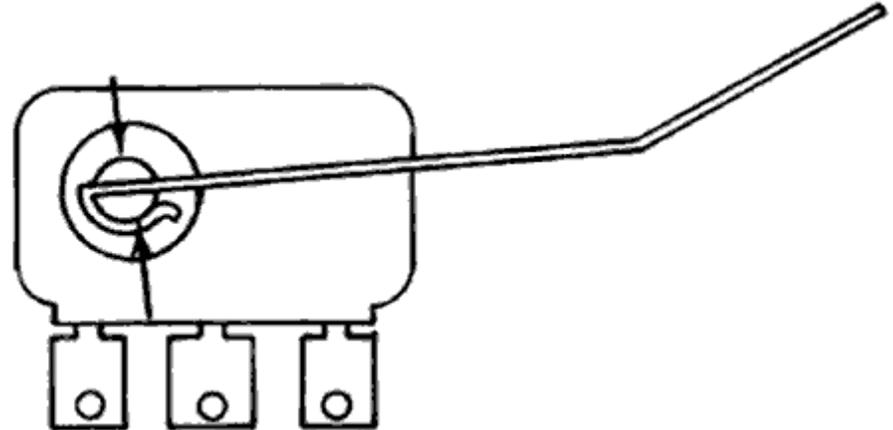
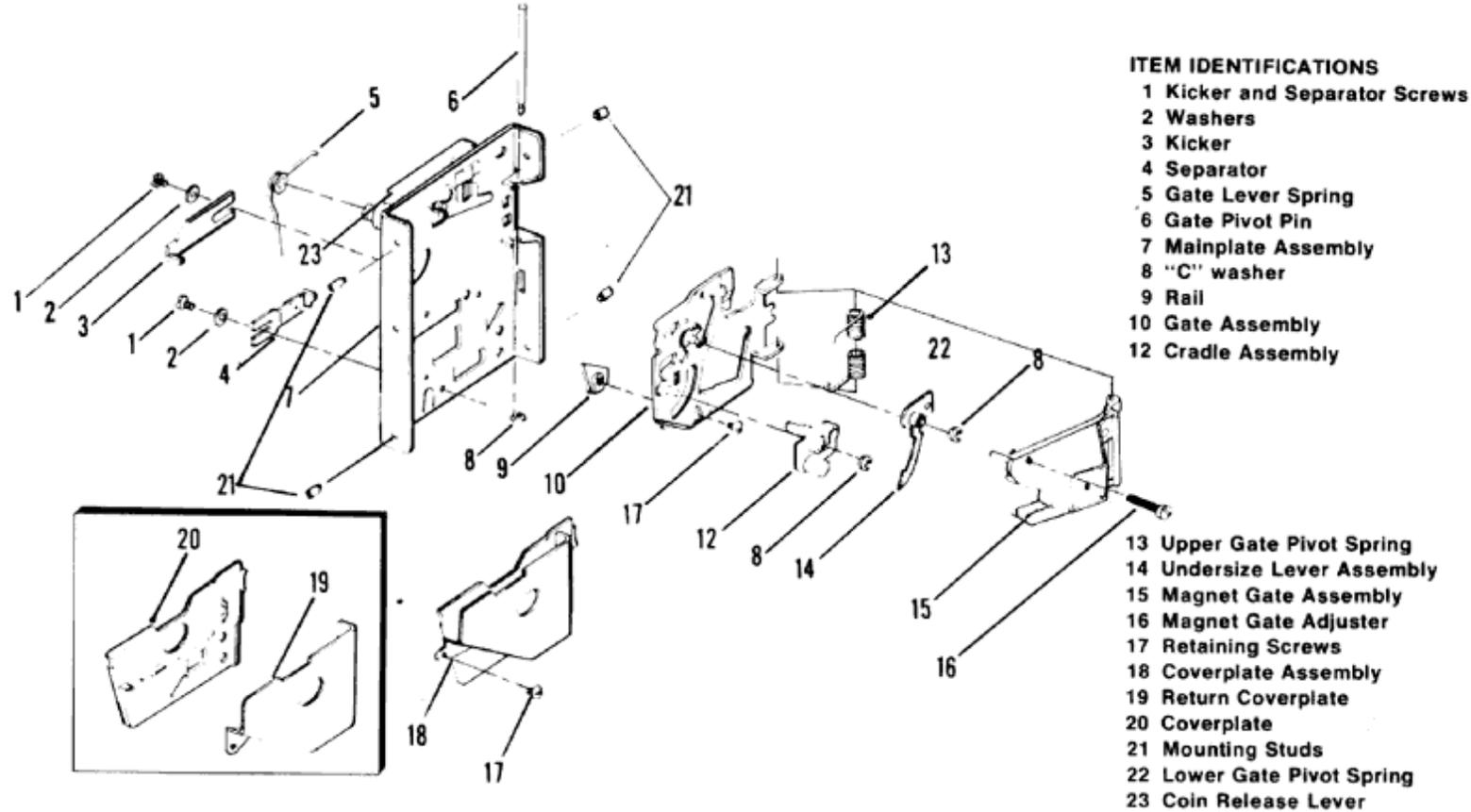


Figure 13 Detail View of Coin Switch and Trip Wire

Mechanical Adjustments on Coin Mechanism

Coin mechanisms are adjusted prior to shipment from the factory and normally will retain these adjustments for many months. If, due to wear or other causes, it becomes necessary to make new adjustments, remove the coin mechanism from the coin door, then take it to a clean well-lighted area where it can be placed in a vertical position on a level surface (such as a bench top). Besides a screwdriver you will need a set of several coins, including both new and old. Figure 14 shows an exploded view of the mechanism and gives procedures for adjusting the kicker, separator, and the magnet gate. These adjustments should only be done by someone who has experience in servicing coin mechanisms and who understands their operation.



Kicker and separator

1. Set the acceptor with the back of the unit facing you in the test position.
2. Loosen the kicker and separator screws (1) and move the kicker (3) and the separator (4) as far to the right as they will go. Lightly tighten the screws.
3. Insert several test coins (both old and new) and note that some are returned by striking the separator.
4. Loosen the separator screw and move the separator a slight amount to the left. Lightly retighten the screw.
5. Insert the test coins again and, if some are still returned, repeat Step 4 until all the coins are accepted.
6. Loosen the kicker screw and move the kicker as far to the left as it will go. Lightly retighten the screw.
7. Insert the test coins and note that some are returned.
8. Loosen the kicker screw and move the kicker a slight amount to the right. Lightly retighten the screw.
9. Insert the test coins again and, if some are still returned, repeat Step 8 until all the coins are accepted.
10. Be sure that both screws are tight after the adjustments have been made.

Magnet gate

1. Set the acceptor with the front of the unit facing you in the test position.
2. Turn the magnet gate adjusting screw (16) out or counterclockwise until none of the coins will fit through.
3. With a coin resting in the acceptor entrance, turn the adjuster in or clockwise until the coin barely passes through the magnet gate.
4. Test this adjustment using several other coins (both old and new) and, if any fail to pass through the magnet gate, repeat Step 3 until all the coins are accepted.
5. Fix the magnet gate adjusting screw in this position with a drop of glue.

Additional Cleaning

- 1) Remove the transfer cradle (12) and the undersize lever (14).
- 2) Use a pipe cleaner or similar effective cleaning tool to clean the bushings and pivot pins.
- 3) Replace the transfer cradle and the undersize lever.
- 4) To be certain the coin mechanism is completely free of any residue, place the mechanism in a solution of boiling water and mild detergent for several minutes. Carefully remove it and let it air-dry completely before reinstalling in the door.

Figure 14: Coin Mechanism, Exploded View

Lubrication

Do not apply lubrication to the coin mechanisms. The only points that may need lubrication (and only rarely) are the shafts of the scavenger buttons (coin rejection buttons) where they pass through the coin door. Apply only one drop of light machine oil, and be positive that no oil drops down onto a coin mechanism. Figure 15 shows this lubrication point.

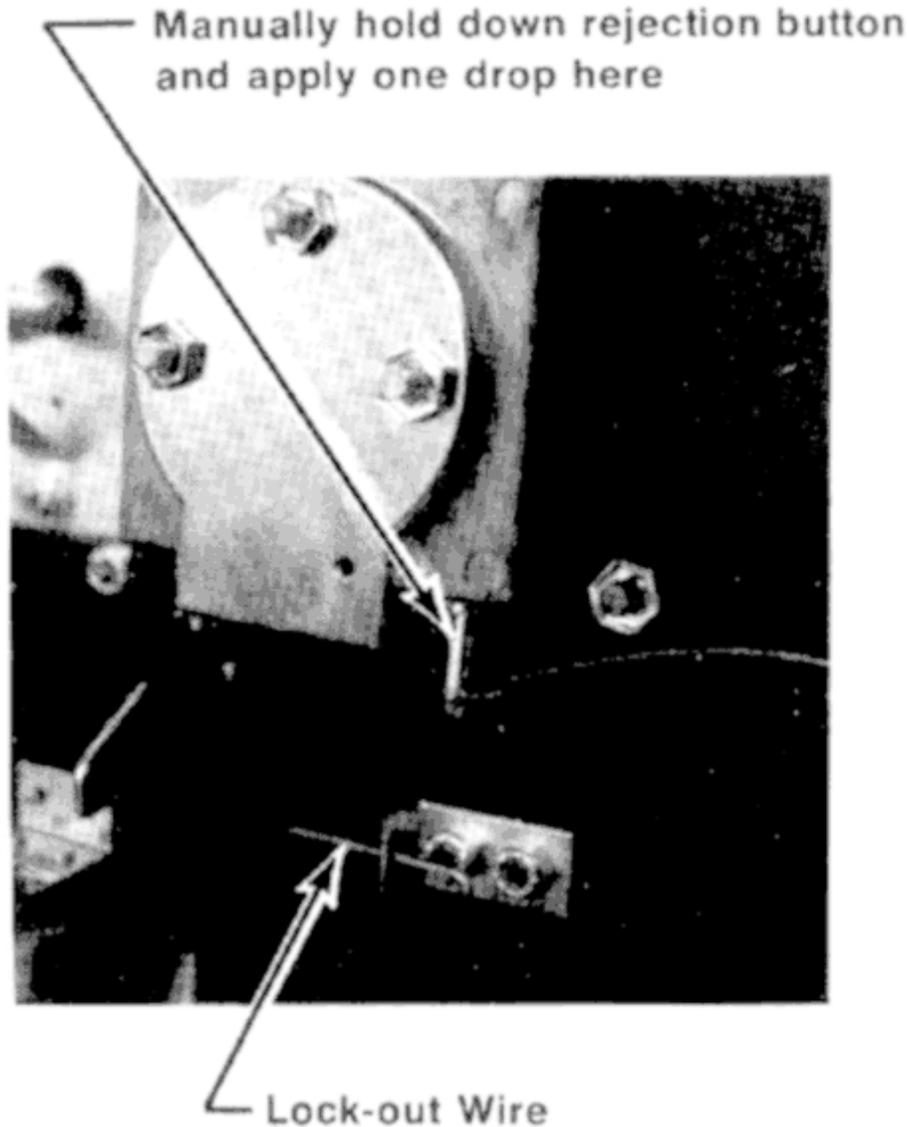


Figure 15: Close-up View of Lubrication Point

General Troubleshooting Hints

The first action is to look for jammed coins. After these have been removed examine the coin path for presence of foreign material or loose objects (such as chewing gum, small metallic objects, paper wads, etc.). In cases where game usage is heavy, it may be necessary to clean the entire coin path periodically, in order to prevent build-up of contaminants that can hinder the movement of coins through the mechanism. Also confirm that the trip wire on each coin switch is intact, and is properly adjusted. If troubles still persist, check the conditions and positions of the lock-out wires, and the mechanical adjustments on the coin mechanisms before suspecting the electronics. If a coin mechanism rejects genuine coins, try to readjust it. If this is not successful, then replace it with a working mechanism.

Correct operation of the slam switch can be verified by putting the game into the test mode and performing the switch test (described in Table 1). Correct operation of the other switches and of the lock-out coil can also be checked by the switch test, or else merely by manually operating them and watching game responses as it changes from the attract mode to play mode, and then back to attract mode again.

D. GAME CONTROLS AND PLAYFIELD COMPONENTS

Opening the cabinet and raising the playfield will give access to the playfield components and the game controls -- START pushbutton switch, flipper switches, pendulum tilt and cabinet tilt switches, Power On/Off Switch, speaker, and the ball shooter.

The game's microcomputer system improves game reliability and significantly reduces maintenance requirements because it replaces conventional electromechanical devices such as step-up rotary switches and motorized trip relay banks. Another game feature is that adjustment-free sealed-contact switches replace all open-contact blade-type switches.

Solenoid Fuses

Plugged onto connector J8 on the Processor PCB is a special miniature PCB assembly that provides individual fuses for each solenoid line. This assembly is identified by the Atari part number A020383. These fuses have been added to prevent the driver transistor from overheating and damaging the surface of the PCB if current flow starts to exceed the maximum fused value.

Whenever a fuse is found to be open, perform the following two checks before replacing the fuse. After making sure that AC power to the game is shut off, first use an ohmmeter to measure the solenoid's DC resistance. Flipper solenoids should have a DC resistance of approximately 7.7 ohms. Hole kickers should have a DC resistance of approximately 18 ohms. The gate solenoids should read approximately 200 ohms with ohmmeter connected in one direction and about 15 ohms with the instrument connected in other direction. Secondly, use the ohmmeter to check the collector-emitter junction of the 2N6044 driver transistor.

Replace only with 2 amp, 125 volts, slo-blo (3AG) fuses.

Troubleshooting of Playfield Switches Connected In Parallel

As described in Chapter 1, Section D, you can use the switch test both for automatically detecting switches with stuck contacts and for manually identifying switches with stuck contacts and for manually identifying switches whose contacts are not closing properly. But in the instance where contacts from two switches are connected in parallel, additional troubleshooting steps will be needed in order to verify whether or not a given switch is defective.

For example, switch test #39 simultaneously checks both inside and outside right lower ball lanes. To confirm whether just one or else both switches are defective, one at a time you must temporarily unsolder the wire to the normally open contact of each switch, while leaving the other switch still connected then perform the switch test separately for each switch connected alone.

Wiring connections to the playfield switches are shown in Chapter 4 in the Wiring Diagram, Sheet 2.

E. GAS-DISCHARGE DISPLAYS

The displays are designed to be maintenance free, so they normally require attention only if incorrect operation is observed. Use the following procedures to isolate and correct problems with the displays.

Preliminary Operational Checks

Make sure that the coin door is closed and locked, Then plug in the power cord and place the Power On/Off Switch in its on position. Immediately after AC power is applied, the Score Display should be showing all 8s and the PLAYER UP indications 1ST UP, 2ND UP, etc.) light one at a time, in numerical sequence. All 8s should be showing in the Credit Display and the Match/Ball Display.

The displays are all operating properly if every display segments lights up at least once. But if one or more segments remain dark, isolate the problem circuitry as described in the following subsection.

Check on +90 and -90 Volts Power Supply Voltages

Remove the playfield glass, then remove the lower arch panel. Troubleshoot the displays as follows:

WARNING: Whenever AC power is applied to the game, voltage potential differences as large as 180 volts are present at the bare terminals of the score panel's edge connector J21, and at various other points on both printed circuit boards.

1. Defeat the Interlock Safety Switch by pulling all the way out on the switch's spring-loaded plunger.
2. Place the Power On/Off Switch in the on position.
3. Connect a voltmeter across the following capacitors shown in Figure 16, and check for the readings listed below:

On Match/Credit Display PCB, place meter's ground lead on "plus" side of C2; other lead placed on "plus" side of C1 gives +90 volts reading, and on "minus" side of C2 gives -90 volts reading.

On Score Panel PCB, place ground lead on "plus" side of C2; other lead on "plus" side of C1 gives +90 volts reading, and on "minus" side of C2 gives -90 volts reading.

4. If one or more readings are low (or at zero volts), check each PCB separately as follows. Disconnect J19 and re-measure the voltages on the Score PCB. If the voltages are OK, then some portion of the circuitry on the Match/Credit Display PCB is pulling down the supply voltages. If the voltages are still incorrect, reconnect J19, disconnect J17, and re-measure the voltages on the Match/Credit Display PCB. If voltages are OK, then some portion of the circuitry on the Score Display PCB is pulling down the supply voltages. If the voltages remained incorrect while each board was checked separately, leave J17 and J19 both disconnected. Then check the +90 volt and -90 volt outputs on the Auxiliary PCB (where the high voltage power supply circuitry is located). These 90-volt supply voltages must both be present on each display PCB before the displays can light up.

If all voltage readings on the display PCBs are within 5% of the correct values, then go on to the next portion of the procedure.

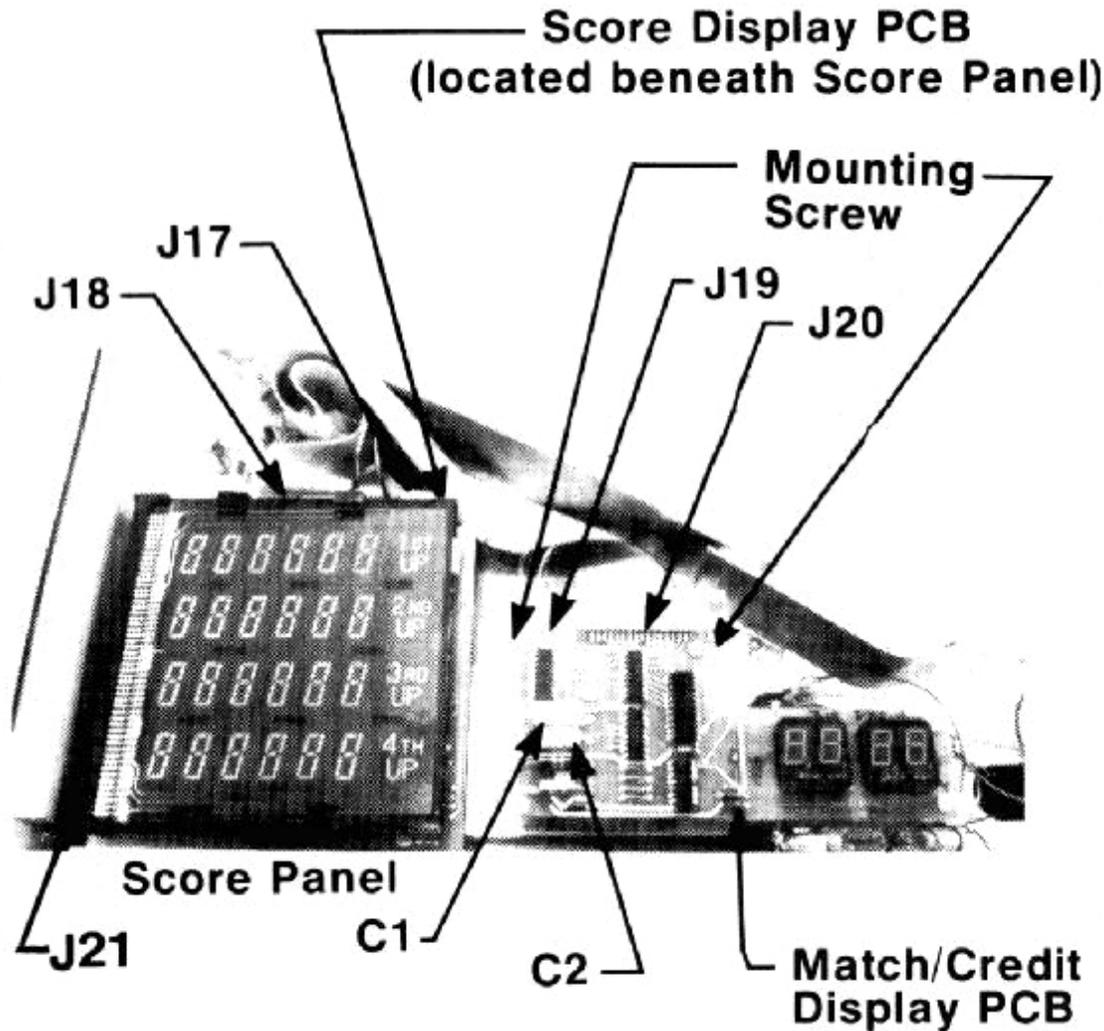


Figure 16: Top View of Score and Match/Credit Display Assembly

Score Panel Removal and Visual Checks

After the +90 volt and -90 volt supply voltages have been verified, the next troubleshooting step on the score panel will be to remove it from connector J21.

1. Turn off AC power to the game, preferably by pulling out the power plug from the wall outlet.
2. Remove the metal clips holding the score panel onto the bracket arms of J21 (refer to Figure 17).
WARNING: Glass edges of score panel may be sharp. Use caution to prevent cutting your hands.
3. Using your right hand, grasp the right edge of the score panel. Carefully lift it up approximately 1/4-inch, and then pull it straight out and remove it completely.
4. Examine the positions of the terminal pins on J21. Tips of the pins should be aligned in the same plane, as shown in the detail view of Figure 17. If not bent out of alignment, all pins can then make contact with the score panel's terminal strips when the panel is plugged in.

5. Next examine the condition of the terminal strips on the score panel. If the surfaces of the strips are corroded, use a pencil eraser to clean them off. Be careful, however, not to rub the eraser against any of the tiny metal ribbons touching certain strips up near the glass (refer to Figure 18). These ribbons must be perfectly centered over the correct pins, not halfway off.

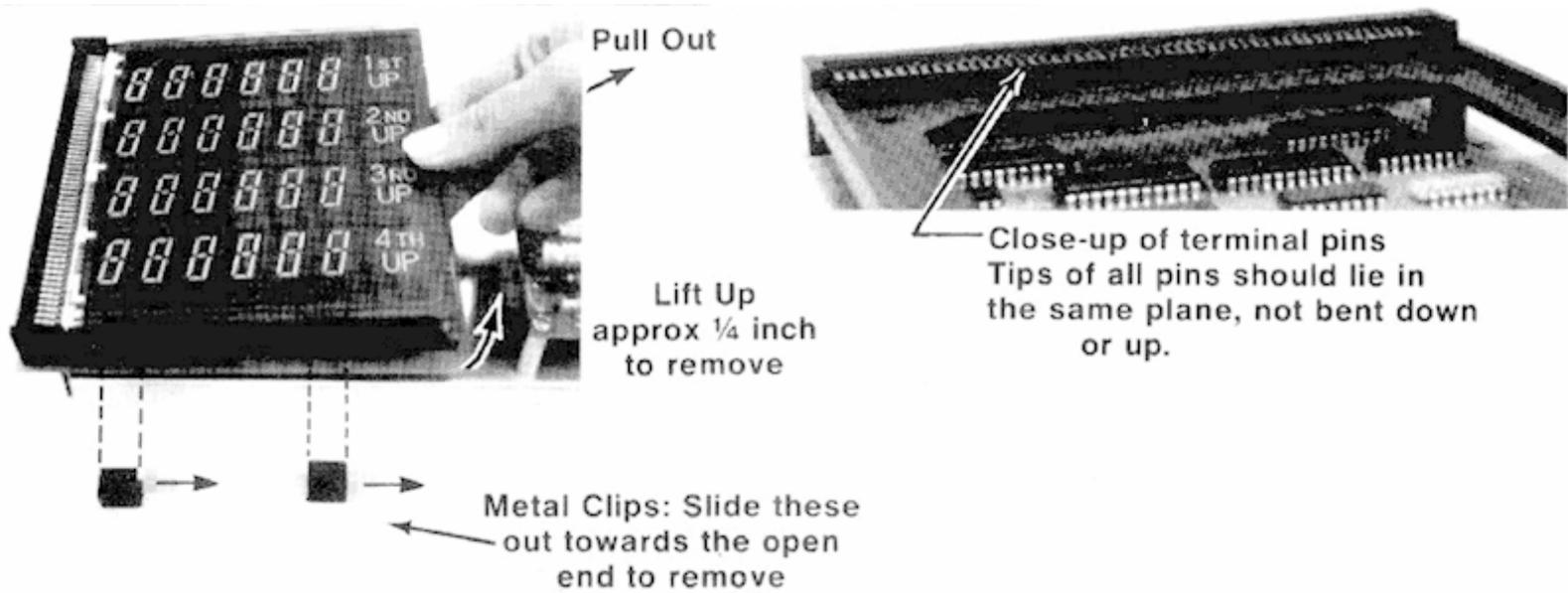


Figure 17: Removal of Score Panel

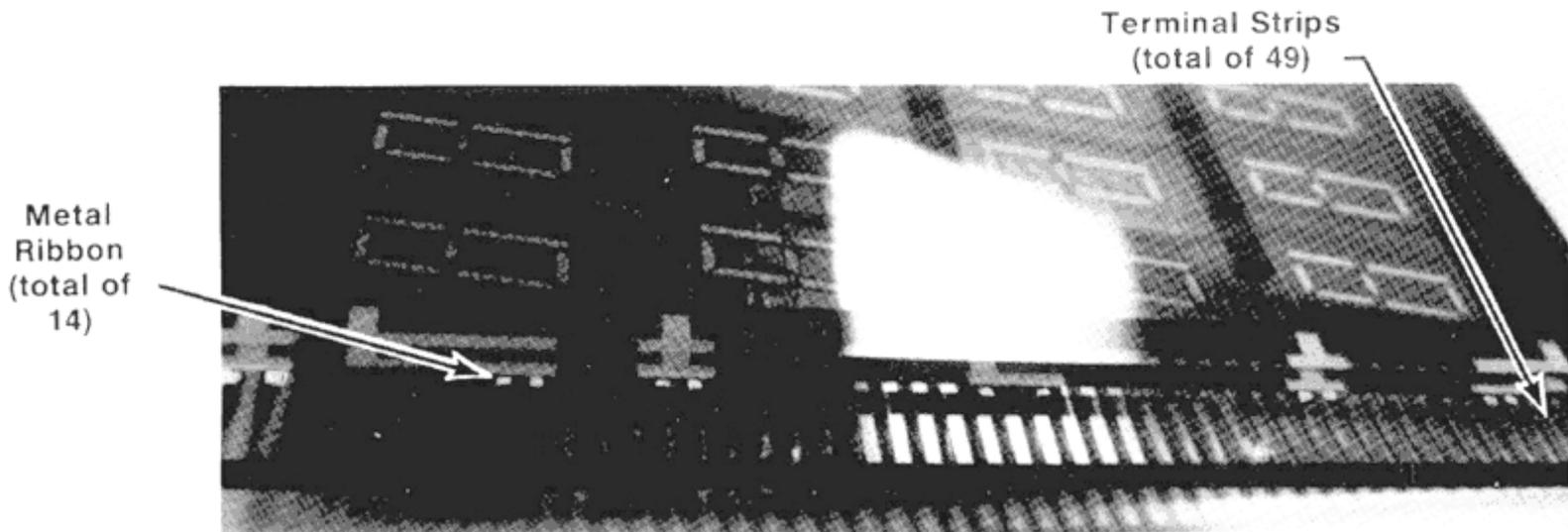
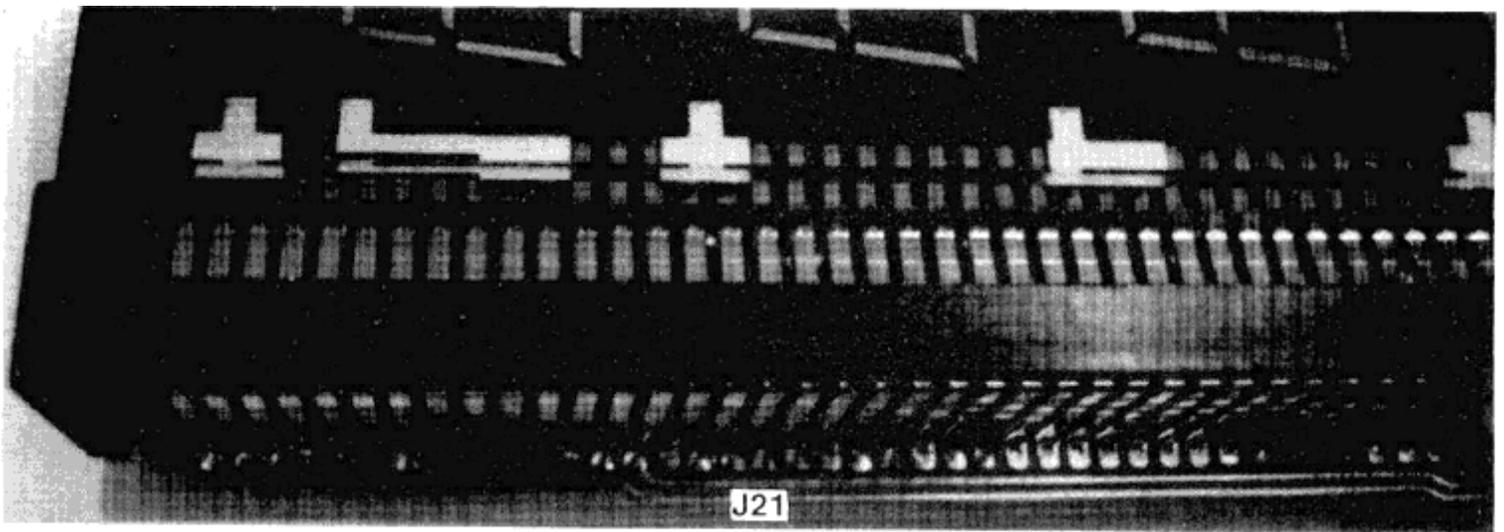


Figure 18: Score Panel Terminals

Replacement of Score Panel

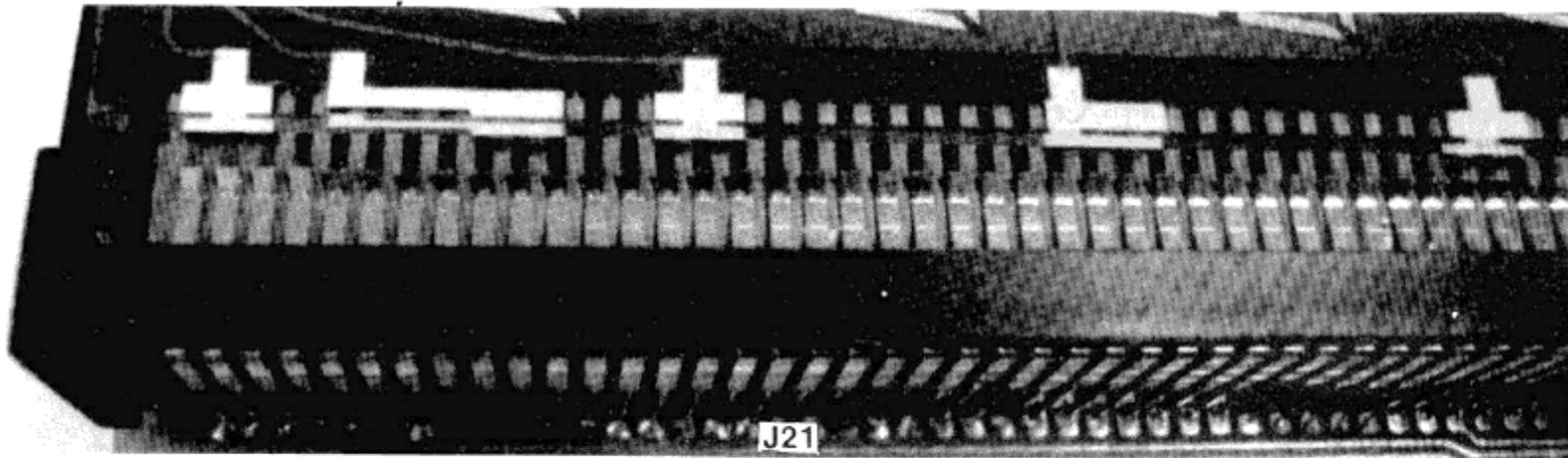
After the visual checks have been made on the J21 terminal pins and on the score panel the original score panel can be put back, or else a new score panel can be substituted in its place, Carefully observe the following procedure when replacing the score panel.

1. Using both hands, grasp the right-hand edge of the panel and carefully slide it fully into connector J21, perfectly aligned. Then lower the edge down until the entire panel rests in the bracket arms. You will note some free space on each side between the panel and the brackets. At the factory a rubbery substance called RTV was placed between the bracket and the score panel. This substance provides a cushion between the glass panel and the metal arms, and positions the panel so that connector J21's terminal pins line up exactly with the panel's terminal strips. Be sure that they are aligned correctly as shown in Figure 19.
2. Replace the metal clips that fasten the score panel to the bracket arms.



CORRECT

Note that terminal strips of Score Panel do line up with terminal pins in score panel connector.



WRONG

Note that terminal strips of Score Panel do not line up with terminal pins.

Figure 19: Line-up of Terminal Pins and Terminal Strips

Removing Display Assembly

Certain portions of the PCBs are accessible for troubleshooting when the display assembly is left mounted on the playfield. However, to gain access to the remaining portions, or to replace components or an entire PCB, use the following procedure.

1. Turn off AC power to the game, preferably by pulling out the power plug.
2. Disconnect connectors J17, J18, J19, and J20.
3. Use a Phillips-head screwdriver to loosen the four screws that fasten the display assembly to the playfield, and then remove the screws.
4. Lift the entire assembly up and remove it from the playfield.

Installing the Display Assembly

After repair and/or replacement of the display boards and displays, use the following procedure to re-attach the assembly to the playfield.

1. Lower the assembly down into its final position and line up the four mounting holes with their mating holes in the playfield. Be careful not to pinch the lamp wires that are routed through a slot at the lower right corner of the assembly (refer to Figure 20).
2. Insert the four mounting screws and use a Phillips-head screwdriver to tighten them down.
3. Connect connectors J17, J18, J19, and J20.

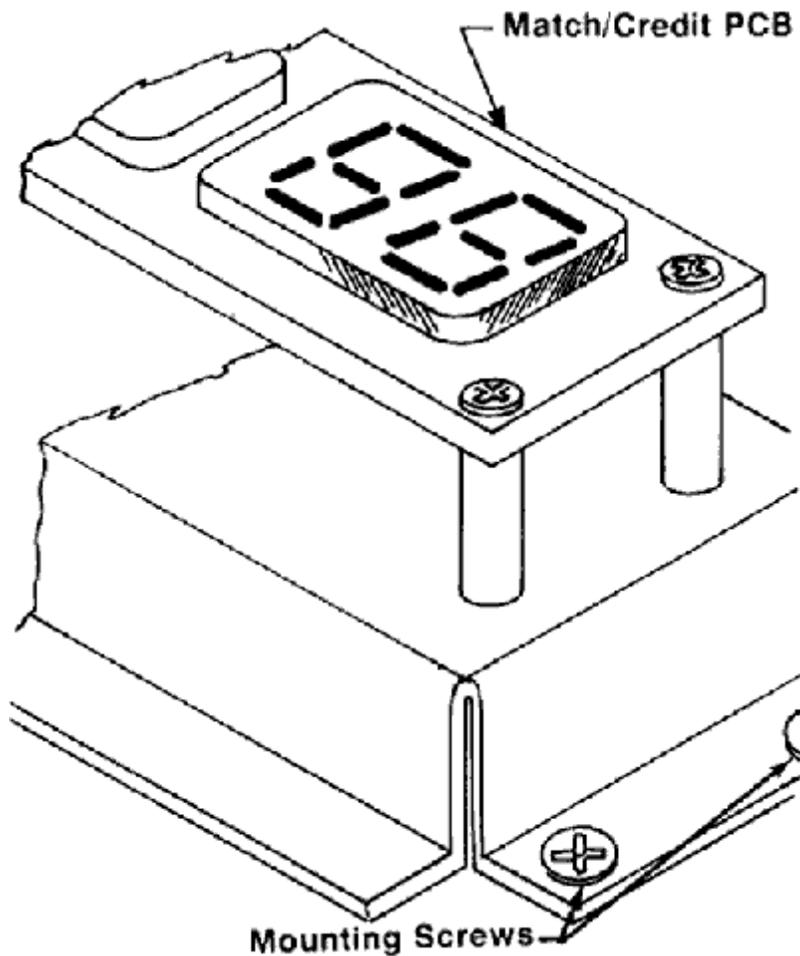


Figure 20: Lower Right Corner of Display Assembly

F. LAMP REPLACEMENT

To insure continued player appeal to the game, you should periodically check for burned-out playfield and back box lamps, and replace defective ones immediately.

Playfield Lamps

CAUTION: When replacing playfield lamps use #47 bulbs only; other bulb types may cause damage to the lamp driver circuits.

If you suspect a burned out lamp, replace lamp with in neighboring "known to be good" lamp. This will establish whether the lamp is bad or a bad lamp socket or lamp driver.

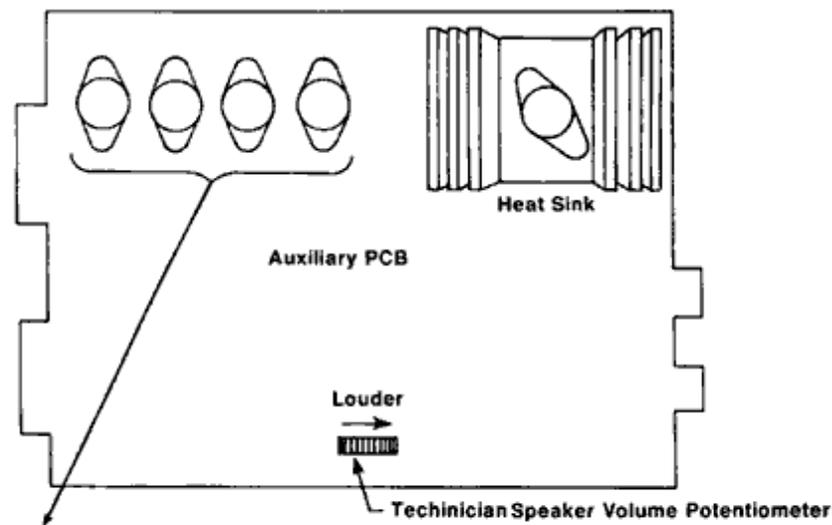
WARNING: Make sure game power is turned off before replacing lamps. This is especially important if the lower arch panel has to be removed to gain access to the lamps beneath it. Whenever AC power is applied to the game, voltage potential differences as large as 180 volts are present at the bare terminals of the score panel's edge connector J21, and at various other points on both display printed circuit boards.

Back Box Lamps

When replacing these lamps use 7.5-watt bulbs. If the lamp is to flash on and off, remember to place a flasher unit (button-shaped disc) in the socket before inserting and tightening down the bulb.

G. ADJUSTMENT OF SPEAKER VOLUME

Airborne Avenger contains two volume controls. One is conveniently mounted inside the cabinet so the operator may adjust the volume without raising the playfield. The other volume control is mounted on the Auxiliary PCB (see Figure 21) and should never be adjusted after being set once.



WARNING
 There is a differential voltage of 180 volts DC between these transistors. Use caution to prevent the hazard of electrical shock.

Figure 21: Location of Technician Adjustment for Speaker Volume

WARNING: Dangerous voltages are present on the Auxiliary PCB. Use extreme caution, while adjusting the adjusting the Auxiliary PCB volume control, to prevent the hazard of electrical shock.

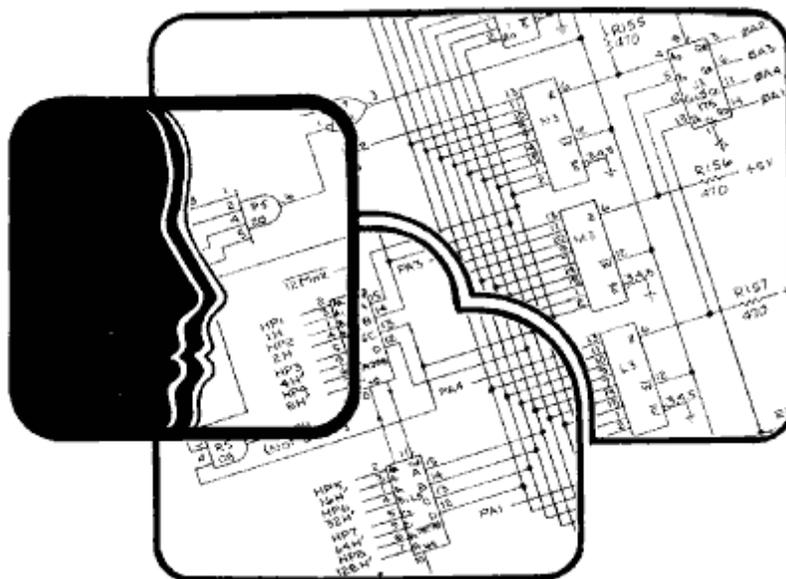
CAUTION: The heat sink on the Auxiliary PCB gets quite hot when the game is turned on. Use caution, while adjusting the Auxiliary PCB volume control, to prevent burning your hand on this heat sink.

To adjust the game volume, first rotate the volume control, mounted inside the cabinet above and to the right of the game speaker, to its mid position. Then adjust the potentiometer on the Auxiliary PCB for maximum volume without distortion. All volume adjustments should now only be done with the control mounted inside the game cabinet.

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CHAPTER 4: THEORY OF OPERATION

A. INTRODUCTION

The block diagram in Figure 22 shows the game's major functional elements and depicts their interconnections. The central element is the microcomputer, which consists of a microprocessor, memories and control logic.

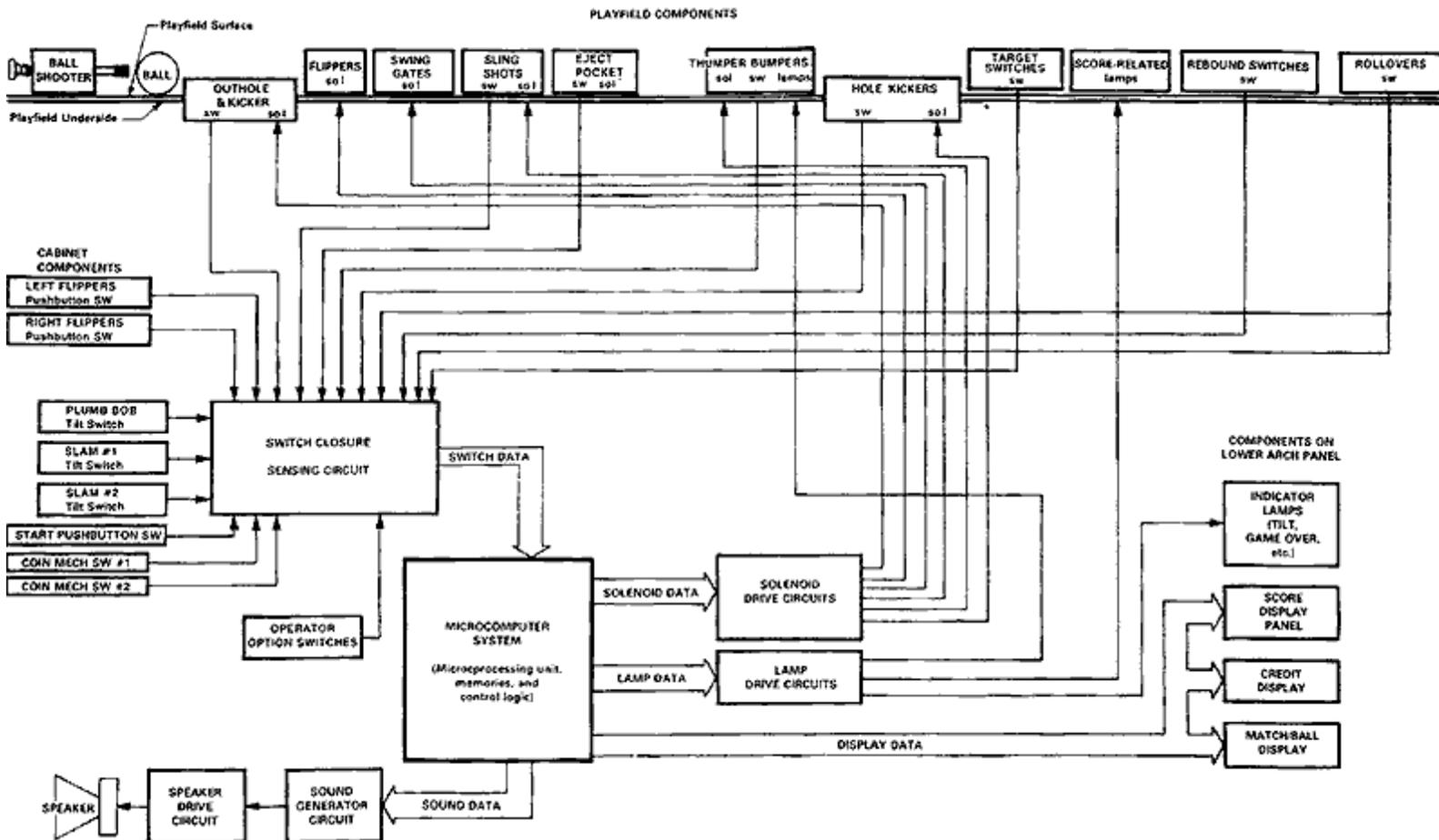
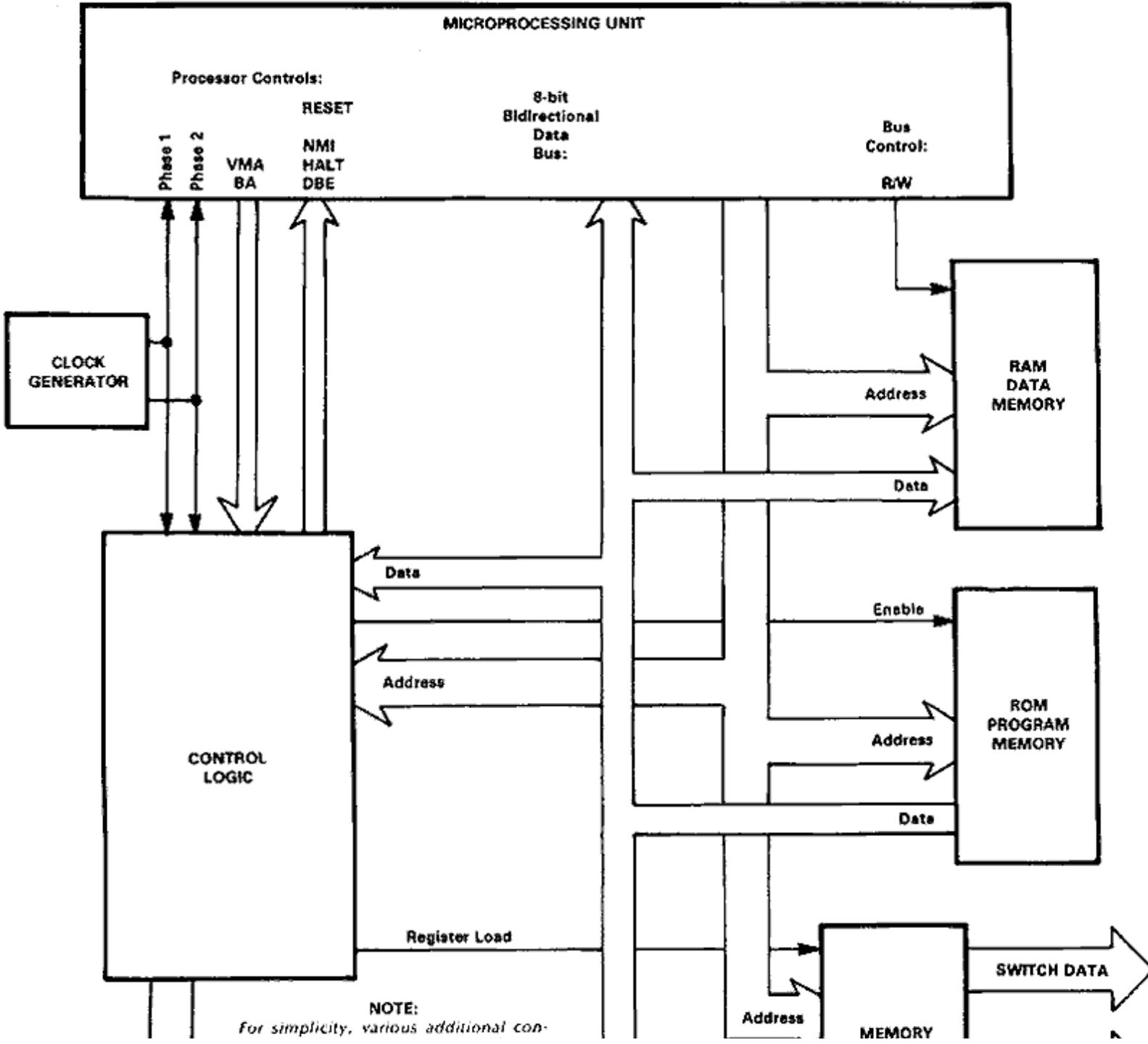


Figure 22: Functional Block Diagram

By means of a switch sensing circuit, the player operated switches, playfield switches and operator option switches produce switch data for the microcomputer. Switch closures occur when a player deposits money in the game, depresses the START pushbutton, operates the ball shooter so the ball goes onto the playfield and interacts with playfield objects, and depresses the flipper buttons. Switch Closures also result when a player tilts the game. Executing the instructions stored in the preprogrammed portion of its memory, the microcomputer then responds to the switch data by energizing various solenoids, lighting various lamps, and producing sound data for the speaker and display data for the Score, Credit and Ball/Match Displays.

B. COMPONENTS OF THE MICROCOMPUTER SYSTEM

The microcomputer system carries out complex tasks of the game by performing a large number of simple tasks. Figure 23 shows a block diagram of the microcomputer system and its various interconnecting data, addressing and control buses. The Microprocessing Unit causes the system to perform the desired operations by addressing the Program Memory for an instruction (via the Address Bus), reading that instruction (via the bidirectional Data Bus), and then executing the simple task dictated by that instruction. The Microprocessing Unit uses the Data Memory for temporary storage of data necessary for the execution of future instructions, such as arithmetic operations. The Microprocessing Unit uses the Memory Output Latches for storing the data that is used for producing game sounds energizing solenoids and lighting lamps.



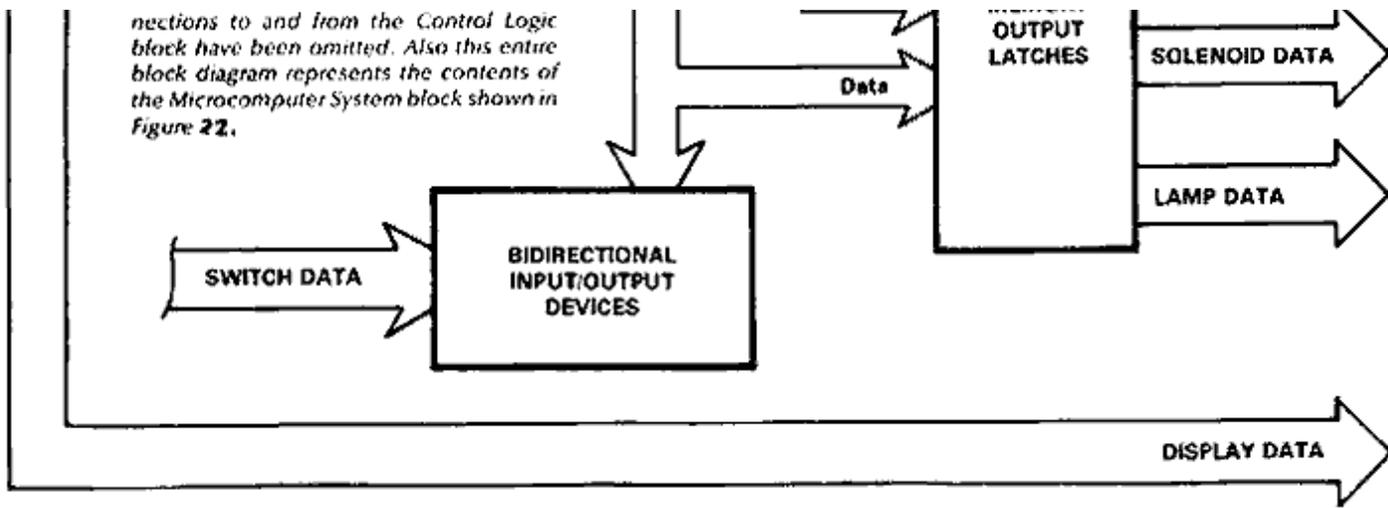
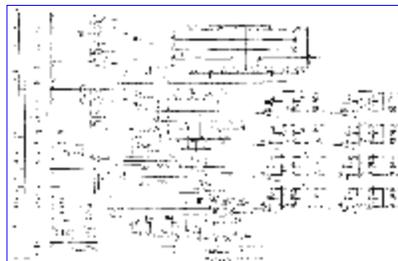


Figure 23: Block Diagram of Microcomputer System



Figure 24: Airborne Avenger Wiring Diagram (2 pages)
Click thumbnails for full-sized versions.

The following paragraphs describe the game's microcomputer system in more detail. The drawing references are to the Processor PCB schematic shown in Figures 25 and 26.



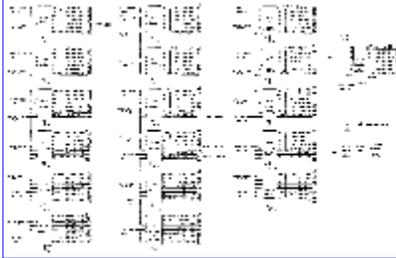
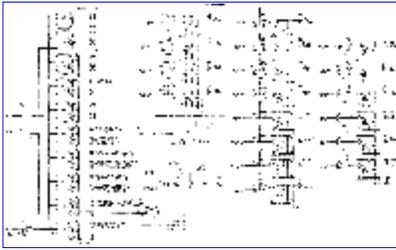


Figure 25-A: Processor PCB Schematic Diagram (4 pages)
Click thumbnails for full-sized versions.

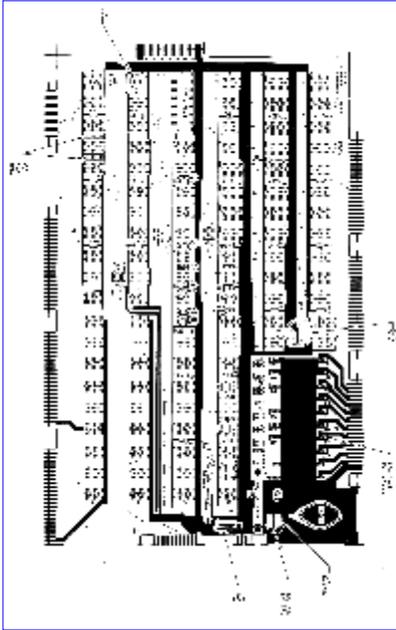


Figure 25-B: Processor PCB Assembly Drawing
Click thumbnail for full-sized version.

Figure 25-C: Processor PCB Assembly Parts List

Item	Part Number	Qty.	Description	
1	006021-01	1	Printed Circuit Board	
2	10-5201	15	Res., Car Comp., 1/4W, 5% 200 OHM	R6-11, 13-20, 23
3	10-5471	5	Res., Car Comp., 1/4W, 5% 470	R27-29, 31, 32
4	10-5102	7	Res., Car Comp., 1/4W, 5% 1K	R2-5, 26, 33, 36
5	10-5822	1	Res., Car Comp., 1/4W, 5% 8.2K	R35
6	10-5223	1	Res., Car Comp., 1/4W, 5% 22K	R34
7	10-5105	1	Res., Car Comp., 1/4W, 5% 1M	R30
8				
9	19-007	2	Res., Network 10K	A3/4, A4/5
10	19-808W4P0	1	Res., Wirewound, 10W, 4 OHM	R1

11				
12	24-250227	1	Cap, Elecrolitic, 220uf, 25V	C2
13	27-250104	27	Cap, Ceramic, 0.1uf, 25V	C3, 5, 9-33
14	28-101390	3	Cap, Mica, 39pf, 100V	C4, 6, 8
15	28-101151	1	Cap, Mica, 150pf, 100V	C7
16	29-006	1	Cap, Tantalum, 1uf, 35V	C1
17	29-007	1	Cap, Tantalum, 22uf, 15V	C34
18				
19	31-1N914 Diode,	16	1N914	CR2-16, 19
20	32-P6KE18	1	Diode, Transient Supp. P6KE18	CR1
21	34-2N6044	15	Transistor, 2N6044	Q1-8, 11-13, 15-17, 20
22	34-2N3643	1	Transistor, 2N3643	Q21
23	37-7400	3	I.C. 7400	D10, A1, F1
24	37-7402	2	I.C. 7402	A2, C7
25	37-7403	1	I.C. 7403	D9
26	37-7404	2	I.C. 7404	D4, E10
27	37-74L04	1	I.C. 74L04	D11
28	37-7407	4	I.C. 7407	D14, D16,D18, D20
29	37-7408	3	I.C. 7408	B2, D2, D3
30	37-74LS08	2	I.C. 74LS08	B/C8, C/D8
31	37-7414	3	I.C. 7414	B11, C9,E9
32	37-7420	1	I.C. 7420	B8
33	37-7427	1	I.C. 7427	B7
34	37-7432	1	I.C. 7432	C8
35	37-7437	1	I.C. 7437	C10
36	37-7474	2	I.C. 7474	B6, B9
37	37-7493	10	I.C. 7493	A6, A7, A8, A9, A10, A11, B3, C11,E12, E13
38	37-74145	8	I.C. 74145	F3, F5, F6, F9, F10, F11, F12, F13
39	37-74157	1	I.C. 74157	B5
40	37-8097	2	I.C. 8097	C4, C5
41	37-9301	2	I.C. 9301	C6, E11
42	37-9316	2	I.C. 9316	B4, D13
43	37-9321	1	I.C. 9321	D1
44	37-9334	8	I.C. 9334	C13, C14, C15, C16, C17, C18, C19, C20
45	37-9602	1	I.C. 9602	B10
46	37-LM323	1	Regulator LM323	
47	37-MC1413	10	I.C. MC1413 (2003A)	A16, A17, A18, A19, A20, B16, B17, B18, B19, B20
48	37-MC14050	3	I.C. MC14050	A3, A4, A5
49				
50				
51	62-001	1	Switch, Push Button SPST	
52	66-118P1T	2	Switch, Dip, 8 Position	F2, F4
53	66-12FP1T	1	Switch, Hex	
54	72-1608S	2	Screw, Mach., Pan Hd. Phil. #6-32 x 1/2"	
55	75-016	2	Washer, Flat #6	
56	75-056	2	Washer, Lock, Int. Tooth #6	
57	75-916C	2	Nut, Hex #6-32	
58	78-06001	1	Heatsink, LM323	
59	78-16005	1	Silpad	

60				
61				
62	79-42040	1	Socket, 40 Position, Med Insertion	C1
63	79-58122	1	Header, 4 Pin	J9
64	90-108	1	Crystal, 4.000 MHZ	Y1
65	90-6001	1	I.C.	C1
66	90-7015	2	Ram, 2111A	D5, D8
67				
68				
69	020244-01	1	Program Prom 1LSB	E1
70	020250-01	1	Program Prom 1MSB	E7
71	020245-01	1	Program Prom 2LSB	E2
72	020251-01	1	Program Prom 2MSB	E8
73	020247-01	1	Program Prom 3LSB	E4
74	020248-01	1	Program Prom 3MSB	E5
75	020246-01	1	Program Prom 4LSB	E3
76	020249-01	1	Program Prom 4MSB	E6
77	020252-01	1	Audio Prom	D12

Figure 25-C: Processor PCB Assembly Parts List

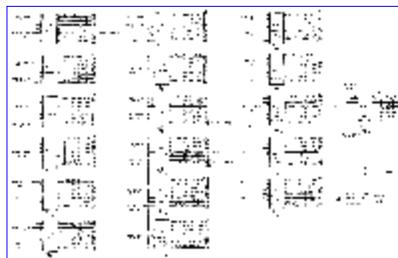
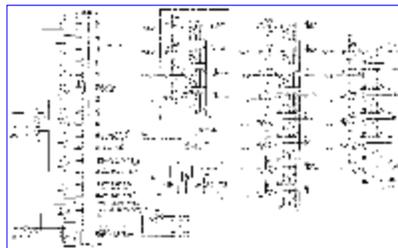


Figure 26-A: Processor PCB Schematic Diagram (4 pages)
 Click thumbnail for full-sized version.

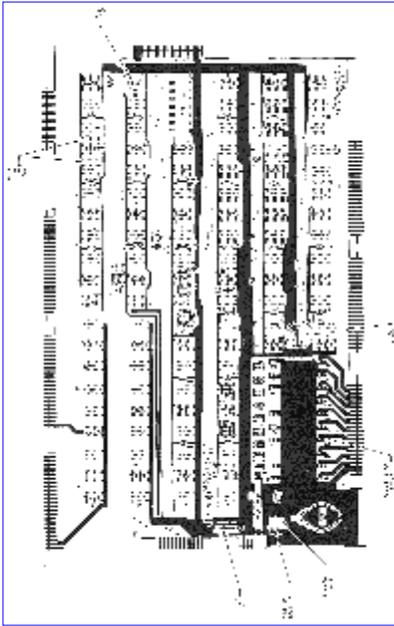


Figure 26-B: Processor PCB Assembly Drawing
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Figure 26-C: Processor PCB Assembly Parts List				
Item	Part Number	Qty.	Description	
1	006021-01	1	Printed Circuit Board	
2	10-5201	15	Res., Car Comp., 1/4W, 5% 200 OHM	R6-11, 13-20, 23
3	10-5471	5	Res., Car Comp., 1/4W, 5% 470	R27-29, 31, 32
4	10-5102	7	Res., Car Comp., 1/4W, 5% 1K	R2-5, 26, 33, 36
5	10-5822	1	Res., Car Comp., 1/4W, 5% 8.2K	R35
6	10-5223	1	Res., Car Comp., 1/4W, 5% 22K	R34
7	10-5105	1	Res., Car Comp., 1/4W, 5% 1M	R30
8				
9	19-007	2	Res., Network 10K	A3/4, A4/5
10	19-808W4P0	1	Res., Wirewound, 10W, 4 OHM	R1
11				
12	24-250227	1	Cap, Electrolytic, 220uf, 25V	C2
13	27-250104	27	Cap, Ceramic, 0.1uf, 25V	C3, 5, 9-33
14	28-101390	3	Cap, Mica, 39pf, 100V	C4, 6, 8
15	28-101151	1	Cap, Mica, 150pf, 100V	C7
16	29-006	1	Cap, Tantalum, 1uf, 35V	C1
17	29-007	1	Cap, Tantalum, 22uf, 15V	C34
18				
19	31-1N914 Diode,	16	1N914	CR2-16, 19
20	32-P6KE18	1	Diode, Transient Supp. P6KE18	CR1
21	34-2N6044	15	Transistor, 2N6044	Q1-8, 11-13, 15-17, 20
22	34-2N3643	1	Transistor, 2N3643	Q21
23	37-7400	3	I.C. 7400	D10, A1, F1
24	37-7402	2	I.C. 7402	A2, C7
25	37-7403	1	I.C. 7403	D9
26	37-7404	2	I.C. 7404	D4, E10
27	37-74L04	1	I.C. 74L04	D11

28	37-7407	4	I.C. 7407	D14, D16,D18, D20
29	37-7408	3	I.C. 7408	B2, D2, D3
30	37-74LS08	2	I.C. 74LS08	B/C8, C/D8
31	37-7414	3	I.C. 7414	B11, C9,E9
32	37-7420	1	I.C. 7420	B8
33	37-7427	1	I.C. 7427	B7
34	37-7432	1	I.C. 7432	C8
35	37-7437	1	I.C. 7437	C10
36	37-7474	2	I.C. 7474	B6, B9
37	37-7493	10	I.C. 7493	A6, A7, A8, A9, A10, A11, B3, C11,E12, E13
38	37-74145	8	I.C. 74145	F3, F5, F6, F9, F10, F11, F12, F13
39	37-74157	1	I.C. 74157	B5
40	37-8097	2	I.C. 8097	C4, C5
41	37-9301	2	I.C. 9301	C6, E11
42	37-9316	2	I.C. 9316	B4, D13
43	37-9321	1	I.C. 9321	D1
44	37-9334	8	I.C. 9334	C13, C14, C15, C16, C17, C18, C19, C20
45	37-9602	1	I.C. 9602	B10
46	37-LM323	1	Regulator LM323	
47	37-MC1413	10	I.C. MC1413 (2003A)	A16, A17, A18, A19, A20, B16, B17, B18, B19, B20
48	37-MC14050	3	I.C. MC14050	A3, A4, A5
49				
50				
51	62-001	1	Switch, Push Button SPST	
52	66-118P1T	2	Switch, Dip, 8 Position	F2, F4
53	66-12FP1T	1	Switch, Hex	
54	72-1608S	2	Screw, Mach., Pan Hd. Phil. #6-32 x 1/2"	
55	75-016	2	Washer, Flat #6	
56	75-056	2	Washer, Lock, Int. Tooth #6	
57	75-916C	2	Nut, Hex #6-32	
58	78-06001	1	Heatsink, LM323	
59	78-16005	1	Silpad	
60				
61				
62	79-42040	1	Socket, 40 Position, Med Insertion	C1
63	79-58122	1	Header, 4 Pin	J9
64	90-108	1	Crystal, 4.000 MHZ	Y1
65	90-6001	1	I.C.	C1
66	90-7015	2	Ram, 2111A	D5, D8
67				
68				
69	020244-01	1	Program Prom 1LSB	E1
70	020250-01	1	Program Prom 1MSB	E7
71	020245-01	1	Program Prom 2LSB	E2
72	020251-01	1	Program Prom 2MSB	E8
73	020247-01	1	Program Prom 3LSB	E4
74	020248-01	1	Program Prom 3MSB	E5
75	020246-01	1	Program Prom 4LSB	E3
76	020249-01	1	Program Prom 4MSB	E6

77	020252-01	1	Audio Prom	D12
78				
79				
80	37-74S00	2	I.C. 74S00A	F0, F1

Figure 26-C: Processor PCB Assembly Parts List

Figure 26-D: Processor PCB Parts List				
Item	Part Number	Qty.	Description	
1	006021-01	1	Printed Circuit Board	
2	10-5201	15	Res., Car Comp., 1/4W, 5% 200 OHM	R6-11, 13-20, 23
3	10-5471	5	Res., Car Comp., 1/4W, 5% 470	R27-29, 31, 32
4	10-5102	7	Res., Car Comp., 1/4W, 5% 1K	R2-5, 26, 33, 36
5	10-5822	1	Res., Car Comp., 1/4W, 5% 8.2K	R35
6	10-5223	1	Res., Car Comp., 1/4W, 5% 22K	R34
7	10-5105	1	Res., Car Comp., 1/4W, 5% 1M	R30
8				
9	19-007	2	Res., Network 10K	A3/4, A4/5
10	19-808W4P0	1	Res., Wirewound, 10W, 4 OHM	R1
11				
12	24-250227	1	Cap, Elecrolitic, 220uf, 25V	C2
13	27-250104	27	Cap, Ceramic, 0.1uf, 25V	C3, 5, 9-33
14	28-101390	3	Cap, Mica, 39pf, 100V	C4, 6, 8
15	28-101151	1	Cap, Mica, 150pf, 100V	C7
16	29-006	1	Cap, Tantalum, 1uf, 35V	C1
17	29-007	1	Cap, Tantalum, 22uf, 15V	C34
18				
19	31-1N914 Diode,	16	1N914	CR2-16, 19
20	32-P6KE18	1	Diode, Transient Supp. P6KE18	CR1
21	34-2N6044	15	Transistor, 2N6044	Q1-8, 11-13, 15-17, 20
22	34-2N3643	1	Transistor, 2N3643	Q21
23	37-7400	3	I.C. 7400	D10, A1, F1
24	37-7402	2	I.C. 7402	A2, C7
25	37-7403	1	I.C. 7403	D9
26	37-7404	2	I.C. 7404	D4, E10
27	37-74L04	1	I.C. 74L04	D11
28	37-7407	4	I.C. 7407	D14, D16,D18, D20
29	37-7408	3	I.C. 7408	B2, D2, D3
30	37-74LS08	2	I.C. 74LS08	B/C8, C/D8
31	37-7414	3	I.C. 7414	B11, C9,E9
32	37-7420	1	I.C. 7420	B8
33	37-7427	1	I.C. 7427	B7
34	37-7432	1	I.C. 7432	C8
35	37-7437	1	I.C. 7437	C10
36	37-7474	2	I.C. 7474	B6, B9
37	37-7493	10	I.C. 7493	A6, A7, A8, A9, A10, A11, B3, C11,E12, E13
38	37-74145	8	I.C. 74145	F3, F5, F6, F9, F10, F11, F12, F13
39	37-74157	1	I.C. 74157	B5
40	37-8097	2	I.C. 8097	C4, C5
41	37-9301	2	I.C. 9301	C6, E11

42	37-9316	2	I.C. 9316	B4, D13
43	37-9321	1	I.C. 9321	D1
44	37-9334	8	I.C. 9334	C13, C14, C15, C16, C17, C18, C19, C20
45	37-9602	1	I.C. 9602	B10
46	37-LM323	1	Regulator LM323	
47	37-MC1413	10	I.C. MC1413 (2003A)	A16, A17, A18, A19, A20, B16, B17, B18, B19, B20
48	37-MC14050	3	I.C. MC14050	A3, A4, A5
49				
50				
51	62-001	1	Switch, Push Button SPST	
52	66-118P1T	2	Switch, Dip, 8 Position	F2, F4
53	66-12FP1T	1	Switch, Hex	
54	72-1608S	2	Screw, Mach., Pan Hd. Phil. #6-32 x 1/2"	
55	75-016	2	Washer, Flat #6	
56	75-056	2	Washer, Lock, Int. Tooth #6	
57	75-916C	2	Nut, Hex #6-32	
58	78-06001	1	Heatsink, LM323	
59	78-16005	1	Silpad	
60				
61				
62	79-42040	1	Socket, 40 Position, Med Insertion	C1
63	79-58122	1	Header, 4 Pin	J9
64	90-108	1	Crystal, 4.000 MHZ	Y1
65	90-6001	1	I.C.	C1
66	90-7015	2	Ram, 2111A	D5, D8
67				
68				
69				
70				
71				
72				
73				
74				
75				
76				
77	020252-01	1	Audio Prom	D12
78	020287-01	1	Program Rom	ED
79	020288-01	1	Program Rom	ED0
80	37-74S00	2	I.C. 74S00A	F0, F1

Figure 26-D: Processor PCB Parts List

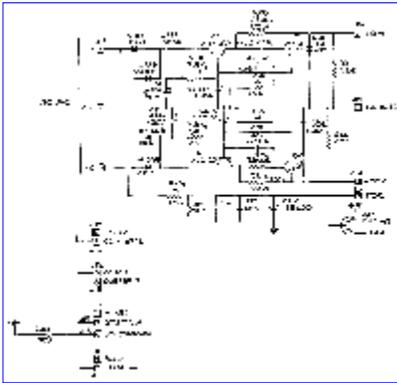
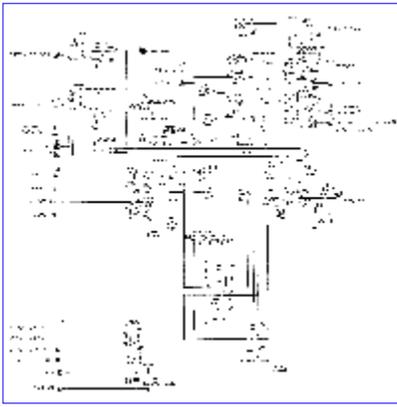


Figure 27-A: Auxiliary PCB Schematic Diagram (2 pages)
Click thumbnails for full-sized versions.

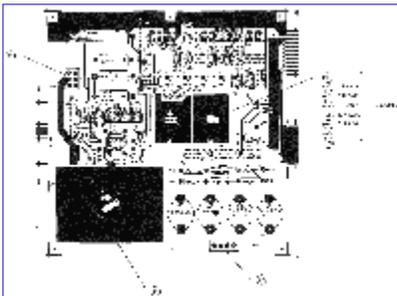


Figure 27-B: Auxiliary PCB Assembly Diagram
Click thumbnail for full-sized version.

Figure 27-C: Auxiliary PCB Assembly Parts List

Item	Part Number	Qty.	Description	
1	006408-01	1	PCB, Blank, Auxiliary Board	
2	10-5122	1	Res. CC, 1.2K ohms, 1/4w, 5%	R15
3	10-5152	1	Res. CC, 1.5K ohms, 1/4w, 5%	R14
4	10-5183	2	Res. CC, 18K ohms, 1/4w, 5%	R2, 18
5	10-52P7	1	Res. CC, 2.7 ohms, 1/4w, 5%	R10
6	10-5331	3	Res. CC, 330 ohms, 1/4w, 5%	R26, 27, 39
7	10-5333	3	Res. CC, 33K ohms, 1/4w, 5%	R5, 12, 17
8	10-5683	4	Res. CC, 68K ohms, 1/4w, 5%	R3, 16, 30, 31
9	10-5822	11	Res. CC, 8.2K ohms, 1/4w, 5%	R4, 6-9, 13, 19, 42-45
10	11-5220	2	Res. CC, 22 ohms, 1/2w, 5%	R28, 29
11	12-5153	2	Res. CC, 15K ohms, 1w, 5%	R24, 25
12	13-5390	4	Res. CC, 39 ohms, 2w, 5%	R40, 41, 46, 47
13	16-5752	2	Resistor, w.w. , 7.5K ohms, 5w, 5%	R37, R38
14	10-5204	1	Res. CC, 200K, 1/4w, 5%	R48

15	19-311502	1	Trimpot, 5000 ohms	R1
16	24-151506	2	Capacitor, Electrolytic,150WVDC, 50ufd	C3, C4
17	24-250106	1	Capacitor, Electrolytic, 25WVDC, 10ufd	C5
18	24-250478	1	Capacitor, Electrolytic, 25WVDC, 4700ufd	C1
19	24-250477	1	Capacitor, Electrolytic, 25WVDC, 470ufd	C2
20	24-250105	1	Capacitor, Electrolytic, 25WVDC, 1.Oufd	C6
21	27-250104	9	Capacitor, Ceramic, 25V, 0.1ufd	C7, 9-14, 18, 19
22	27-250103	2	Capacitor, Ceramic, 25V, .01ufd	C15, C16
23	28-101101	1	Capacitor, Mica, 100V, 100pfd	C8
24	3A-MDA100A	1	Rectifier Assembly, Bridge, MDA100A	nbsp;
25	31-1N914	1	Diode, 1N914	CR20
26	31-1N4005	8	Rectifier, 1N4005	CR10-12, 15-18, 22
27	32-P6KE30	1	Transient Suppressor Diode, P6KE30	CR5
28	32-1N5235	2	Diode, Zener, 1N5235	CR3, CR4
29	32-1N5242B	1	Diode, Zener, 1N5242B	CR19
30	32-1N4763A	2	Diode, Zener, 1N4763A	CR13, CR14
31	33-2N3644	1	Transistor, PNP, 2N3644	Q2
32	33-2N5883	4	Transistor, PNP, 2N5883	Q6-Q9
33	34-2N3643	2	Transistor, NPN, 2N3643	Q1, Q12
34	34-2N3583	1	Transistor, NPN, 2N3583	Q3
35	34-2N6044	2	Transistor, NPN, 2N6044	Q10, Q11
36	34-2N6282	1	Transistor, NPN, 2N6282	Q5
37	33-2N6420	1	Transistor, PNP, 2N6420	Q4
38	37-LM380	1	Integrated Circuit, LM380	D1
39	37-MC1413	1	Integrated Circuit, MC1413(ULN2003)	A1
40	37-741	1	Integrated Circuit, 741	C1
41	37-4016	1	Integrated Circuit, 4016	D2
42	37-7402	2	Integrated Circuit, 7402	A2, A3
43	37-7407	2	Integrated Circuit, 7407	D3, C2
44				
45	11-5391	1	Resistor, Carbon Comp., 390 ohms, 1/2w, 51%	R35
46	72-16O8C	10	Screw, Mach., Pan Hd- Phillips, 6-32 x 1/2" Lg.	
47	75-016S	10	Washer, Flat, Regular Pattern, #6	
48	75-056	10	Washer, Lock, Internal Tooth, #6	
49	75-916C	10	Nut, Hex, Regular Pattern, 6-32, Steel	
50	12-5103	1	Resistor, Carbon Comp., 10K ohm, 1w, 5%	R36
51	78-06002	2	Heatsink, Thermalloy #6111B-66	
52	79-58123	1	Header, 6-pin, Amp #350431-1	
53	79-58124	1	Header, 4-pin, Amp #350761-4	
54	78-06012	1	Heatsink, Modified Wakefield #641	
55	32-1N6335	1	Diode, Zener, 1N5335	CR1
56	32-1N5230	1	Diode, Zener, 1N5230	CR21
57	10-5101	1	Resistor, Carbon Comp., 100 ohms, 1/4w, 5%	R11
58				
59	78-16011	2	Silpad, TO-66	
60	72-1408C	4	Screw, Mach, Pan Hd Phil., #4-40 x 1/2 Cres	
61	75-014S	4	Washer, Flat, Reg Pattern #4	
62	75-054	4	Washer, Lock, Int. Tooth #4	
63	75-914C	4	Nut, Hex, Reg Pattern #4-40 Cres	
64	75-09012	4	Washer, Shoulder	
65	78-OA01	2	Cover, Insulating, to-66	Q10, 11
66				

67	10-5221	1	Res., C.C. 220 Ohms, 1/4w, 5%	R33
68	75-09015	3	Shoulder Washer (Seastrom 5605-25)	
69	10-5201	2	Res., C.C., 200 Ohms, 1/2w 5%	R21, 22

Figure 27-C: Auxiliary PCB Assembly Parts List

On the schematic the symbol P (which appears at various inputs to logic gates and other integrated circuits) indicates a connection to +5 volts through a pull-up resistor.

As an aid for locating integrated circuit devices referred to in the schematics and assembly drawings, and on the boards themselves, each IC position is given a letter/number designation. On the PCB the IC devices are arranged in columns (along the short dimension of the board) and rows (along the long dimension). The letter refers to a column, and the number refers to a row.

Thus, for example, the type-9321 IC device given the designation D1 and drawn near the center of sheet 1 is found as the second device in the "D" row of devices mounted on that board.

Microprocessing unit

The large block drawn along the left side of sheet 1 of the schematic represents the Microprocessing Unit. The signal names for the various Data Bus, Address Bus and Processor Controls are labeled inside the block.

Program Memory

Eight ROM devices in locations E1 through E8 for the -08 PCB and two ROM devices in locations E00 and E0 for the -09 PCB form the program memory. Note that the address inputs of all ROMs are connected in parallel and are tied to the A0B through A9B signals. These signals are produced by buffer logic connected to the Microprocessing Unit's Address Bus (signals A0 through A9). Also note that all CE2 inputs (pin 10) are tied together and driven by a common signal, and that the CE1 inputs are driven by signals derived from A10 and A11 produced by the Microprocessing Unit. All ROM data terminals are connected in parallel to the Data Bus (DO through D7).

Although all eight devices are ROMs, they should never be interchanged (that is, E1 unplugged and plugged into the E2 position, and vice versa), because different data has been programmed in each ROM.

Inside each ROM the data is organized in a 1K x 4 format (1024 bits by 4), giving each ROM a capacity of 4096 data bits.

Data Memory

The four devices in locations D5 through D8 form the Data Memory. Note that all address inputs are connected in parallel (together with the ROMs) to the A0B through A9B signals, and that all RAM data terminals are connected in parallel (together with the ROMs) to the Data Bus. The Microprocessing Unit's R/W bus control signal is buffered and then connected to all RAM R/W inputs.

Memory Output Latches

The eight type-9334 devices along the right side of the sheet form the Memory Output Latches. The addressing signals applied to each latch (at pins 1, 2, and 3) are derived from the A2, A3, and A7 Address Bus signals. One Data Bus bit is applied to each latch device (for example, Bit DO is applied to the latch in location C20, Bit D1 to C19, and so forth). The **^REG LD^** (Register Load) signal, produced by the Control Logic, is applied to the **^E^** (Enable not) input of every latch device (at pin 14).

*Editor's note: **^THIS^** notation will be used to indicate a horizontal line over words; this is impossible to show in HTML.*

Each latch device has eight outputs, giving a total of 64 LATCH signals. Twelve of these (the signals LATCH 1080 BIT 0 through 4, LATCH 1084 BIT 0 through 4, and Latch 1084 BIT 0 through 4), provide the Sound Data, 32 provide the Lamp Data, and the remaining 20 provide the Solenoid Data.

Clock Generator

The circuit is shown along the bottom of the sheet. The basic frequency source is a 4-MHz crystal-controlled oscillator. Its output is then shaped, divided down, and buffered to produce the **^(PHI)1^** and **^(PHI)2^** signals (phase 1 not and phase 2 not). These are the non-overlapping, non-symmetrical square wave complements required by the Microprocessing Unit. They are also used in the Control Logic.

Tri-State Buffers

The two type-8097 devices in locations C4 and C5 on sheet 2 connect Switch Data, power line phasing information, display address information, and other Control Logic signals to bits D6 and D7 of the Data Bus, and to Bits A0 through A5 and A12 through A14 of the

Address Bus. Keep in mind that these are Tri-State devices. When its control line is in the disable state, a tri-state device's data connections become a high impedance, the equivalent of removing the device from the circuit. But when the control line is in the enable state, the device's data connections are capable of having normal high and low ("1" and "0") levels.

Control Logic

The portion of the Control Logic that produces the **^RESET^** signal for the Microprocessing Unit is shown at the top of sheet 2. The five type-7493 Counter devices form a single, simple binary counter configuration that is driven by the phase 1 clock signal. The AUDIO CLOCK signal produced by the first 7493 device (at A6 pin 8) is used in the Sound Generator circuit.

If, at any time after power is applied to the game, the count advances far enough to bring the last stage high (A10 pin 9 high), then the **^RESET^** signal will be brought low. (**^RESET^** can also be brought low by manually depressing the **^RESET^** pushbutton mounted on the surface of the Processor PCB.) **^RESET^** going low causes the Microprocessing Unit to begin the restart sequence. The execution of a routine to initialize the processor from its reset condition will be started.

In normal game operation the **^RESET^** signal stays low. The WAKE-UP RESET signal (applied at pins 2 and 3 of both A9 and A10) periodically goes high, preventing the last counter stages from going high. If some abnormal circumstance occurs, such as a momentary interruption in game power caused by severe transients on the AC power line, then the program sequence inside the Microprocessing Unit may be disrupted and the WAKE-UP RESET signal may remain low for longer than 100 milliseconds. In such a case, a high-to-low-level transition (positive-going edge) on the **^RESET^** signal is produced, and the microcomputer system resets itself.

Other portions of the Control Logic are covered under the Circuit Descriptions that follow.

C. CIRCUIT DESCRIPTIONS

Solenoid Driver Circuits

Twenty of the outputs from the Memory Output Latches constitute the Solenoid Data shown in Figure 23. These are the signals LATC 1080 BIT 4 through 7, LATCH 1084 BIT 4 through 7, LATCH 1088 BIT 4 through 7, and LATCH 108C BIT 0 through 7 (shown on sheet 1 of Processor PCB schematic).

Two of these signals, LATCH 1080 BIT 4 and 5, connect to the Auxiliary PCB where they each drive a type-7407 Inverter followed by a 2N6044 Darlington- connected transistor pair. The remaining eighteen LATCH signals connect to the same types of devices (7404 and 2N6044) on the Processor PCB.

Figure 30 shows a simplified diagram of the basic solenoid drive circuit for all solenoids. One side of the solenoid coils connects to the collectors of the 2N6044 transistors; the other side is brought, together with all the other coils, to an unregulated, full-wave rectified DC power supply of about 35 volts amplitude. This power supply is located in the Power Supply Assembly in the right rear corner of the cabinet. Note that a suppression diode is placed across each coil; the diode protects the 2N6044 from reverse inductive kickback (back emf) when the coil is de-energized. The emitters of all 2N6044 devices and the ground side of the 35-volt supply are returned to SOLENOID GRD (at J9, pin 3).

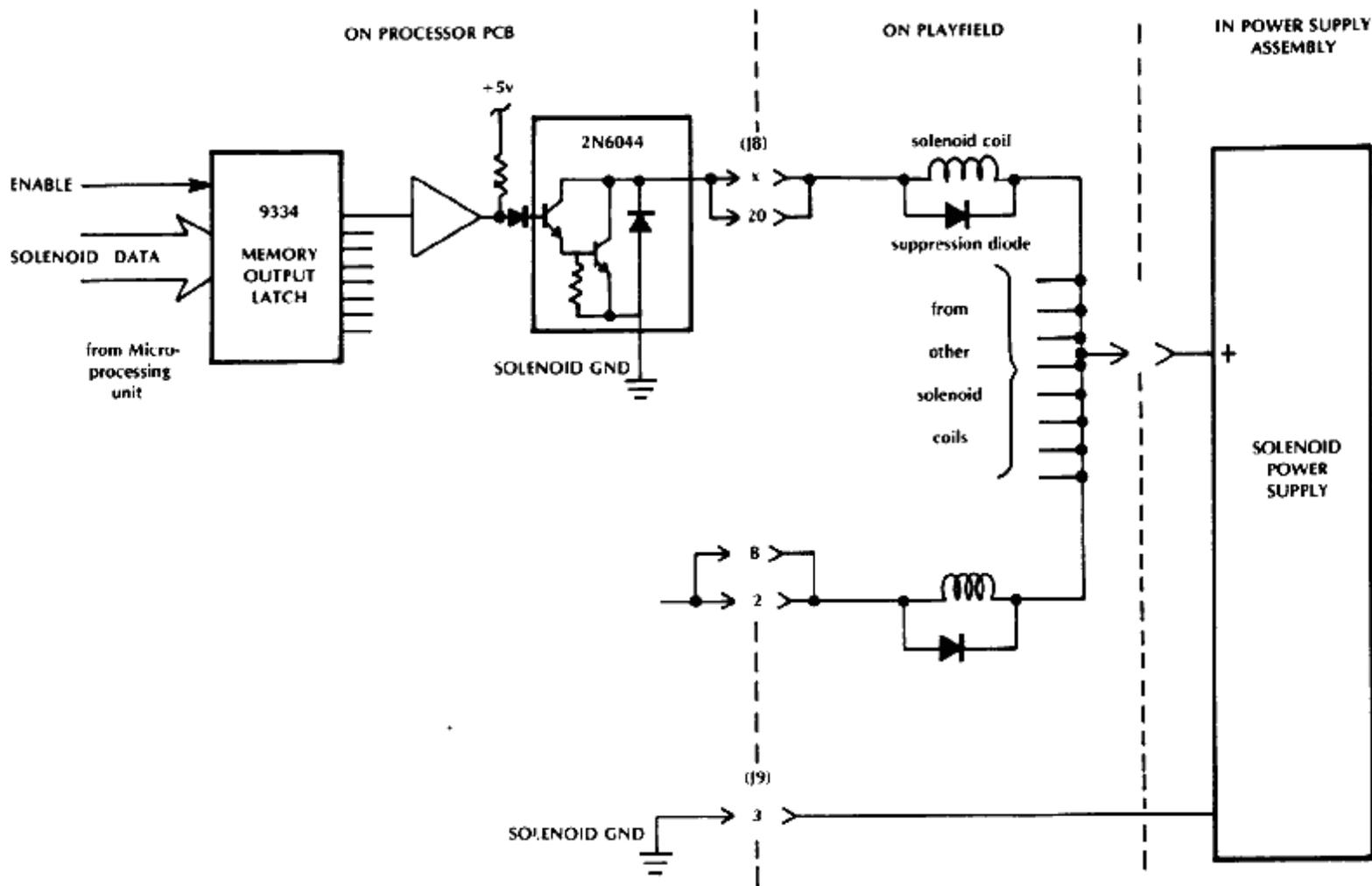


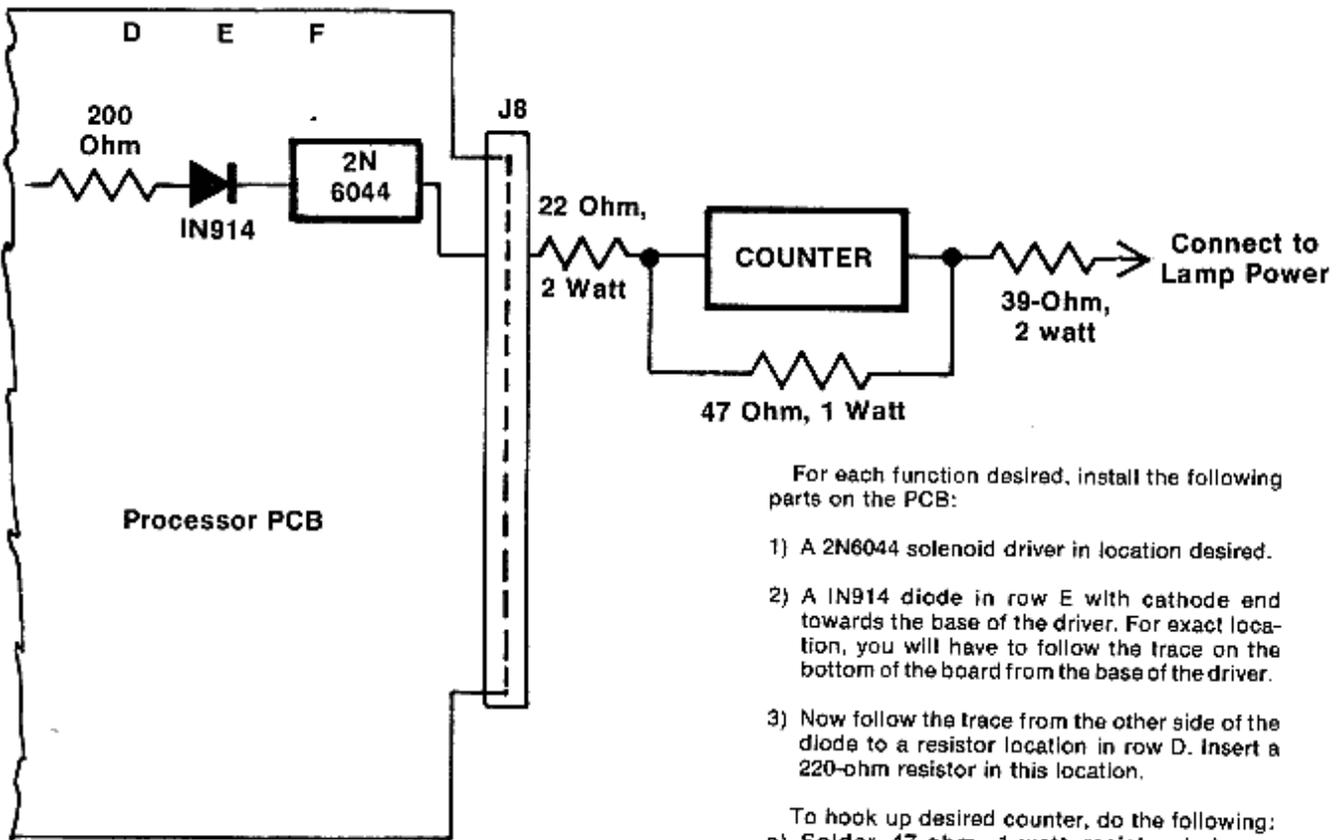
Figure 30: Simplified Diagram of Basic Solenoid Driver Circuit

Remember that the microcomputer, by means of the PHASE signal, is able to synchronize the turning on of the solenoids so that it will start only at a zero crossing point (zero power point) of the power line waveform.

Drive components for the coin counter metering function are on the Processor PCB. Also provided are signals from the microcomputer and spaces on the board for additional drive components, so that operators wishing to have four additional functions can do so by installing additional components. The four functions, components required, and their circuit designations are listed in Table 15. Figure 31 shows the circuit for each metering function to be added.

Table 15: Components Required for Special Metering Functions
(Available at edge connector J-8 on the main processor PCB)

Function Being Metered	Processor PCB Edge Connector J8 Pin	2N6044 Driver Number	1N914 Designation	Resistor Designation
Total replays	X, 20	10	CR20	R25
Total specials awarded	U, 17	19	CR17	R21
Total game time (min.)	V, 18	9	CR18	R24
Total plays	W, 19	20	CR19	R23



For each function desired, install the following parts on the PCB:

- 1) A 2N6044 solenoid driver in location desired.
- 2) A IN914 diode in row E with cathode end towards the base of the driver. For exact location, you will have to follow the trace on the bottom of the board from the base of the driver.
- 3) Now follow the trace from the other side of the diode to a resistor location in row D. Insert a 220-ohm resistor in this location.

To hook up desired counter, do the following:

- a) Solder 47-ohm, 1-watt resistor between counter lead wires.
- b) Solder one lead of a 22-ohm, 2-watt resistor to one lead of 47-ohm resistor soldered between the counter leads.
- c) Solder a 22-gauge, stranded wire to the other lead of the 22-ohm resistor and another 22-gauge stranded wire to the counter lead that is soldered only to the 47-ohm resistor.
- d) Solder an edge-connector pin (Atari:P/N 79-20353) to the other end of the wire.
- e) Plug the edge-connector pin into the desired Processor PCB connector J8 pin location.
- f) Solder the unterminated wire (connected to the counter lead) to lamp power line from pin 5 of connector P21 on the power supply.

Figure 31: Additional Components to be Installed for Each Metering Function Added

Lamp Driver Circuits

Thirty-two of the outputs from the Memory Output Latches constitute the lamp data shown in Figure 23. These are the BIT 0 through BIT 7 signals LATCH 1000, LATCH 1004, LATCH 1008 and LATCH 100C. All thirty-two signals connect to the inputs of the type ULN-2003A devices shown on sheet 4 of the Processor PCB schematic. These are open-collector interface devices that accept TTL input levels, and produce the high current outputs needed to light the lamps. Note that these devices connect to a lamp ground (J19, pin 3).

Figure 32 shows a simplified diagram of the basic lamp driver circuit. One side of each lamp connects to a ULN-2003A output terminal, and the other side connects to a strobe line on the Auxiliary PCB (STROBE A, STROBE B, etc.). In the wiring harness, beneath the playfield, black wires are used for lamps connecting to STROBE A, green wires for those to STROBE B, blue wires for STROBE C, and red wires for STROBE D.

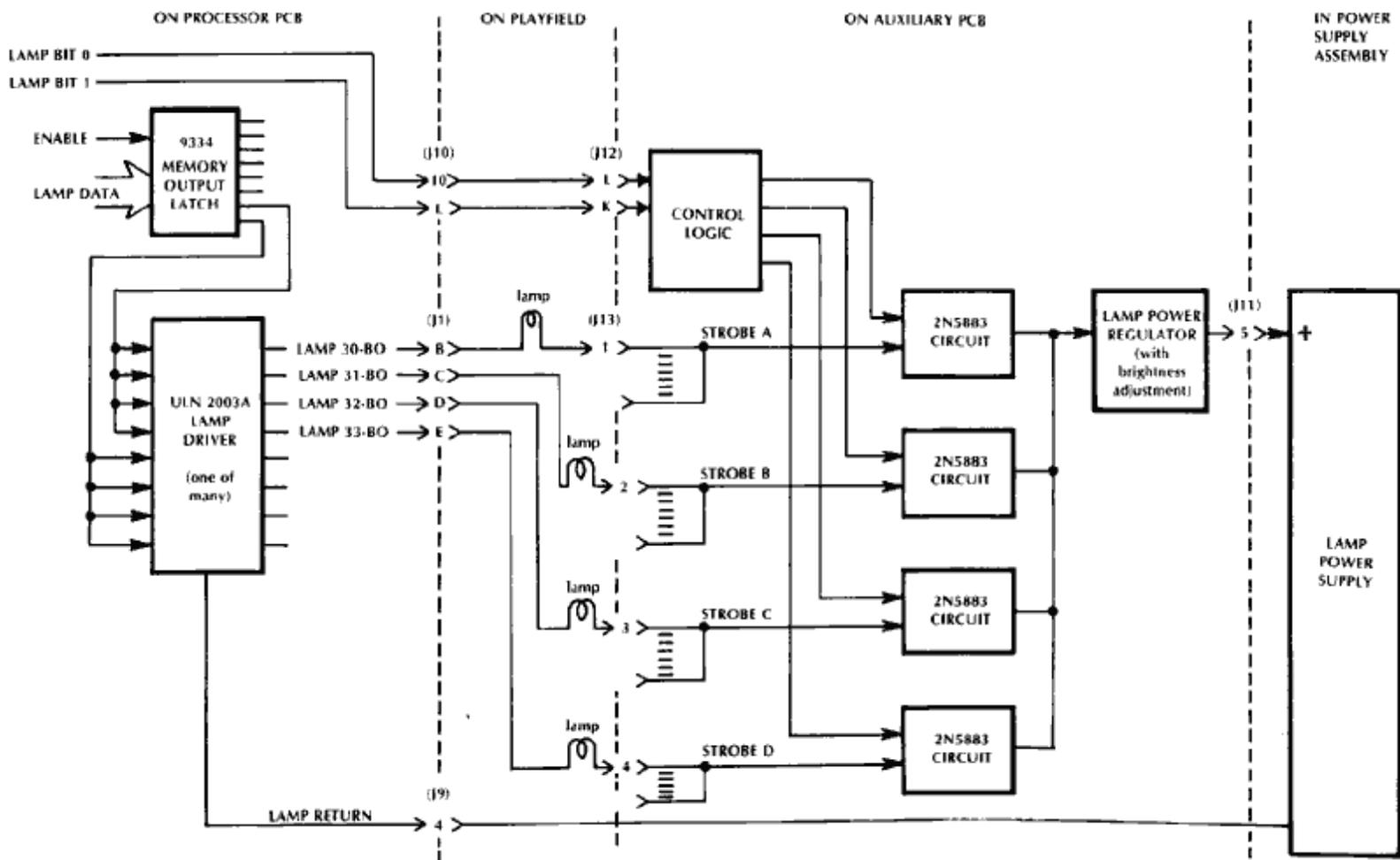


Figure 32: Simplified Diagram of Basic Lamp Driver Circuit

The control logic decodes the LAMP BIT 0 and LAMP BIT 1 signals to produce four transistor based drive signals, one for each 2N5883. (LAMP BIT 0 and LAMP BIT 1 come from the same circuit that produces the DISPLAY ADRS 1 and DISPLAY ADRS 2 signals on the Processor PCB schematic.) The timing of the four signals driving the 2N5883 transistors is such that any one transistor is brought into conduction only 25% of the time (25% duty cycle). This means that the playfield lamps, which appear to the eye to be of uniform brightness when lighted, are in reality blinking on and off.

CAUTION: During troubleshooting of the game by service technicians, while operating the game with the cabinet open and power applied, do not hold down the RESET pushbutton (mounted on the Processor PCB) for long periods of time. Doing this will cause one of the 2N5883 transistors to be brought into conduction 100% of the time. Lamp current is very high in this situation, and can lead to premature burning out of the lamps.

Switch Sensing Circuit

The switch sensing circuit accepts switch closure information as an input, and produces switch data as an output. This switch data is sent to the microcomputer system on a single signal line. Figure 33 shows a simplified diagram of the switch sensing circuit.

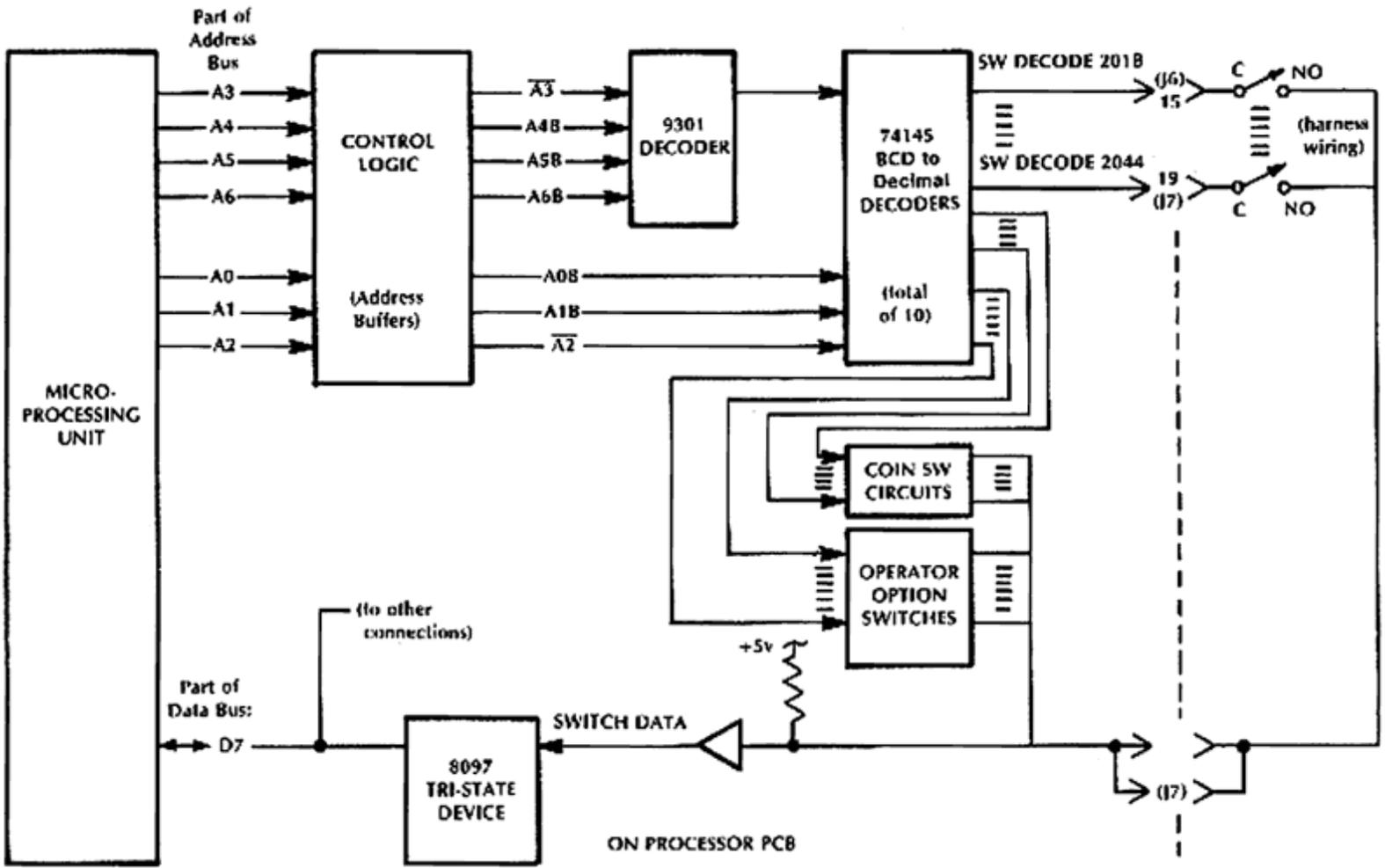
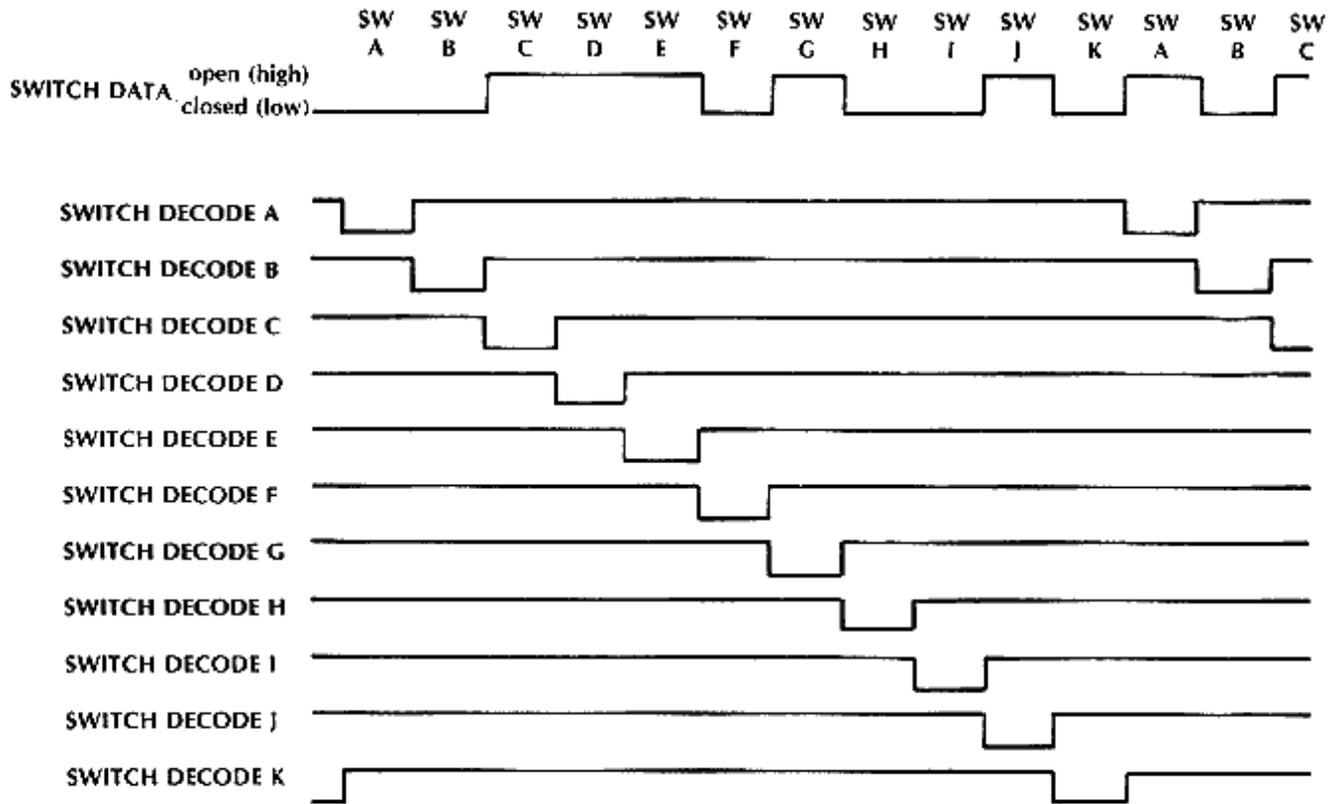


Figure 33: Simplified Diagram of Switch Sensing Circuit

The normally open (NO contacts) of the various playfield switches and certain cabinet switches are connected together in the playfield harness wiring, and then a common lead is brought to the Processor PCB at connector J7 (pins 5 & 6). (Refer to sheet 2 of the Processor PCB schematic.) On the board's artwork, the NO contacts from the Operator Option Switches (along with signals derived from the rest of the cabinet switches -- COIN 1, COIN 2, START, and SLAM), are also connected electronically to this point. Also, this point is connected to resistor R27, tied to +5 volts, and to the pin-13 input of the type-7414 Inverter in location C9. The output of this Inverter, C9 pin 12, is the Switch Data line, which is applied to pin 12 of the type-8097 tri-state buffer in location C5. The device terminal at C5 pin 11 is connected to bit D7 of the Microprocessing Unit's bidirectional Data Bus.

By means of multiplexing technique, the switch closure information being sent on the switch data line is derived from the timing of addressing signals being sent out by the Microprocessing Unit over the Address Bus. To determine whether or not a specific switch is closed, the Microprocessing Unit compares the timing of that switch's address code with the state of the switch data signal being received at that moment on bit D7 of the data bus.

Figure 34 shows simplified wave form diagrams that illustrate this timing comparison multiplex technique for an imaginary circuit having only eleven switches.



NOTE:

During the first sensing of Switch A it is closed, but on the second sensing it is open.

Figure 34: Simplified Diagram of Switch Sensing Circuit Waveforms

In the actual game, anytime that the Microprocessing Unit addresses a specific switch, and that switch is closed at that moment, the SWITCH COMMON line will be low. The 7414 Inverter changes this to high, and a high goes out on the Data Bus on bit D7. So when the Microprocessing Unit reads back a high in that location on the data bus, it knows that the specific switch had been closed.

The control logic used for decoding the Microprocessing Unit's addressing information is shown on the left side of sheet 3 of the schematic. One SWITCH DECODE line is produced for each switch (switch DECODE 200B, SWITCH DECODE 200A, etc.).

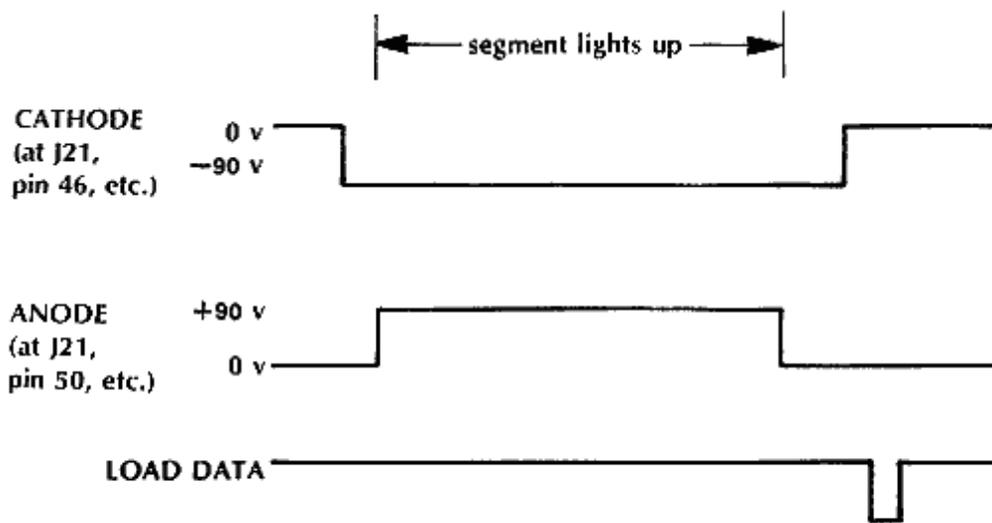
Displays and Display Data

The Score Display consists of a glass plate panel that plugs into an edge connector, and a printed circuit board beneath that plugs into a second connector. The two connectors are hard-wired together. The Credit and Ball/Match displays are both built on a separate PCB.

WARNING: Whenever AC power is applied to the game, voltage potential differences as large as 180 volts are present at the bare terminals of the glass plate's edge connector, and at various other points on both printed circuit boards.

All three are gas-discharge type displays with the following principle of operation. If a sufficiently high voltage is applied to a gas, a point will be reached at which the gas ionizes, producing a conduction current and giving off radiation (which can be in the form of visible light). Fluorescent lamps are common examples of illumination sources that also make use of the gas-discharge phenomenon.

A display segment lights up when +90 volts is applied to the anode at the same time that -90 volts is applied to the cathode, as illustrated by the waveforms in Figure 35.



NOTE:

Segments are updated approximately every 500 microseconds.

Figure 35: Waveforms for Gas Discharge Displays

Although to the human eye a lighted segment seems to be uniformly bright, in actuality the segment is being turned on and off at a rate faster than the eye can detect. This technique is called *segment multiplexing*.

The Microcomputer System block diagram in figure 23 shows how the microprocessing unit addresses the RAM Data Memory (via the Address Bus) and passes data to this memory (via the Bidirectional Data Bus), and how the Control Logic also shares these buses.

The microprocessing unit brings its BA (Bus Available) signal at C1 pin 7 to high when it is off the buses. During game operation the microprocessing unit periodically writes new display data into the RAM Data Memory and then gives up the buses. Subsequently the Control Logic takes over the buses, addressing the RAM Data Memory and then reading its display data off the Bidirectional Data Bus. The Control Logic then produces the four signals DISPLAY DATA 0 through DISPLAY DATA 3. It also produces seven addressing signals DISPLAY ADRS 0 through DISPLAY ADRS 6, and three control signals ANODE BLANK, **^CATHODE BLANK^** and **^LOAD DISPLAY^**.

The addressing signals are used to identify which displays are to accept data at any given moment. The control signals are used to blank the displays while the microprocessing unit is on the buses, and to strobe in new display data, respectively.

The circuitry for the Control Logic is shown on the right side of sheet 2 of the Processor PCB schematic. The type-74157 2-line to 1-line multiplexer in location B5 produces four DISPLAY DATA signals from the eight inputs D0B through D7B (These eight signals come from the type-LS08 buffers B/C8 and C/D8 on sheet 1; the buffers are driven directly from the Data Bus signals D0 through D7.) The seven DISPLAY ADRS signals are produced by counters B4 and B3 whose outputs also drive the Address Bus through the type-8097 Tri-State devices C4 and C5. The three display control signals are produced by timing logic driven also by counters B3 and B4 as well as by the **^BA^** signal from the microprocessing unit, and by the **^RESET-A^** signal from the microcomputer reset circuit.

The circuit for each display consists of an anode drive portion and a cathode drive portion. The anode portions derive timing signals from the DISPLAY ADRS 0 through DISPLAY ADRS 2 signals and the ANODE BLANK control signal. The cathode portions perform three functions: storage of data derived from the DISPLAY DATA signals (under control of the **^LOAD DISPLAY^** signal), decoding of this data into 7-segment format, and keeping the segments turned off part of the time (under control of the **^CATHODE BLANK^** signal).

The +90 volts and -90 volts required by the displays is produced in a regulated power supply circuit built on the Auxiliary PCB. The 170 VAC input to this circuit comes from the power transformer located in the Power Supply Assembly.

Credit and Match/Ball Display Circuit

Note that the top half of the Match/Credit PCB Schematic describes the cathode circuitry. The bottom half covers the anode circuitry.

The type-14556 device examines the DISPLAY ADRS 5 and DISPLAY ADRS 6 signals to determine when new data is available for these display digits. The output from the 14566 device is applied to the LE (Latch Enable) input of a type-14511 device. The four signals DISPLAY DATA 0 through 3 are applied to the inputs of a type-14511 device. This device has a latching capability and also performs segment decoding.

The 14511 device's segment outputs are applied to a type-584-8 device that performs an interfacing function; it accepts TTL logic level inputs and produces a 90-volt swing (from 0 volts to -90 volts) at its output. The seven outputs from this device are applied to the cathode terminals

of all display segments. The CATHODE BLANK signal, applied to the B1 input (pin 4 of the 14511 device), will cause all segments to be blank, regardless of what data is stored, when the multiplex timing calls for that digit to remain unlighted.

The Type-14028 device, in the anode portion of the circuit, examines the three signals DISPLAY ADRS 0 through 2 to determine which of the display digits to turn on. The outputs from the 14028 are applied through series-connected diodes to a type-585-6 interface device that drives the anode terminals of the display digits with a voltage swing from 0 volts to +90 volts.

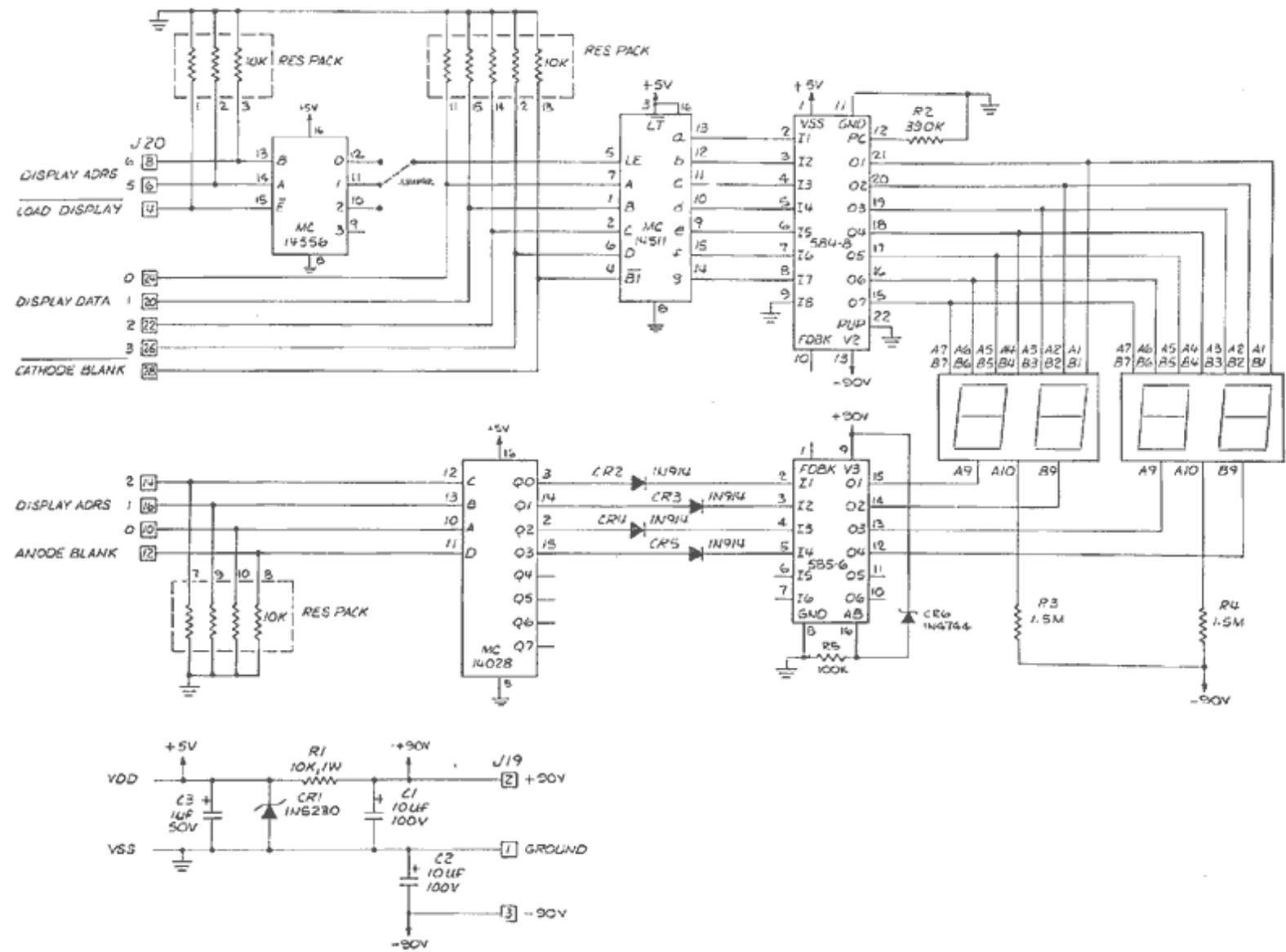


Figure 29-A: Match/Credit PCB Schematic Diagram

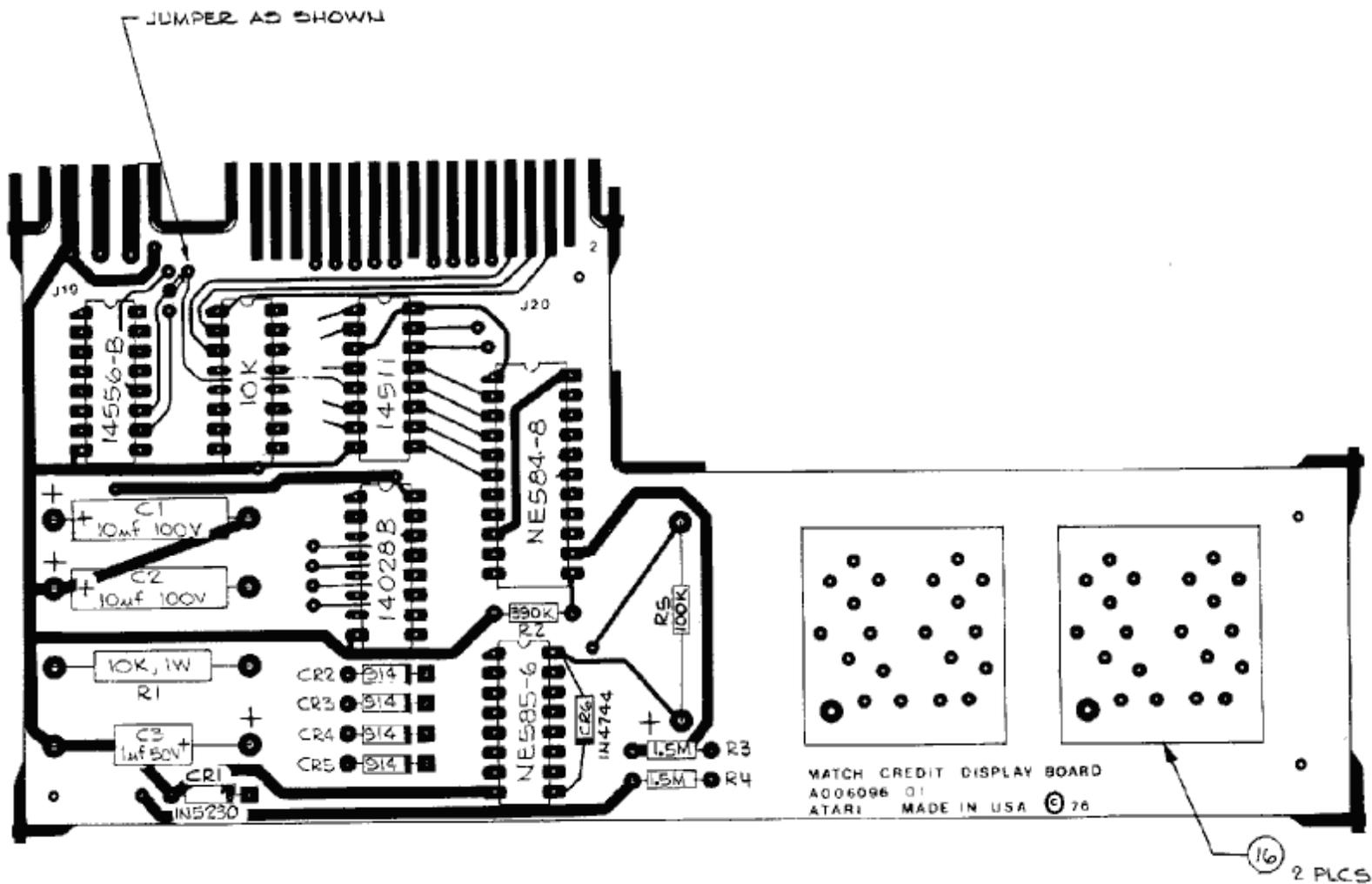


Figure 29-B: Match/Credit PCB Assembly Drawing

Figure 29-C: Match/Credit PCB Assembly Parts List

Item	Part	Number	Description	
1	006104-01	1	PCB, Blank, Match/Credit Display Board	
2	10-5155	2	Resistor, Carbon Comp., 1.5 Megohms, 1/4w, 5%	R3, 4
3	10-5394	1	Resistor, Carbon Comp., 390K ohms, 1/4w, 5%	R2
4	12-5103	1	Resistor, Carbon Comp., 10K ohms, 1w, 5%	R1
5	24-500105	1	Capacitor, Electrolytic, 50 WVDC, 1.0 ufd	C3
6				
7	24-101106	2	Capacitor, Electrolytic, 100 WVDC, 10 ufd	C1, 2
8	32-1N5230	1	Diode, Zener, 1N5230	CR1
9	37-MC14028	1	Integrated Circuit, MC14028	
10	37-MC14511	1	Integrated Circuit, MC14511	
11	37-MC14556	1	Integrated Circuit, MC14556	
12	37-584-8	1	Integrated Circuit, 584-8	
13	37-585-6	1	Integrated Circuit, 585-6	
14	19-008	1	Resistor Network, 10K ohms, CTS#761-1-R10K	
15	31-1N914	4	Diode, 1N914	CR2-5
16	79-41001	2	Socket, Beckman Type CS-352	
17	10-5104	1	Res, Carbon Comp., 100K, 1/4W, 5%	R5
18	32-1N4744	1	Diode, Zener 1N4744	CR6

Figure 29-C: Match/Credit PCB Assembly Parts List

Score Display Circuit

The connections to the score display panel are made in the form of a rectangular matrix, with seven anode connections on one side and 28 cathode connections on the other. Figure 36 illustrates the arrangement of these connections. In the multiplex timing the six vertical rows of digits, plus the one vertical row of *player up* indications, are driven one at a time. All the anodes in the *player up* indications are brought together electrically to J21, pins 1 and 2, the ANODE 1 signal, All the anodes for the least significant digits are brought to J21, pins 50 and 5, the ANODE 2 signal, etc. The sequence of lighting the anodes is: ANODE 2, then 4, then 6, then 3, then 5, then 7, and finally ANODE 1.

Likewise, the cathodes of all segments of the digits in a row are tied together, For example, all the "b" segments in the top row are tied together and brought to J21, pin 46.

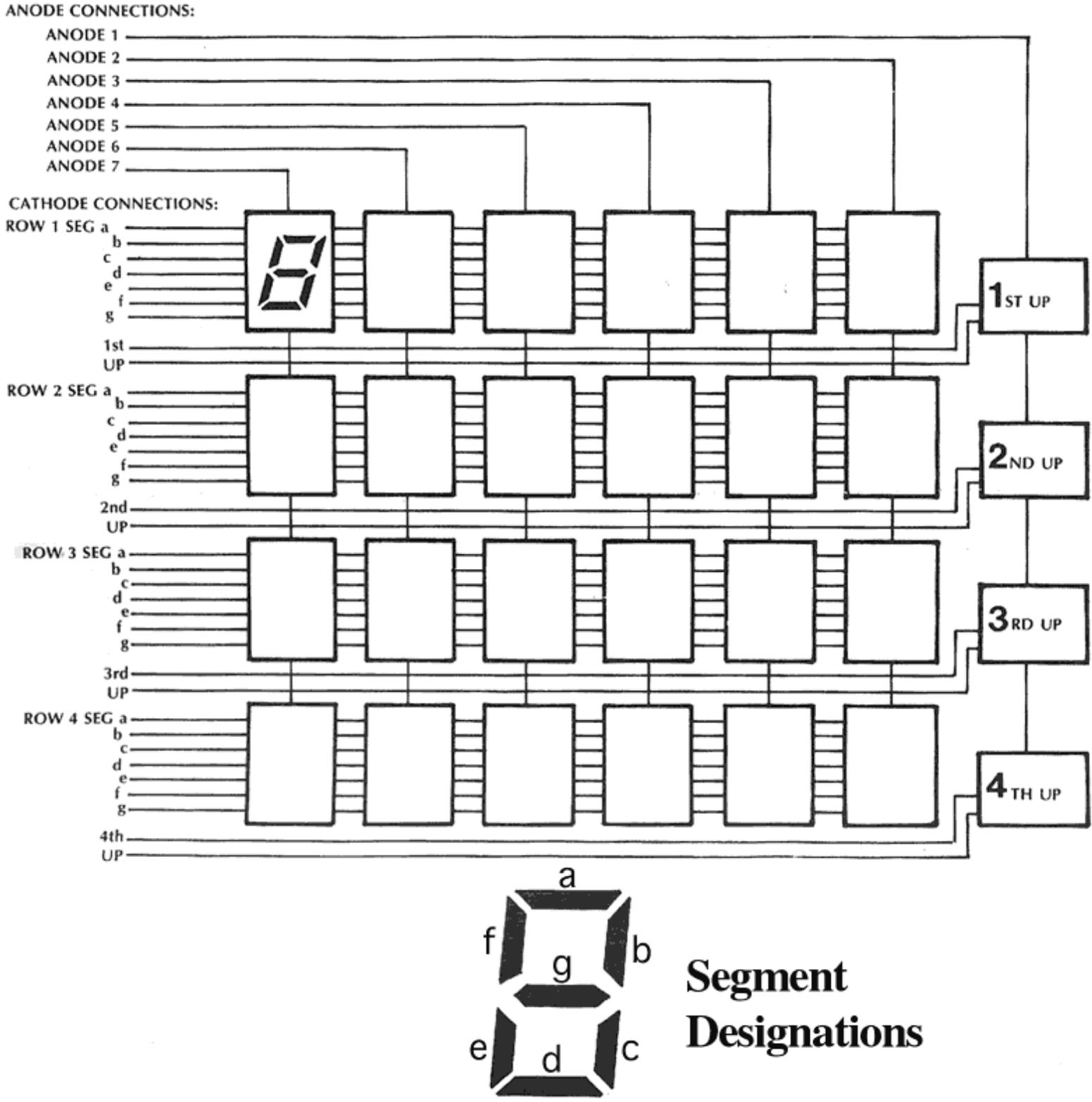


Figure 36: Arrangement of Connections to Score Panel

For the circuit descriptions that follow, refer to the schematic in Figure 28. The four display address signals (DISPLAY ADRS 3 through 6) are applied to type-14556 devices which produce four outputs. One of these outputs is applied to the LE input (pin 5) of each of the type-14511 Latch/Segment Decoder devices in locations D2, C3, B3, and A2. The 14556 devices decide which of the Latch/Segment Decoders are to receive display data (are to be loaded) at any one moment.

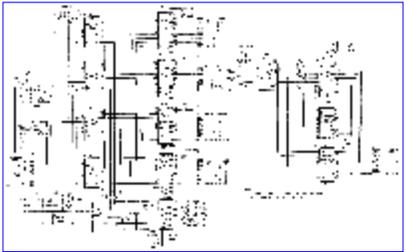


Figure 28-A: Score Panel Drive PCB Schematic Diagram
Click thumbnail for full-sized version.

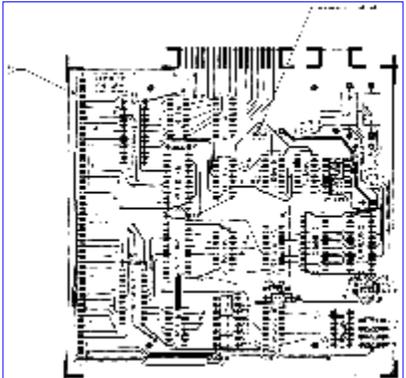


Figure 28-B: Score Panel Drive PCB Assembly Drawing
Click thumbnail for full-sized version.

Figure 28-C: Score Panel Drive PCB Assembly List

Item	Part Number	Qty.	Description	
1	004922-01	1	PCB, Blank, Score Panel Drive	
2	10-5102	8	Res., Carbon Comp., 1000 ohms, 1/4w, 5%	R5-12
3	10-5224	2	Res., Carbon Comp , 220K, ohms, 1/4w, 5%	R1, 4
4	10-5564	2	Res., Carbon Comp., 560K ohms, 1/4w, 5%	R2, 3
5	10-5822	4	Res., Carbon Comp., 8200 ohms, 1/4w, 5%	R16-19
6	11-5153	1	Res., Carbon Comp., 15K ohms, 1/2w, 5%	R14
7	13-5682	1	Res., Carbon Comp., 6800 ohms, 2w, 5%	R13
8	24-101106	2	Capacitor, Electrolytic, 100WVDC, 10ufd	C1-2
9	24-500105	1	Capacitor, Electrolytic, 50WVDC, 1.0ufd	C3
10	32-1N4751	1	Diode, Zener, 1N4751	CR9
11	32-1N5230	1	Diode, Zener, 1N5230	CR1
12	19-008	1	Res. Network, 10K ohms, CTS# 761-1-R10K	
13	37-MC14028	1	Integrated Circuit, MC14028	
14	37-MC14511	4	Integrated Circuit, MC14511	
15	37-MC14556	1	Integrated Circuit, MC 14556	
16	37-MPQ7091	1	Integrated Circuit, MPQ7091	
17	37-UDN6184A	1	Integrated Circuit, UDN6184A	
18	37-584-8	4	Integrated Circuit, 584-8	
19	006123-01	1	Integrated Circuit, MC1413, 75V (Atari Custom)	
20	004770-01	1	Connector, Score Panel	

21	72-1408S	4	Screw, Mach., Pan Hd., Phil., 4-40 x 1/2" Lg., Stl	
22	10-5104	1	Res., Car Comp., 100K ohms 5%	R15
23	32-1N4744	1	Diode, Zener 1N4744	CR10
24	10-5382	1	Res. Car Comp., 1.8K ohms 1/2w, 5%	R20
25	27-10104	1	Capacitor, Ceramic Disc 0.1uf 100V	C4

NOTE: This is the preferred assembly parts lists for the Score Display PCB, to be used when item 17 is obtainable. If item 17 is unavailable (only) use the assembly parts list, A004924-02 as an alternate procedure.

Figure 28C: Score Panel Drive PCB Assembly Parts List

The individual segment outputs ("a" through "g") produced by the segment decoders are applied to four type-584-8 Cathode Driver devices in locations D1, C2, B2, and A1. These Cathode Drivers perform an interfacing function; they accept TTL logic level inputs and they produce a 90-volt swing (from 0 volts to -90 volts) at their outputs. A separate circuit (formed by four 8.2K-ohm resistors, a 4-transistor MPQ 7091 device in location A5, and the 006123-01 device in A4), produces the signals applied to the "Player Up" cathodes (4TH UP 3RD UP, etc.)

The circuitry for driving the anodes of the display is shown on the right half of the sheet. The type-14028 device examines the DISPLAY ADR 0 through 2 signals to determine which of the seven ANODE lines are to be turned on. The outputs of the 14028 are applied to interface device or devices that will produce the 90-volt swing (from 0 volts to +90 volts) at their outputs. This PCB is laid out in such a way that two choices of device type are possible. (A board will be built using only one choice.) The choices are: one type-UDN 6184A device, or two type-585-9 devices.

Sound Generator and Speaker Driver Circuits

The initial portion of the Sound Generator circuit is built on the Processor PCB. The final portion and the Speaker Driver are built on the Auxiliary PCB. In the lower left corner of sheet 2 of the Processor PCB schematic, four Memory Output Latch signals (LATCH 1088 Bit 0 through LATCH 1088 Bit 3) are applied to the type-9316 counter in location D13. This counter is driven by the AUDIO CLOCK signal and serves as a frequency generator. The counter's TC (terminal count) output (at D13 pin 15) is applied to a second counter configuration formed by two type-7493 counter devices. The AUDIO ENABLE and AUDIO RESET signals (produced by Control Logic section shown on schematic sheet 1) are applied to the R01 and R02 reset inputs of these counters (pins 2 and 3). These two signals control when the Same's sound is allowed to come on and when it is kept off.

Five output signals from the 7493 counters, together with four more Memory Output Latch signals (LATCH 1080 BIT 0 through BIT 3), are applied to the address inputs of the ROM device in location D12. This ROM has been pre-programmed to perform a waveform shaping function. The ROM outputs, AUDIO 0 through AUDIO 3, are sent to the Auxiliary PCB.

On the Auxiliary PCB schematic these four AUDIO signals are connected to type-7407 open-collector buffers. The buffer outputs connect, via a "weighted" resistor network, to the pin 3 positive input of the amplifier in location C1. The network is called "weighted" because of the binary-weighted values of the resistors; 68K ohms is double the value of the 33K-ohms resistor which is double the value of the 18K-ohm resistor, etc. This weighted resistor-buffer arrangement performs a D-to-A (digital to analog) converter function. Note that other resistors, a 1.5K-ohm to ground and a 1.2K-ohm that connects to +13.6 volts, are also tied into this resistor network.

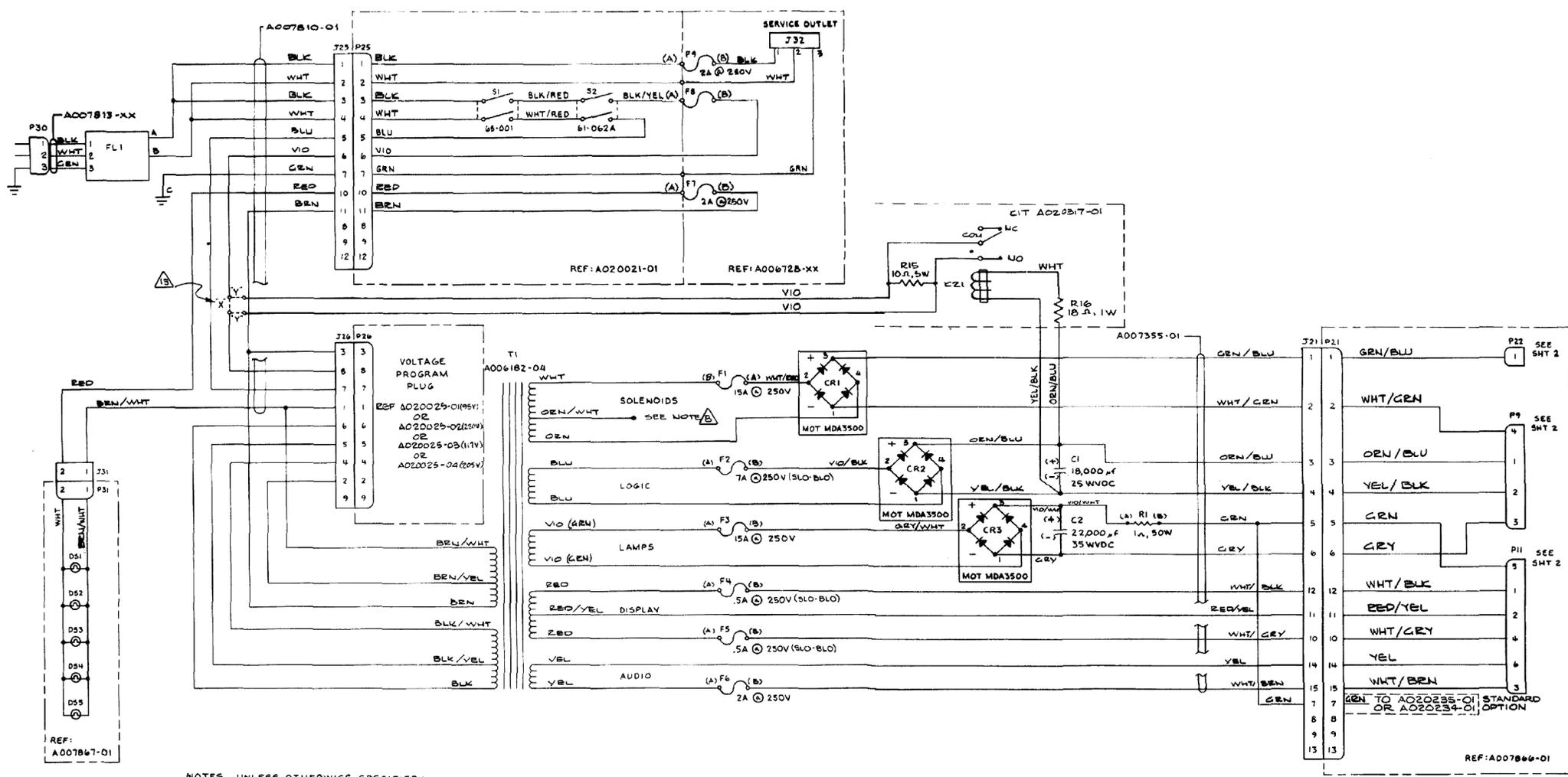
Four more Memory Output Latch signals (LATCH 1084 BIT 0 through BIT 3) are applied to the Auxiliary PCB. After buffering by type-7407 devices, these signals are applied to the gate inputs (pins 5, 6, 12, and 13) of the type-4016 Quad CMOS Analog Switch in location D2. These four latch outputs provide the amplitude modulation information portion of the Sound Data. The outputs of the type-4016 Analog Switch connect, via another "weighted" resistor network, to the negative input (pin 2) of amplifier C1. Thus the 4016 device provides amplitude or gain control for the amplifier. Amplifier C1 acts as a mixer stage for all the Sound Data, and its output (at C1 pin 6) is applied to the Speaker Drive circuit.

The LM380 amplifier in location D1 serves as the Speaker Driver. Potentiometer R1 provides the game's first speaker volume adjustment. The LM380 output at D1 pin 8 connects, via harness wiring, to the second speaker volume potentiometer. This potentiometer is located underneath the cabinet at the front left corner. The wiper of the potentiometer connects directly to the game speaker.

End of Manual

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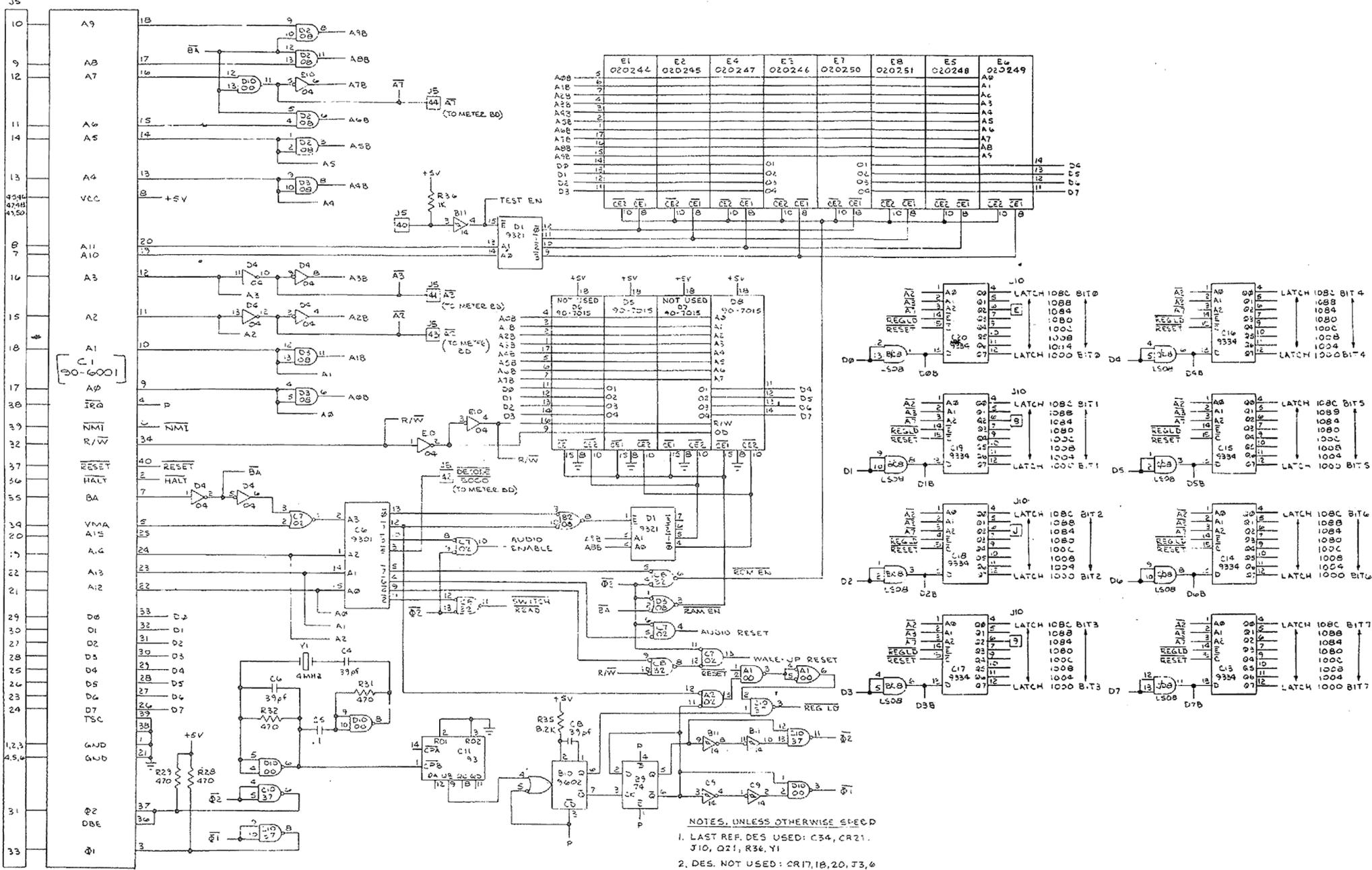
[Back](#) to Chapter 3



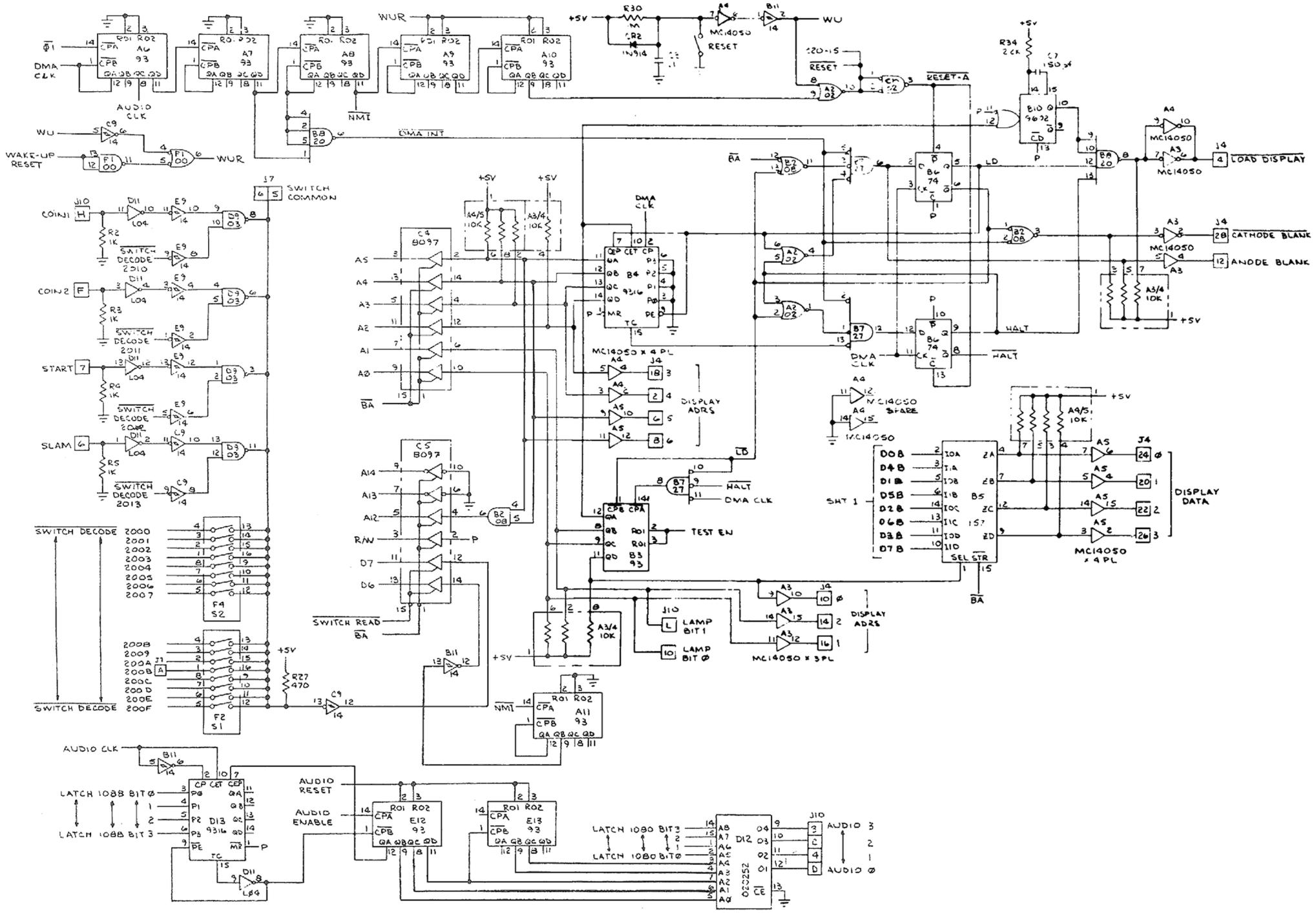
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 - ⚠ "X" WIRING IS FOR 95V & 110V GAMES. "Y" WIRING IS FOR 205V & 220V GAMES.
 - ⚠ ADD 556 FOR DOMESTIC GAMES ONLY
 - ⚠ ADD 556 FOR FOREIGN GAMES ONLY

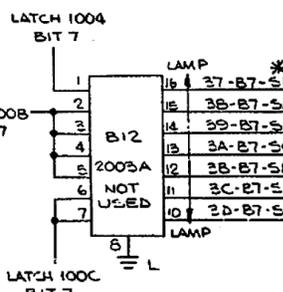
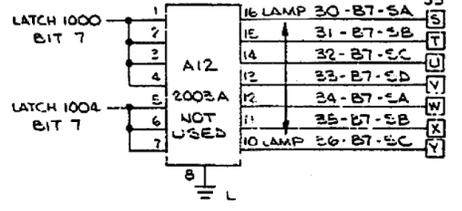
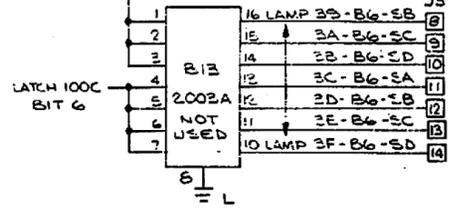
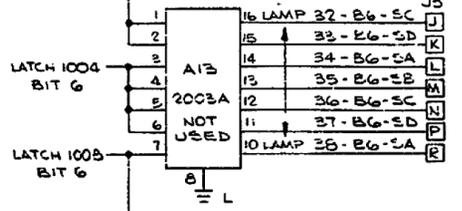
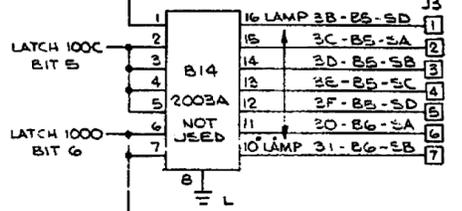
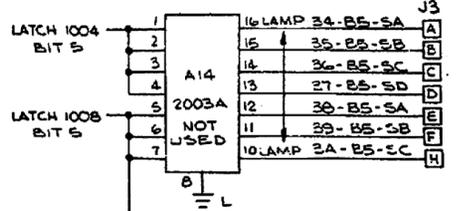
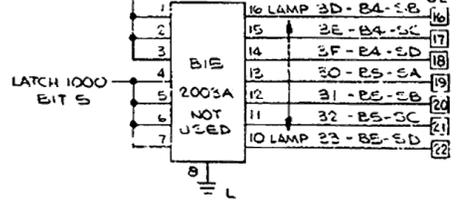
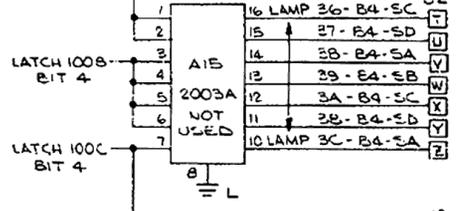
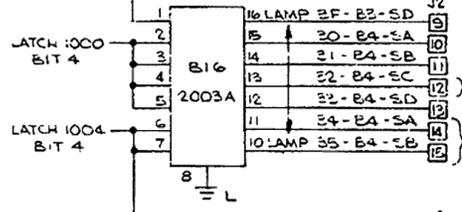
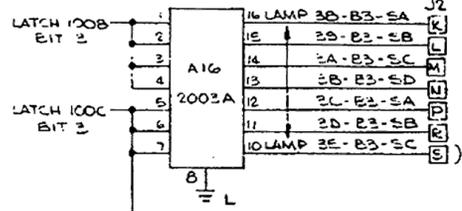
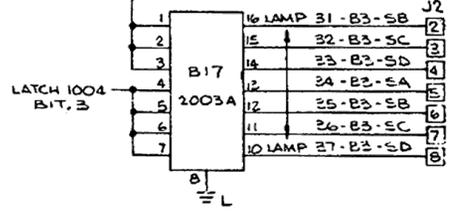
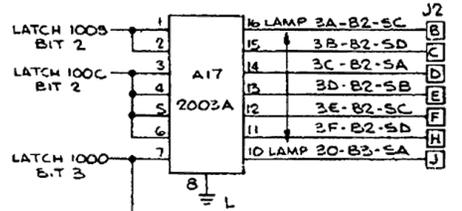
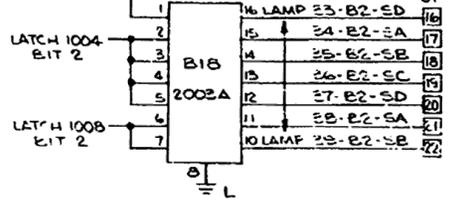
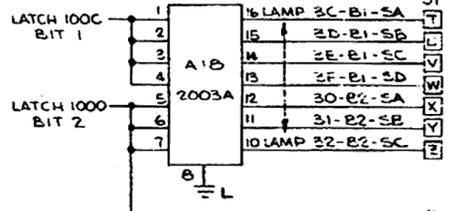
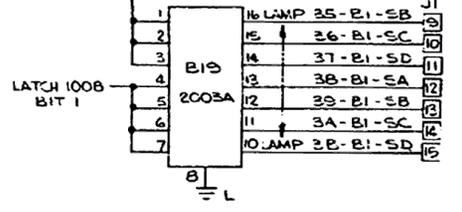
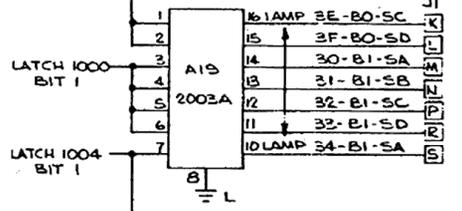
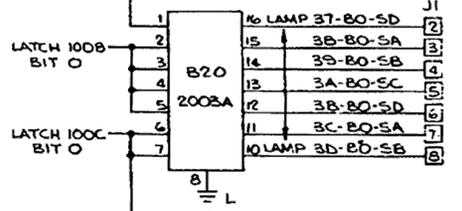
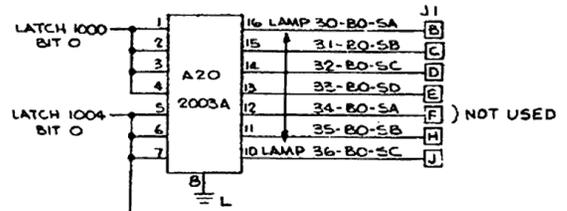
GEN TO A020235-01 STANDARD OR A020234-01 OPTION

REF: A007866-01



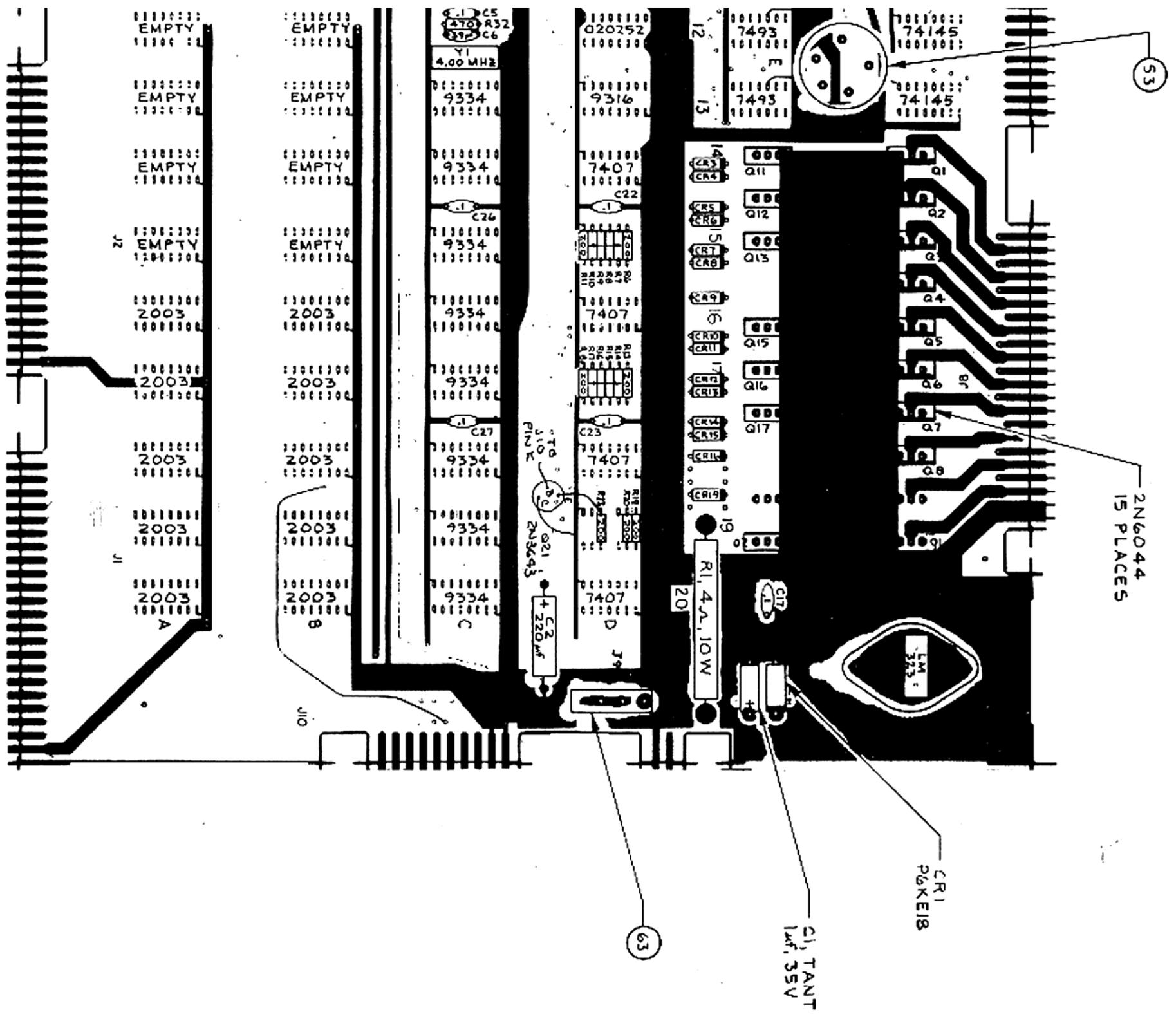
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 Q9, 10, 14, 18, 19, 12, 21, 22, 24, 25

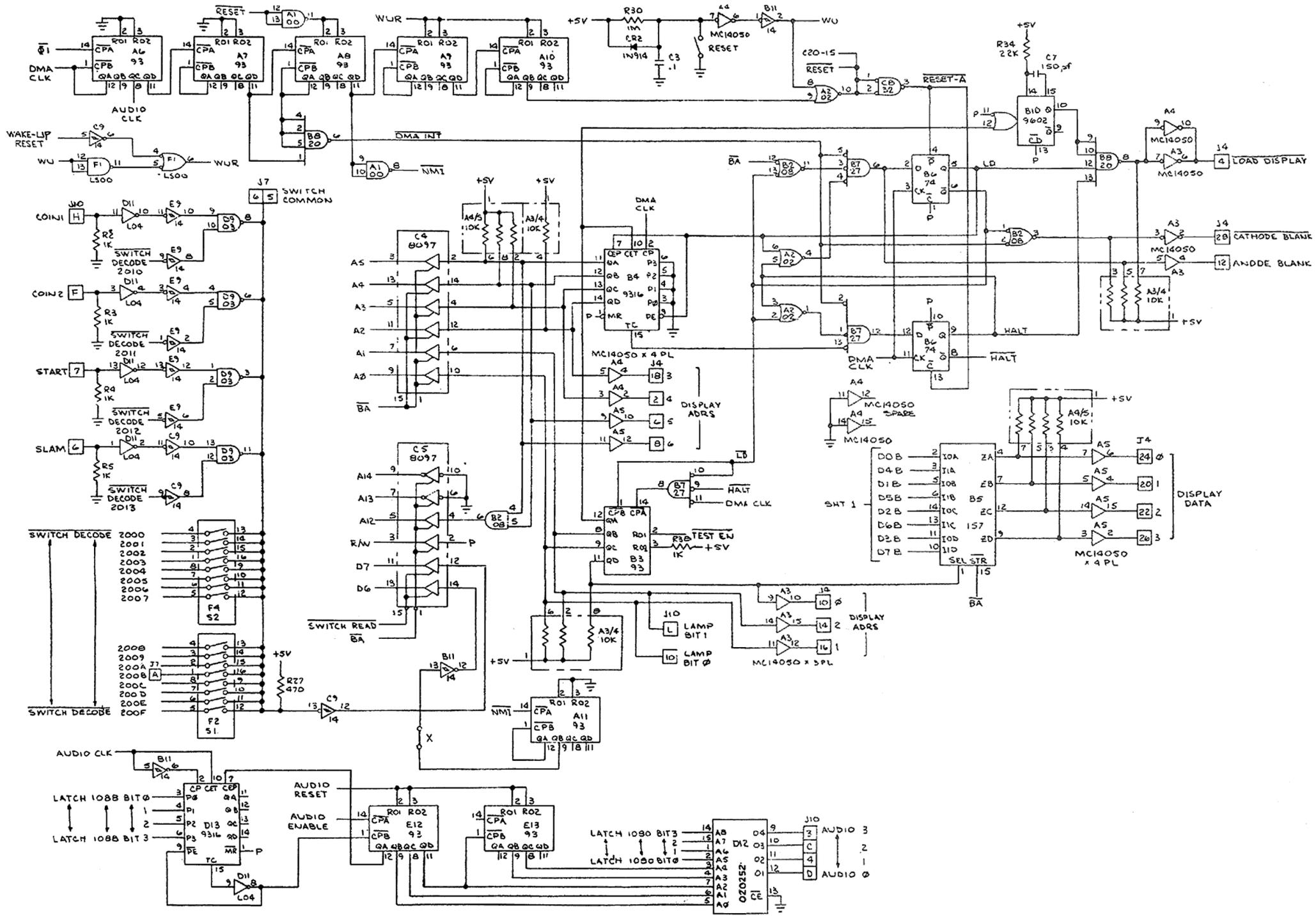


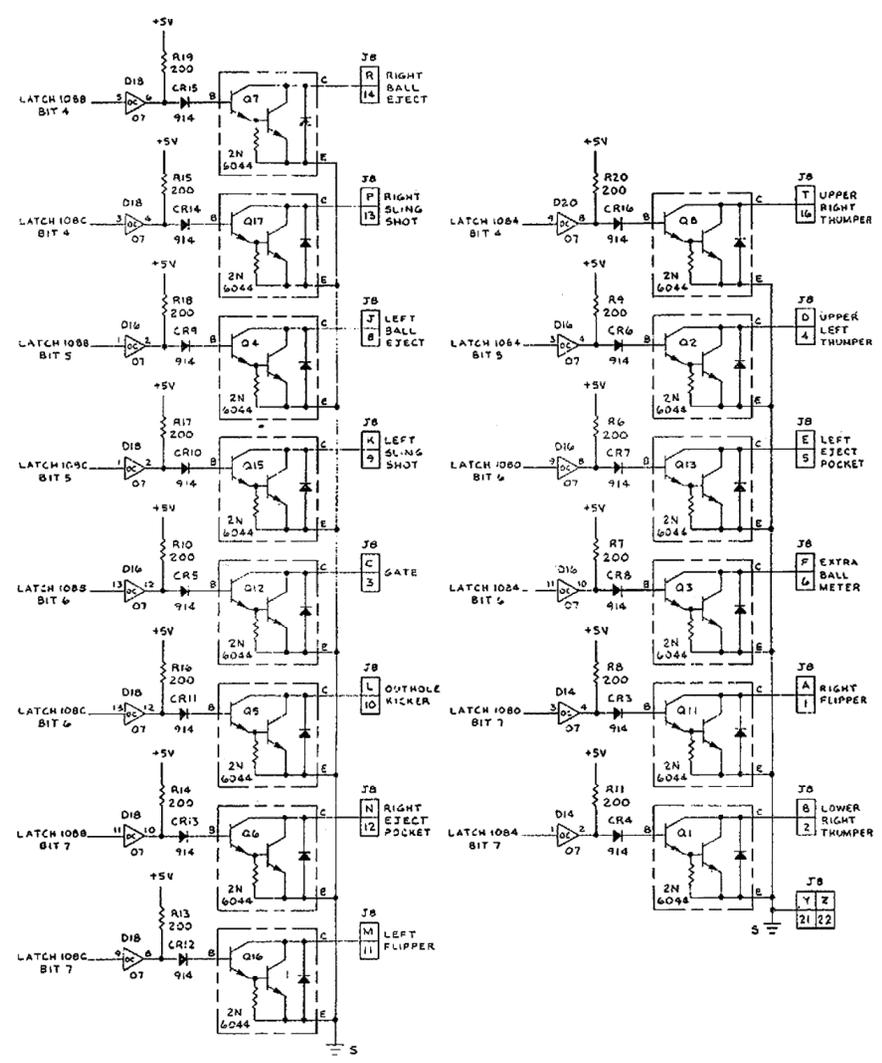
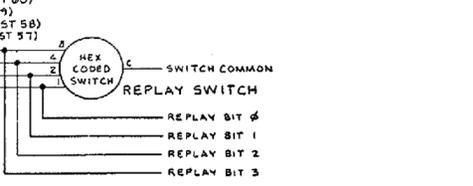
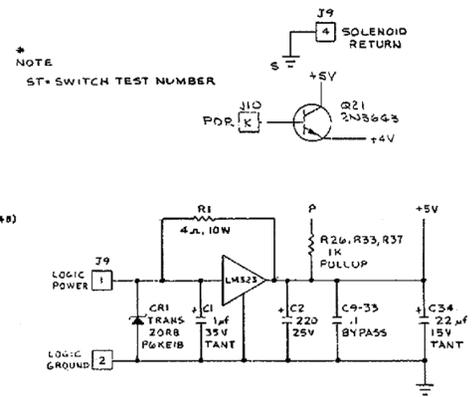
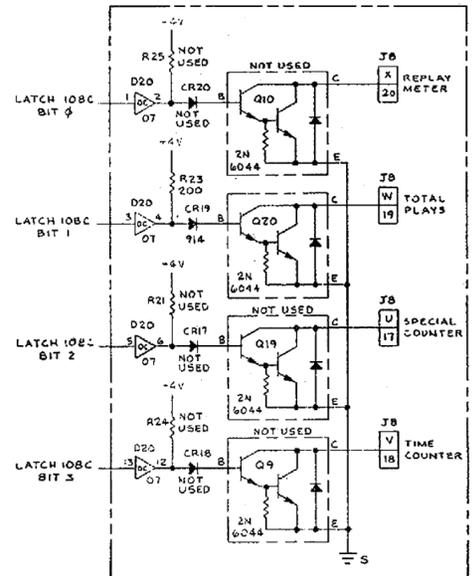
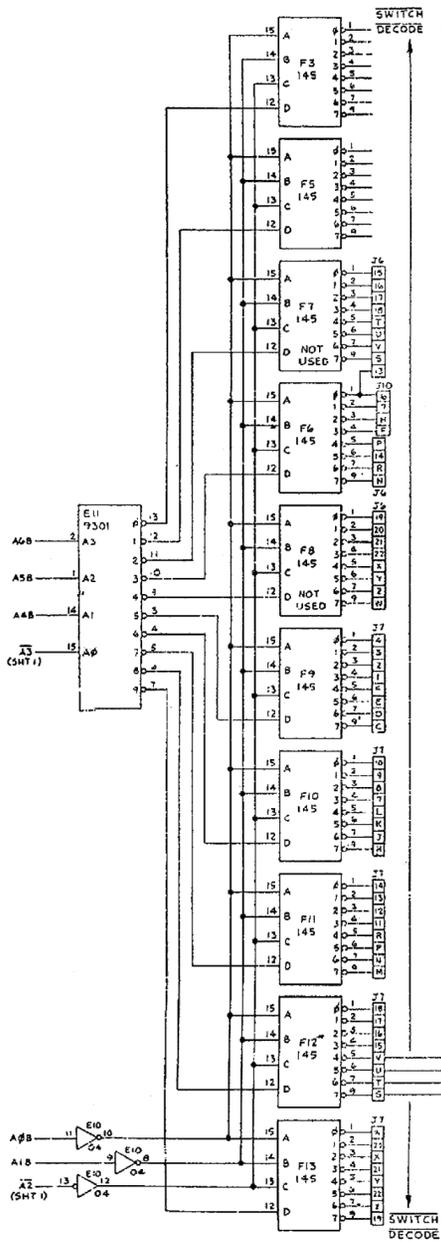


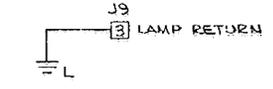
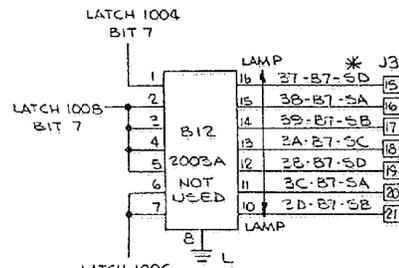
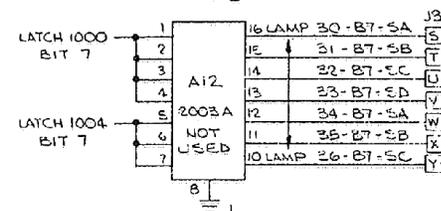
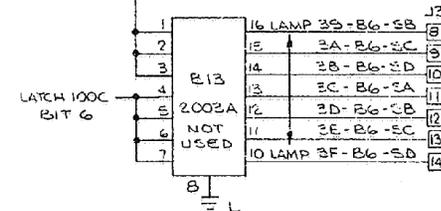
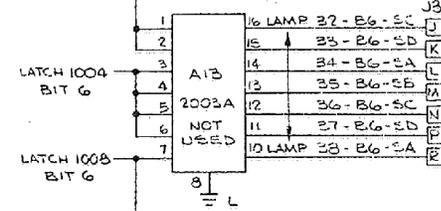
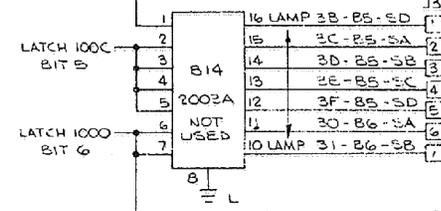
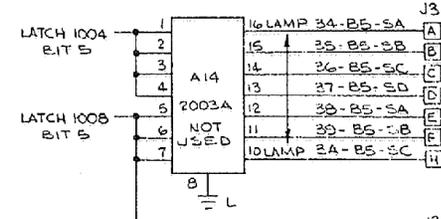
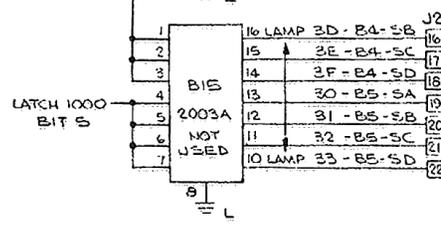
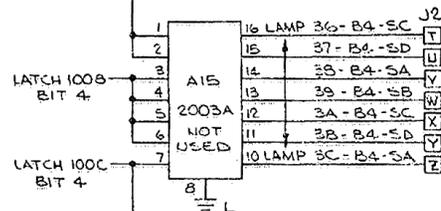
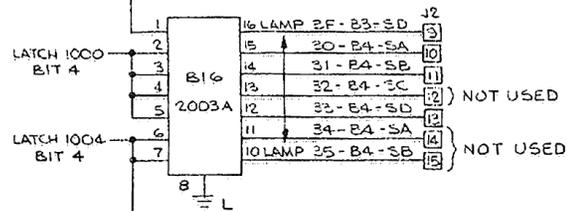
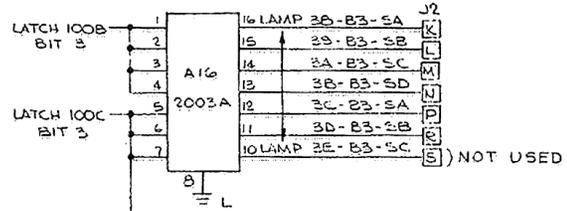
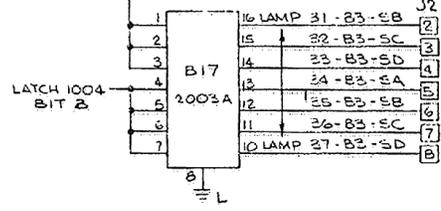
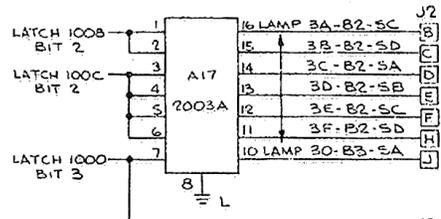
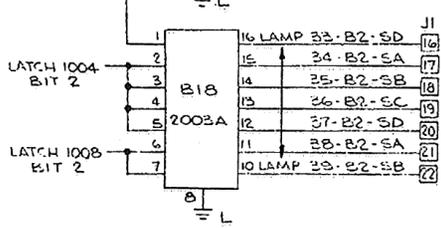
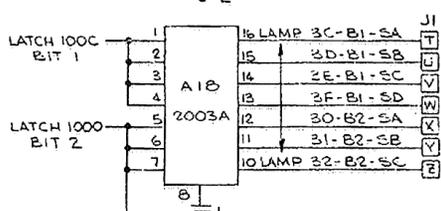
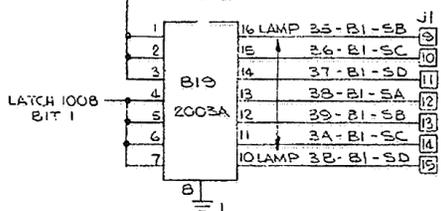
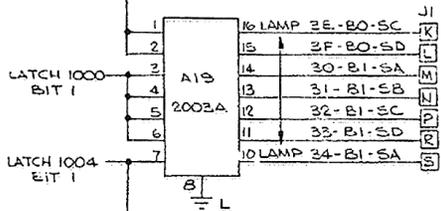
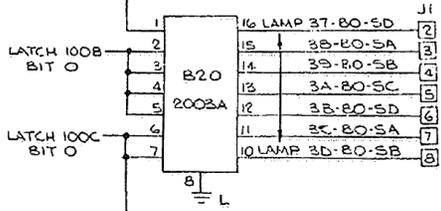
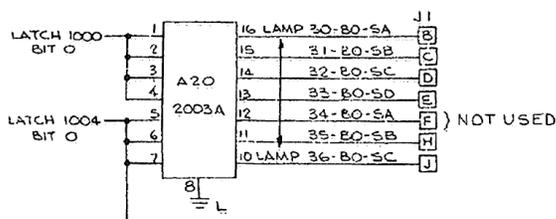
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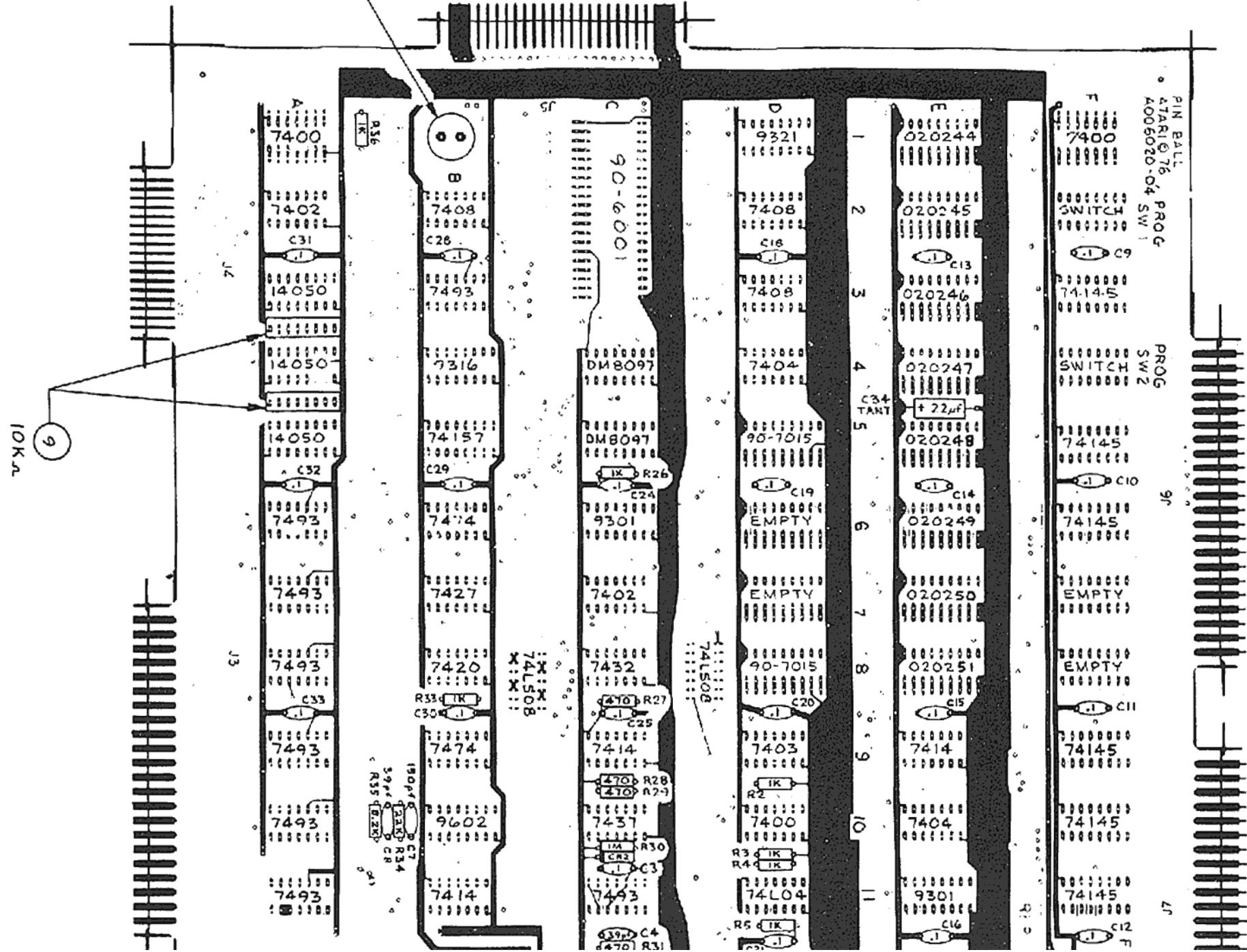






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RAM LOC	BIT NO	STRB
37	B7	SD



PIN BALL
 ATARI® 76 PROG
 4006020-04 SW 1

PROG
 SW2

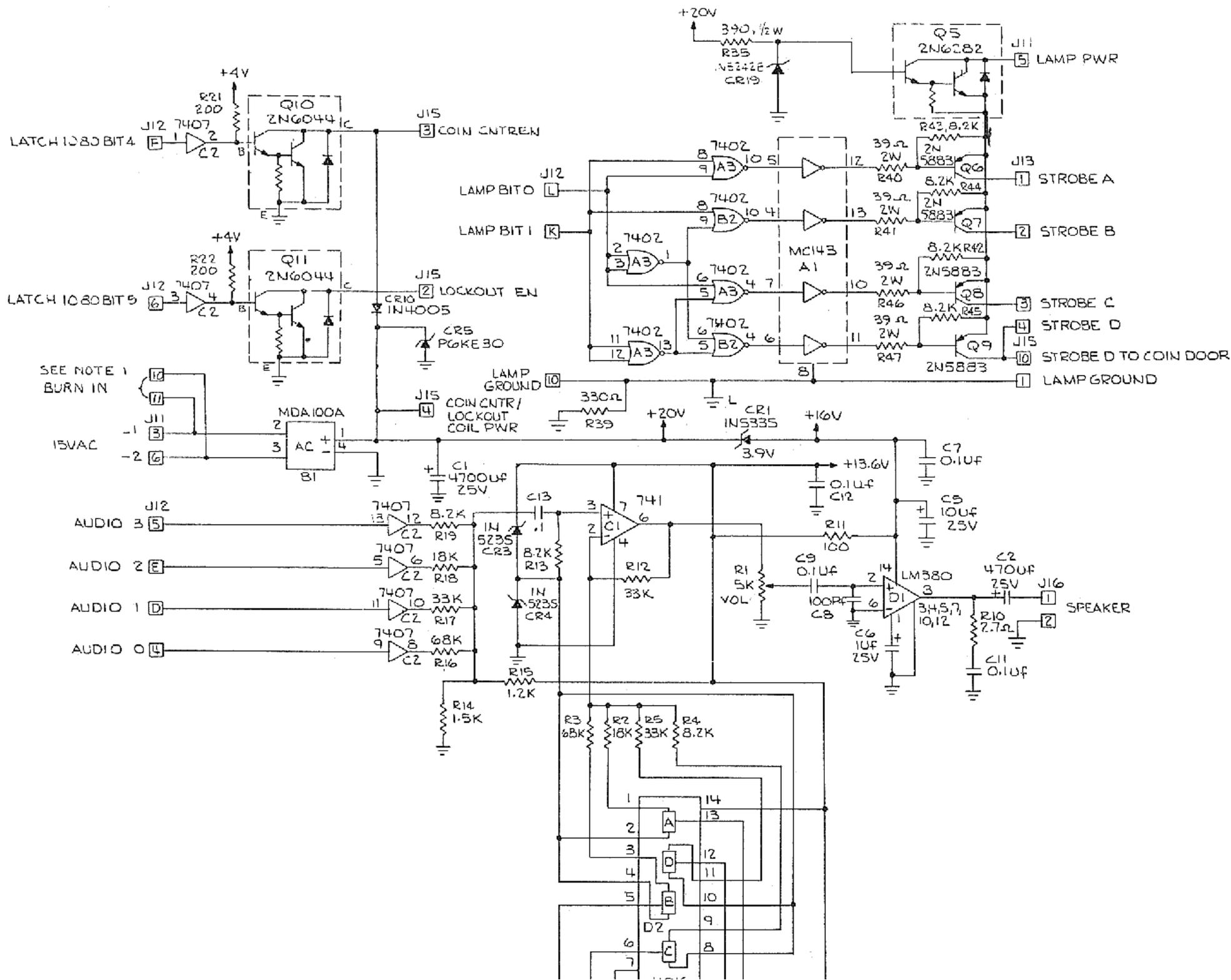
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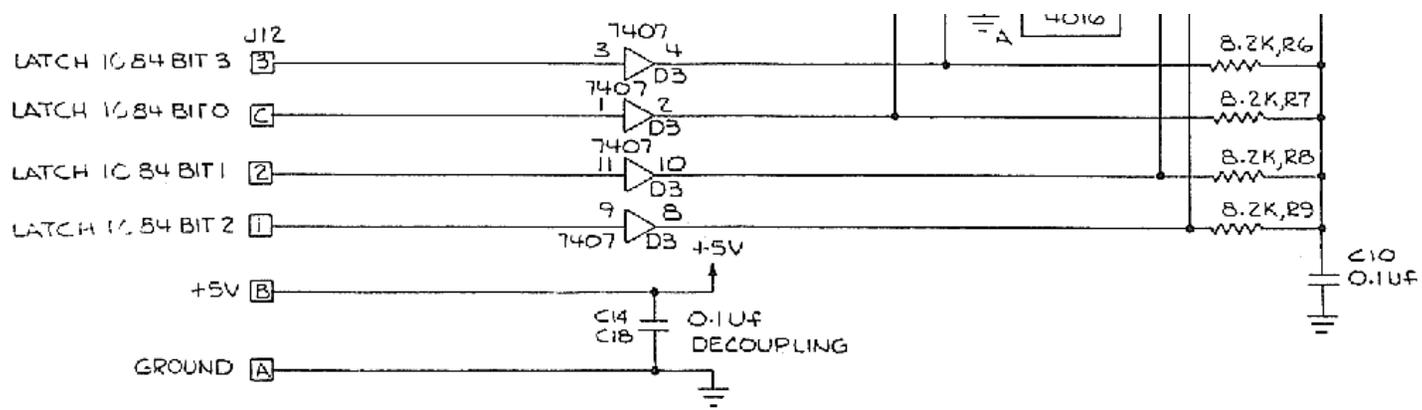
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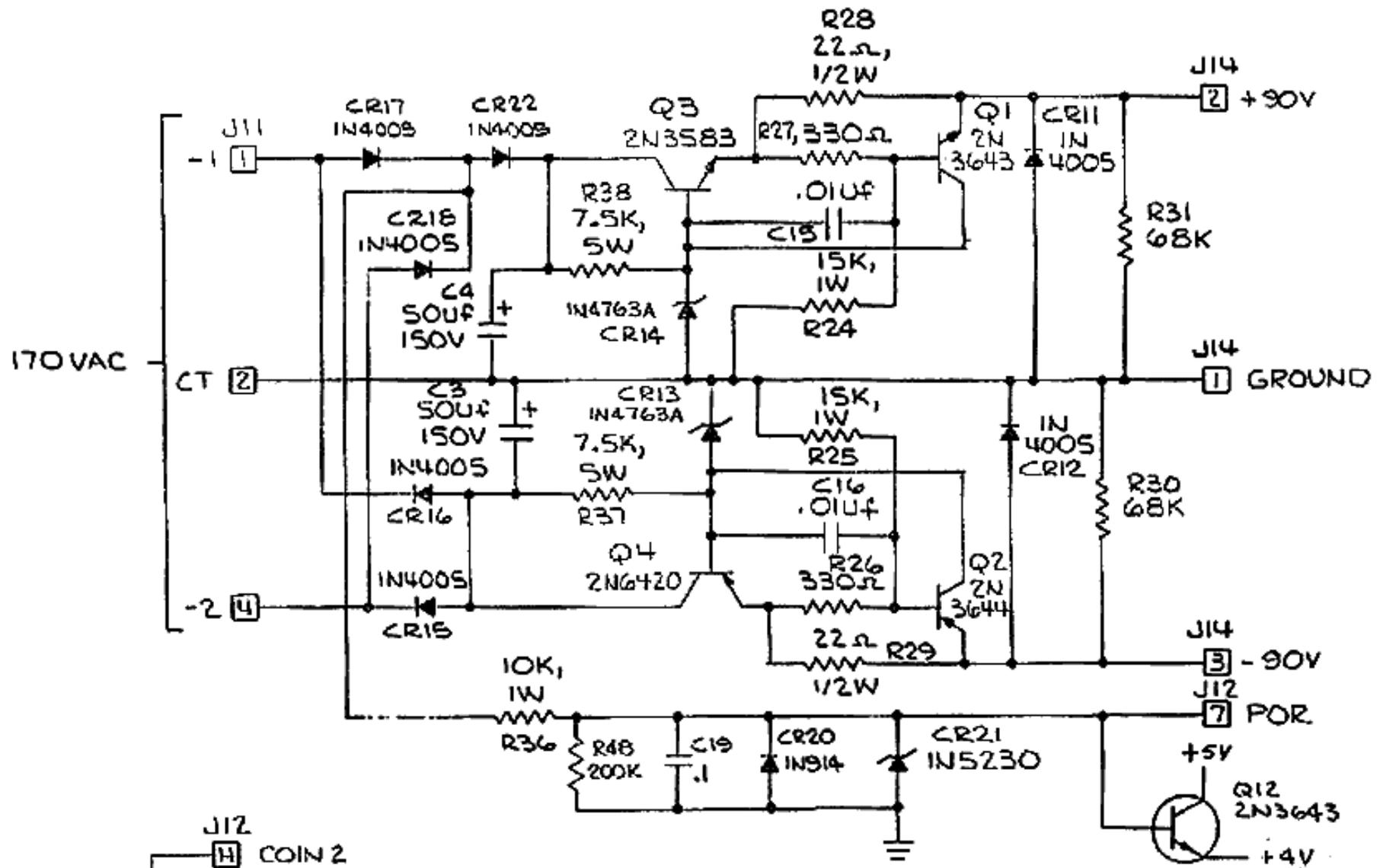
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9

10KΩ



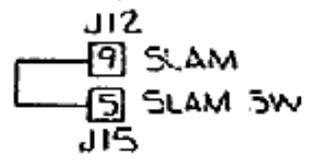
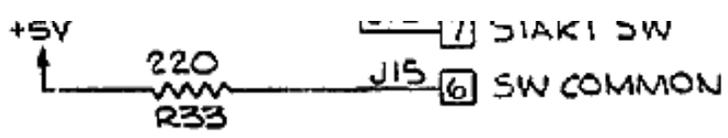




J12
 [14] COIN 2
 [9] COIN SW 2
 J15

J12
 [8] COIN 1
 [8] COIN SW 1
 J15

J12
 [1] START
 J15



JUMPER AS SHOWN

20

SCORE PANEL DRIVE 2
A004924-01
ATARI © 76
MADE IN USA

