CRYSTAL CASTLES

Operators Manual

With Illustrated Parts Lists

CRYSTAL CASTLES™

Operators Manual

With Illustrated Parts List

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Notice Regarding Non-ATARI Parts

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┌──────── ⚠ ── WARNING ── ⚠ ────────┐
│ Use of non-ATARI parts or modifications of any │
│ ATARI® game circuitry may adversely affect the │
│ safety of your game, and may cause injury to │
│ you and your players. │
└────────────────────────────────┘
```

You may void the game warranty (printed on the inside back cover of this manual) if you do any of the following:

* Substitute non-ATARI parts in the game.
* Modify or alter any circuits in the game by using kits or parts *not* supplied by Atari.

NOTE

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of Federal Communications Commission (FCC) Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area or modification to this equipment is likely to cause interference in which case the user, at his own expense, will be required to take whatever measures may be required to correct the interference. If you suspect interference from an ATARI® game at your location, check the following:

* All green ground wires in the game are properly connected as shown in the game wiring diagram.
* The power cord is properly plugged into a grounded three-wire outlet.
* The game printed-circuit boards (PCB) are properly installed within the Electromagnetic Interference (EMI) cage.
* The EMI Shield PCB is properly installed and connected in series with the game PCB harness.
* All filter capacitors required on the EMI Shield PCB are properly soldered in place.

If you are still unable to solve the interference problem, please contact ATARI Customer Service. See the inside front cover of this manual for service in your area.

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Glossary of Terms

Glossary of Terms begins on page *GL-1*

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Safety Summary

The following safety precautions apply to all game operators and service personnel. Specific warnings and cautions will be found throughout this manual where they apply.

⚠ WARNINGS ⚠

Properly Ground the Game. Players may receive an electrical shock if this game is not properly grounded! To avoid electrical shock, do not plug in the game until it has been inspected and properly grounded. This game should only be plugged into a grounded 3-wire outlet. If you have only a 2-wire outlet, we recommend you hire a licensed electrician to install a grounded outlet. Players may receive an electrical shock if the control panel is not properly grounded! After servicing any parts on the panel, check that the grounding clip is firmly secured to the metal tab on the inside of the control panel. Only then should you lock up the game.

AC Power Connection. Before connecting the game to the AC power source, verify that the proper voltage-selection plug is installed on the game's power supply.

Disconnect Power During Repairs. To avoid electrical shock, disconnect the game from the AC power source before removing or repairing any part of the game. When removing or repairing the video display, extra precautions must be taken to avoid electical shock because high voltages may exist within the display circuitry and cathode-ray tube (CRT) even after power has been disconnected. Do not touch internal parts of the display with your hands or metal objects! Always discharge the high voltage from the CRT before servicing this area of the game. To discharge the CRT: Attach one end of a large, well-insulated, 20-kV jumper to ground. Momentarily touch the free end of the grounded jumper to the anode by sliding it under the anode cap. Wait two minutes and discharge the anode again.

Use Only ATARI Parts. To maintain the safety integrity of your ATARI game, do not use non-ATARI parts when repairing the game. Use of non-ATARI parts or other modifications to the game circuitry may adversely affect the safety of your game, and injure you or your players.

Handle Fluorescent Tube and CRT With Care. If you drop a fluorescent tube or CRT and it breaks, it may implode! Shattered glass can fly six feet or more from the implosion.

Use the Proper Fuses. To avoid electrical shock, use replacement fuses which are specified in the parts list for this game. Replacement fuses must match those replaced in fuse type, voltage rating, and current rating. In addition, the fuse cover must be in place during game operation.

CAUTION

Properly Attach All Connectors. Make sure that the connectors on each printed-circuit board (PCB) are properly plugged in. Note that they are keyed to fit only one way. If they do not slip on easily, do not force them. A reversed connector may damage your game and void the warranty.

Set-Up

How to Use This Manual

This manual, written for game operators and service technicians, describes your new ATARI game.

Chapter 1 contains a game overview, game specifications, inspection procedures, voltage plug and fuse information, switch locations, and option information.
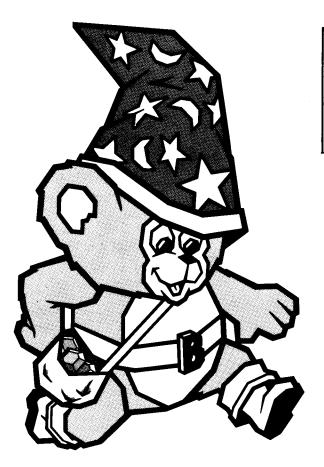
Chapter 2 contains self-test procedures.
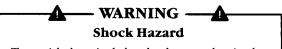
Chapter 3 contains troubleshooting procedures.

Chapter 4 contains maintenance and repair procedures.

Chapter 5 contains illustrated parts lists. Notes in this chapter refer you to other places in the manual for more detailed information.

Schematic diagrams of the game circuitry are included as a supplement to this manual.

⚠ — WARNING — ⚠
Shock Hazard

To avoid electrical shock, do not plug in the game until it has been inspected and properly set up for the line voltage in your area.

Do not touch internal parts of the display with your hands or metal objects!

Chapter 1

**Fluorescent Tube &
Attraction Panel**
See Figure 5-4

**Game Identification
Label**

EMI Cage
Not Used in Ireland
See Figure 5-9

Game PCB ★
Insided EMI Cage
See Figure 5-11

Speaker
See Figure 5-5

Access Panel

Video Display ★
See Figure 5-1

Deflection PCB ★
Used with Atari Display
See Figure 5-1

EMI Shield PCB
Not Used in Ireland
See Figure 5-10

Control Panel
See Figure 5-2

Regulator/Audio II PCB ★
See Figure 5-12

**Lighted
Midi Trak-Ball**
See Figure 5-3

Power Supply
See Figure 5-13

Power On/Off Switch

Coin Door
See Figures 5-7 or 5-8

Utility Panel
See Figure 5-6

★ Item with a serial number label

⚠ WARNING ⚠
Shock Hazard

Do not plug in the game until it has been inspected. This game should only be connected to a grounded 3-wire outlet. If you have only a 2-wire outlet, we recommend you hire a licensed electrician to install a grounded outlet. Players may receive an electrical shock if this game is not properly grounded!

Figure 1-1 Game Overview

Game Overview

Crystal Castles is a merry chase into a mythical land of incredible creatures that thrill at every turn of game play. Its hero, Bentley Bear, collects gemstones as he moves around 16 different playfields, including a castle, fortress, palace, and even a dungeon. Scary creatures, such as nasty trees, gem eaters, a swarm of bees, and Berthilda the witch, chase Bentley Bear as he explores tunnels, elevators that take him from one plateau to another, and sometimes a secret ramp.

Crystal Castles has three new features. Even if you are familiar with Atari games, you should note these important differences:

Lighted Midi Trak-Ball™. The Midi Trak-Ball on the control panel of this game is translucent. A small lamp controlled by the game PCB shines through the ball. The result is a glowing Trak-Ball. During game play, the lamp flashes on and off creating a spectacular effect.

Game Playfield Color Changes. You may notice that the castles and gems occasionally change colors. This is a feature, not problems with the color display. After each one hundred paid games, the color schemes of the castles change colors.

All major parts of the cabinet are illustrated in Figure 1-1.

Installation Specifications

Table 1-1 describes the physical, electrical, and environmental specifications of the game.

Table 1-1 Installation Requirements

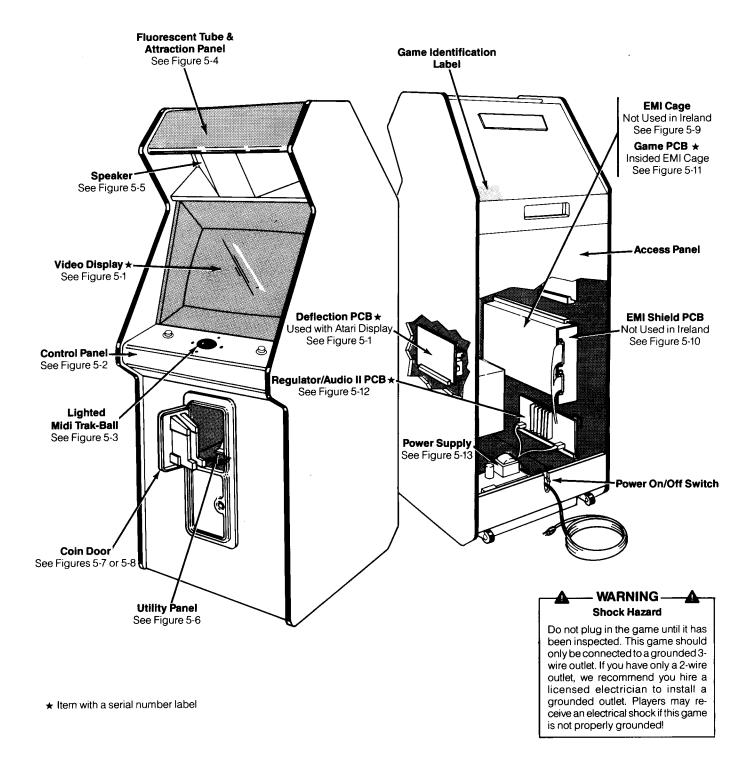| Characteristic	Requirement
Power Consumption	120 W
Temperature	0° to +32°C (+32° to +100°F)
Humidity	Not to exceed 95% relative
Line Voltage	100 to 240 VAC
Width	65.4 cm (25.75 in.)
Depth	78.7 cm (31 in.)
Height	182.9 cm (72 in.)

Inspecting the Game

Please inspect your game carefully to ensure that it was delivered to you in good condition.

1. Examine the exterior of the game cabinet for dents, chips, or broken parts.

2. Remove the screws from the rear access panel. Unlock and open this panel and the coin door. Inspect the interior of the game as follows:

    a. Ensure that all plug-in connectors (on the game harnesses) are firmly plugged in. Replug any connectors found unplugged. Do not force connectors together. The connectors are keyed so they only fit in the proper orientation. *A reversed edge connector may damage a printed-circuit board (PCB) and will void your warranty.*

    b. Ensure that all plug-in integrated circuits on each PCB are firmly plugged into their sockets.

    c. Unhook the power cord from the top of the game cabinet. Inspect the power cord for any cuts or dents in the insulation. Repair or replace it as required.

    d. Inspect the power supply. Make sure the fuse block is mounted in place. Check that the green ground wires are connected.

    e. Inspect other major subassemblies, such as the control panel, video display, EMI cage, and each PCB. Make sure they are mounted securely and that the green ground wires are connected.
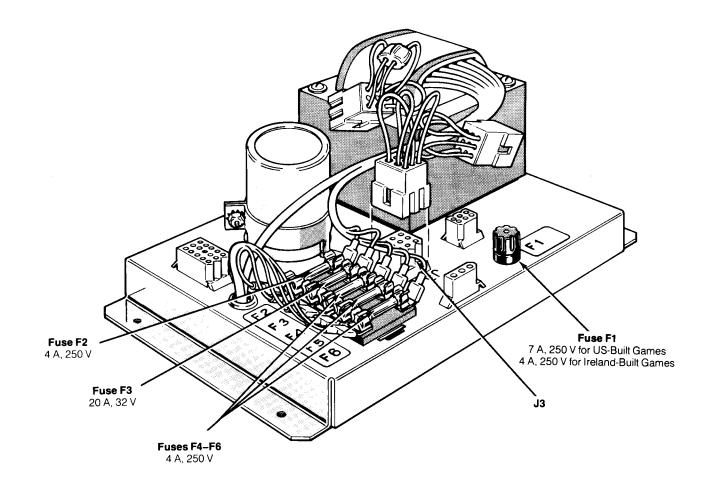
Voltage-Plug Selection and Fuses

The power supply in your game contains six fuses. When you replace a fuse, use the identical type fuse with the same electrical rating (see Figure 1-2).

This power supply operates on the line voltage of many countries. The power supply comes with either one, two, or three voltage-selection plugs. Plug voltages and wire colors are 100 VAC (violet wire color), 120 VAC (yellow wire color), 220 VAC (blue wire color), and 240 VAC (brown wire color).

See Figure 1-2 for placement of the voltage-selection plug. Before plugging in your game, check your line voltage. Next, check the wire color on the voltage-selection plug. Make sure the voltage-selection plug is correct for the line voltage of your location.

Now plug the game into a **grounded** 3-wire outlet.

Fuse F2
4 A, 250 V

Fuse F3
20 A, 32 V

Fuses F4–F6
4 A, 250 V

Fuse F1
7 A, 250 V for US-Built Games
4 A, 250 V for Ireland-Built Games

J3

Fuse cover is shown in Figure 5-13.

Figure 1-2   Voltage-Selection Plug and Fuse Locations

Switch Locations

Power On/Off Switch

The power on/off switch is located on the back of the cabinet on the lower left side (see Figure 1-1).

Utility Panel Switches

The volume control, coin counter(s), self-test switch, and auxiliary coin switch are on the utility panel. The utility panel is located inside the upper coin door (see Figure 1-2). The volume control adjusts the level of sound produced by the game. The coin counter(s) records the number of coins entered into the game. The self-test switch initiates the self-test mode. The auxiliary coin switch credits the game without activating a coin counter. See Figures 1-3 and 5-6 for details of these switches.

Option Switch

Figure 1-3 shows the location of the dual-inline-package (DIP) switch at R8 on the game printed-circuit board (PCB). This option switch controls whether coins are counted on 1 or 2 coin counters.

Setting the Coin Counter Switch

Toggle 1 of this option switch is the only switch that is used. When set to the ON position, the left and right coin counter outputs of the game PCB are paralleled together.

Therefore, any coin received from the right or left coin inputs will be counted on one counter connected to either the left or right coin-counter output. The US-built games have one coin counter. Therefore, on US-built games, toggle 1 of the switch should be set to ON.

When toggle 1 is set to OFF, a second coin counter must be connected to the unconnected coin counter output. For Ireland-built games, the second coin counter is standard. Therefore, on Ireland-built games, toggle 1 of the switch should be set to OFF.

Selecting the Coin, Credit, and Game Options

Setting the coin, credit, and game options is done with the player controls during the Self-Test mode of operation. Therefore, you should never need to remove the game PCB from the electromagnetic interference (EMI) cage unless the PCB is in need of repair. All selected options are retained in a special integrated circuit (IC) on the PCB. Even when the power is turned off, the selected options are saved in this IC.

To select the coin, credit, and game options, see Chapter 2, Self-Test Procedures.
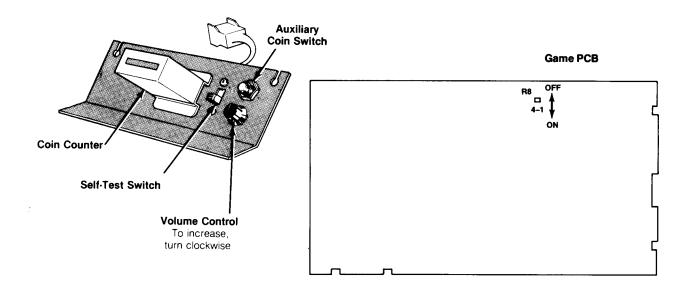

Figure 1-3 Switch Locations

Game Play

Crystal Castles is a fast-action, 1- or 2-player, third-person adventure game. By using the Lighted Midi Trak-Ball, the player moves Bentley Bear about the castle walkways and walls to collect gems. To avoid being overpowered by gem eaters, nasty trees, or bee swarms, use the left- or right-hand jump buttons.

Crystal Castles has 6 modes of operation: the power-up self-test mode, the attract mode, the ready-to-play mode, the play mode, the hall-of-fame entry mode, and the self-test mode.

Power-Up Self-Test Mode

The power-up self-test mode begins when power is applied to the game. The power-up self-test checks the random-access memory (RAM), the electrically erasable read-only memory (EEROM), and the read-only memory (ROM) of the game PCB. If any of these tests fail, a message on the display or tones from the game speakers identify the failing component(s). If the tests pass, the game program advances to the attract mode. Refer to Chapter 2 for a description of the menu-driven self-test mode selected by the self-test switch located on the utility panel.

Attract Mode

The attract mode consists of 4 displays: the coin message display, the game demonstration display, the hall-of-fame display, and the hints display.

The coin message display begins after the power-up self-test, after the play mode, or after the hall-of-fame entry mode. This display lasts for about 10 seconds and is only interrupted by depositing a coin or by entering the self-test mode. The coin message display starts with a three-dimensional painting of the game playfield and the first-level, first-wave castle. At the top left of the display is a box that, during game play, contains the player(s) score(s). During the attract mode, the score(s) are displayed only if the player(s) of the previous game didn't get a high enough score to enter their initials into the hall-of-fame table.

At the top right of the display, the coin message appears in a large box. In this box, the message *INSERT COINS* appears and disappears. Immediately below the insert coins message is the message *0 CREDITS.* If the previous player reached castle 2 of level 2 (or beyond), the highest score of the hall-of-fame table appears immediately above the insert coins message. The initials entered for the highest score of the hall-of-fame table appear carved into the roof of the castle.

The game demonstration display begins immediately after the coin message display. This display lasts about 10 seconds and is only interrupted by depositing a coin or by entering the self-test mode. The game demonstration display is similar to the coin message display except that Bentley Bear, three opponent crystal balls, and the gems are now displayed. The gems are on the walkways and walls of the castle. In the top right message box are the messages *CRYSTAL CASTLES* and *COPYRIGHT ATARI 1983 ALL RIGHTS RESERVED.* Soon after the beginning of this display, Bentley Bear moves about the castle walkway collecting gems. Point values appear in the top left box for each gem collected by Bentley Bear. Bentley Bear jumps a few times before coming in contact with one of the opponent balls. When Bentley Bear comes in contact with the ball, the cartoon caption *#!?* comes from the mouth of Bentley Bear. Next, Bentley Bear "flies to heaven."

The hall-of-fame display begins immediately after the game demonstration display. This display lasts about 10 seconds and is only interrupted by depositing a coin or by entering the self-test mode. At the top of the display is the message *CRYSTAL CASTLES HALL OF FAME.* Below this is a two-column listing of the 32 highest scores. If this list is cleared in the self-test mode, the scores range from a low of 27,000 to a high of 30,000 points.

The hints display begins immediately after the hall-of-fame display, or immediately following a game mode in which the player(s) did not reach a score level sufficient for entering initials in the hall-of-fame entry mode. This display has the word *HINTS* across the top of the display, followed by four game hints.

The first hint is about the magic hat that Bentley Bear can wear to make himself invincible. Both the hat and Bentley Bear are shown on the screen with the message *MAGIC HAT MAKES YOU INVINCIBLE. WEAR IT AND YOU CAN KILL BERTHILDA.*

The second hint shows two gem eaters. One is eating gems and the other is shown moving from side to side. With these is the message *CATCH GEM EATERS WHEN THEY ARE EATING. STAY AWAY WHEN THEY ARE MOVING FROM GEM TO GEM.*

The third hint shows the bee swarm with the message *TAKE TOO MUCH TIME AND THE SWARM RETURNS.*

The fourth hint show the trees with the message *JUMP OVER TREES TO STUN THEM.*

Ready-to-Play Mode

The ready-to-play mode begins when a coin is accepted by one of the two game coin mechanisms. This mode lasts until enough coins are received for a 1- or 2-player game and the 1-player or 2-player button is pressed. This mode is identical to the coin message display of the attract mode, except the coin message shows the number of credits, from a possible ½ credit to a maximum of 18 credits, resulting from coin(s) deposited into the game coin mechanism.

Play Mode

The play mode begins when enough coins have been deposited in the game coin mechanism and the 1-player or 2-player start button is pressed. This mode ends after the last life has been lost during game play.

The player's objective is to collect all the gems from the castle walkways and walls by moving Bentley Bear about the castle with the Trak-Ball controller. Bentley Bear must collect all the gems without being killed by any of the 8 possible computer-controlled opponents—crystal balls, trees, a swarm of bees, gem eaters, Berthilda the witch, a ghost, a skeleton, or a dust devil. In the lower levels of game play, this feat is easily learned by new players. In higher levels, experience, skill, and luck help the player to accomplish the objective.

When game play begins, Bentley Bear is at the lower right corner of the castle walkway. Immediately after the player's control is enabled for moving Bentley Bear, the opponents are displayed about the castle walkways and walls. The player may move Bentley Bear either up or down the stairs or the elevators to get the gems. When Bentley Bear passes over a gem, the gem disappears. Points are scored for each gem collected by Bentley Bear and shown in the score display area. If Bentley collects all the gems from the castle, the player receives bonus points. The initial bonus is 1,000 points for the first castle of the first level. The bonus is increased by 100 points for each subsequent castle (i.e., the bonus for castle 2 of level 1 is 1,200 points; castle 1 of level 2 is 1,400 points; etc.).

When a start button is pressed, the gems and Bentley Bear appear on the castle walkway and the game tune begins. Soon afterward, three crystal balls (the only opponents of this wave) drop from above and land at the far right corner of the castle walkway. These three balls begin a slow pursuit of Bentley Bear. As the Trak-Ball is rotated, Bentley Bear moves about the walkway. As he passes over a gem, the gem disappears and a score value is added to the score in the window at the top left of the display. If Bentley Bear gets all the gems, the three balls rise out of sight above the castle. Then Bentley Bear also disappears. If Bentley Bear gets the last gem, the message *YOU GOT THE LAST GEM. BONUS 1000* appears across the castle. If the opponents get the last gem, the message *THEY GOT THE LAST GEM. NO BONUS* appears across the the castle.

Crystal Castles consists of 37 castle mazes that are laid out with a walkway between each castle. The castles are arranged in ten levels with four castles on each level, except for level 10, which has only one castle. As Bentley Bear advances to the next castle on each level, the difficulty in collecting all the gems increases. Each level also increases in complexity. The result is a nice variety of mazes, from the easy first castle of level 1 to the extremely difficult castles in the higher levels. At the beginning of play at each castle, a message appears in the window at the top right of the display. This message identifies the level being played. Other messages, such as next bonus point level, also appear in this window.

A message may appear in the message window to identify the activation of a warp. For example, if a player reaches castle 2 of level 2 (or beyond), a door appears in the first castle of level 1. If Bentley Bear enters into this door and the player presses the jump button, Bentley Bear will warp (advance) to the first castle of the third level. Some secret warps also exist.

In this printing of the manual, we will tell you of two secret warps. One is located at the rear corner of the first castle of level 1. To use this warp, the player must move Bentley Bear to this spot and press the jump button. Bentley Bear will advance to the first castle of level 3. The second secret warp is in the rear corner of the hidden ramp of the first castle of level 3. However, Bentley Bear must be wearing the hat when he jumps at this location. When this warp is used, Bentley Bear will advance to the first castle of level 5. Future printings of this manual will include other secret warps.

Bentley Bear has eight opponents: crystal balls, trees, a swarm of bees, gem eaters, Berthilda the witch, a ghost, a skeleton, and a caldron. Figure 1-4 shows six of these opponents, which are encountered during game play. If Bentley Bear touches a gem eater while it is in the process of eating a gem, the gem eater dies and 500 points are awarded the player. However, if the gem eater is not eating a gem when Bentley Bear touches it, Bentley Bear dies. When Bentley Bear is wearing his magic red hat, he is invincible. When he is wearing the hat he has the power to kill Berthilda the witch when he touches her. However, the magic of the hat only lasts about 5 seconds.

Each of the opponents has its own characteristic. The swarm of bees appears near the honey approximately every five seconds. However if Bentley Bear takes the honey, he collects 1,000 points for the honey, and the bees will appear less frequently. The gem eaters are relatively stupid creatures. The only thing they are interested in is eating gems. However, if gems are not in their area, the gem eaters will rush around randomly looking for gems. The crystal balls and trees act much the same. They will go

directly for Bentley Bear. However, if Bentley keeps obstacles between him and either of these opponents, he is relatively safe from attack. The skeleton and the ghost usually stay within their immediate areas, move about randomly, but not very fast. They guard their area well. Berthilda the witch flies around on her broom in one small area in the lower levels of game play. However, in the higher levels she boldly flies about the castles.
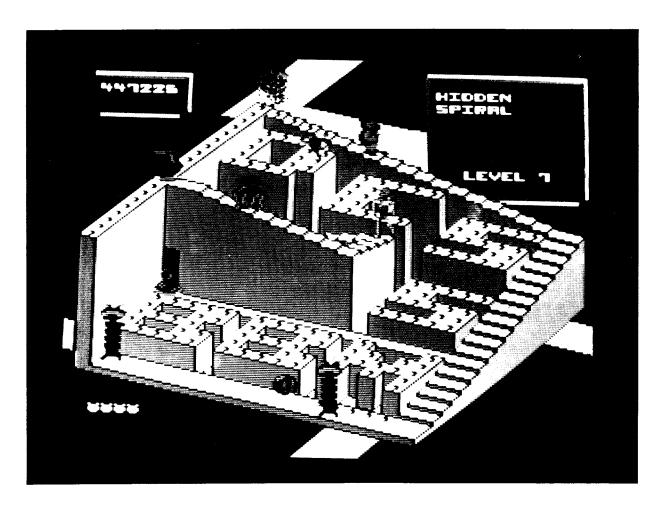
Figure 1-4 Opponents of Castle 3, Level 7

Self-Test

This game will test itself and provide data to show that the game circuitry and controls are operating properly. Self-test data is presented visually on the video display and audibly through the speakers. No additional equipment is required.

We suggest you perform a self-test when you first set up, each time you collect money, change the game options, or suspect game failure.

Chapter 2

Entering Self-Test

To enter the self-test mode, set the self-test switch on the utility panel to the ON (up) position (see Figure 1-3 for the location of this switch). The game tests the custom Input/Output (I/O) integrated circuits (ICs), the random-access memory (RAM), the bit-mode circuitry, the electronically erasable read-only memory (EEROM), and the read-only memory (ROM). Figure 2-1 shows the resulting video display if these tests pass. The custom I/O test is the only test not shown on the video display. If this test passes, you will hear sounds that range from a low frequency to a high frequency.
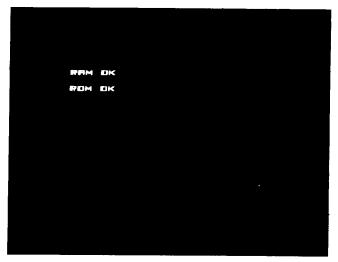
Figure 2-1 Test Passes Video Display

If the RAM fails, a sequence of seven "beep" sounds will be emitted from the game speakers, followed by a pause, then the sounds will be repeated. Table 2-1 identifies the failing RAM for the emitted sounds. In this table, the "High" indicates high tones from the game speaker and the "Low" indicates low tones.

If the bit-mode circuitry fails, a sequence of "beep" sounds will be emitted as follows: High, low, high, low, low, low, low.

If the EEROM fails, the video display will identify the failed IC as shown in Figure 2-2. The display will indicate a failed IC at either location 4A or 4B.

If a ROM fails, the video display will be as shown in Figure 2-3. In this figure, integrated circuit 1L has failed. The correct checksums are as follows: checksum 01 for 1K, 02 for 1L, 03 for 1N, 04 for 1H, and 05 for 1F. Checksums of any other value indicate a failure for that IC.

Figure 2-2 EEROM Failure Video Display

Figure 2-3 ROM Failure Video Display

Table 2-1 RAM Failure Tone Sequence

Tone Sequence							
1	2	3	4	5	6	7	PCB Location
High	Low	Low	Low	Low	Low	Low	RAM at 4E
High	High	Low	Low	Low	Low	Low	RAM at 4F
High	High	High	Low	Low	Low	Low	RAM at 4H
High	High	High	High	Low	Low	Low	RAM at 4J
High	High	High	High	High	Low	Low	RAM at 6B
High	High	High	High	High	High	Low	RAM at 6D

Self-Test Main Menu

If all initial self-tests pass, the main menu will be displayed as shown in Figure 2-4. This menu allows you to select from seven different items. As indicated at the bottom of the display, set the self-test switch to off (down) to exit from self-test.

```
ADVANCE WITH LEFT BUTTON
SELECT WITH RIGHT BUTTON

→ GRID

  ACCOUNTING

  CLEAR ACCOUNTING

  GAME OPTIONS

  TEST EEROM

  SWITCH TEST

  RESET HALL OF FAME

SWITCH SELF TEST SWITCH TO EXIT
```

**Figure 2-4 Self-Test Main
Menu Video Display**

Grid Display

The grid display shown in Figure 2-5 is used for adjusting the video display. When properly adjusted, the grid should be white on a black background. The corners of the grid should just barely go off the corners of the display.
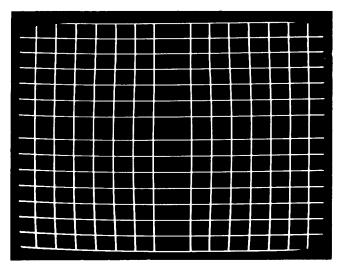
Figure 2-5 Grid Video Display

Accounting Display

The accounting display shown in Figure 2-6 is used for displaying historical information about the game. The photograph shown in Figure 2-6 was taken of an engineering prototype game. Therefore, in our example, no coins are shown for the left mechanism and only two coins for the right mechanism; but 46 coin credits are shown for the auxiliary coin switch. Ordinarily, the coin information is never cleared unless the EEROM are changed or damaged. Thus, this information may be compared with the information from the mechanical coin counter(s) for determining the accuracy of the mechanical coin counters.

The most important information shown on the accounting display is the average game time. This time should be *between 2 and 3 minutes.* The display in Figure 2-6 is a good example of optimum game time. A histogram of game time is shown at the bottom of the screen.

```
            ACCOUNTING

    AUX COINS                   46
    LEFT COINS                   0
    RIGHT COINS                  2
    TOTAL PAID COINS             2
    1 PLAYER GAMES              26
    2 PLAYER GAMES               5
    TOTAL CREDITS PLAYED        36
    AVERAGE GAME TIME         2: 36
    HISTOGRAM
                 0: 40       0
                 1: 20       3
                 2: 00      10
                 3: 40      11
                 3: 20       5
                 4: 00       3
                 5: 20       1
                 6: 00       3


                    0
```
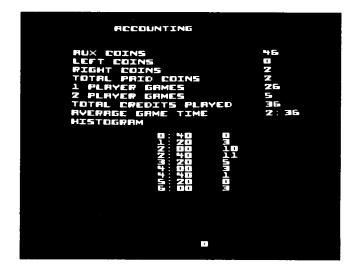
Figure 2-6 Accounting Video Display

Clear Accounting Display

The clear accounting video display is shown in Figure 2-7. Note that the coin information is never cleared.
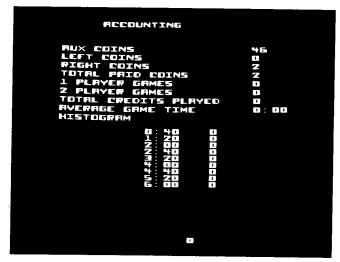

Figure 2-7 Clear Accounting Video Display

Game Options Menu

The manufacturer's recommended game options are shown in Figure 2-8. To move the arrow that points to each selectable option, press the left JUMP button. To change the option, press the right JUMP button. All available options are as follows:

COIN VALUE. The coin-value option determines the number of coins entering the left or right coin mechanisms, required to play one game. The values available are ½, 1, or 2. For game demonstrations, the FREE PLAY option is also available.

LEFT MECH VALUE. The available left mechanism values are 1 or 2. The chosen value multiplies the coins received in this mechanism by that value. When set to 1, a coin dropped into the left coin mechanism of the coin door has the value of 1 coin. When set to 2, a coin dropped into this mechanism has the value of 2.

RIGHT MECH VALUE. The available right mechanism values are 1, 4, 5, or 6. The chosen value multiplies the coins received in this mechanism by that value. This option makes it possible to receive coins with a higher denomination than the left mechanism.

GAME DIFFICULTY. This option allows you to increase or decrease the difficulty of the game, thus increasing or decreasing the average game time. When used with the accounting display, you may tune the game for the optimum game time of 2 minutes and 30 seconds by setting this option to EASY, MEDIUM, HARD, or HARDEST.

STARTING LIVES. This option allows you to increase the number of lives per game from 3 to 5. The available options are 3, 4, and 5. Using this option along with the accounting display will allow you to tune the game for an optimum average game time of 2 minutes and 30 seconds.

EXTRA LIVES. This option allows you to award bonus lives for every 70,000 points scored. The available options are YES and NO. Using this option along with the accounting display will allow you to tune the game for the optimum average game time of 2 minutes and 30 seconds.

RESTORE FACTORY OPTIONS. This option allows you to restore the options to those retained in the game program memory. These factory-recommended options are shown in Figure 2-8.

EXIT. This is not an option, but the way back to the main menu.

Figure 2-8 Game Options Video Display

Test EEROM Display

If the EEROM test passes, the results of the test are shown in Figure 2-9. If either EEROM integrated circuit 4A or 4B fails, the failed IC will be displayed as shown in Figure 2-2. However, the message RAM OK will not be displayed.
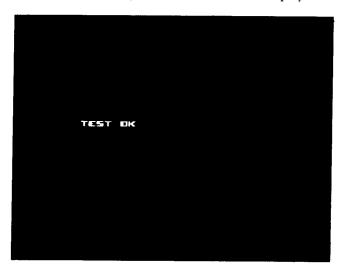
Figure 2-9 EEROM Test OK Video Display

Switch Test Display

In the switch test, the left, right, and auxiliary coin switches; the left and right JUMP switches; and the Midi Trak-Ball are tested. When each switch is activated, the location of that switch appears on the display. In Figure 2-10 all switches are activated. When the left JUMP switch is pressed, the motion-object pictures change from one group to another. When the right JUMP switch is pressed, the motion-object pictures change within that group of pictures.

The Midi Trak-Ball is tested by rotating the ball vertically and horizontally. The hexadecimal numbers by the words HOR and VERT increase from 00 through FF, or decrease from FF through 00, as the ball is rotated. Likewise, the numbers beside the words GREEN and BLUE increase from 0 to 7. The GREEN numbers increase or decrease with a horizontal motion of the Midi Trak-Ball. The BLUE numbers increase or decrease with a vertical movement of the control. Also, the colors of the color bar at the bottom of the display change shades of green when the ball is rotated horizontally and shades of blue when moved vertically.
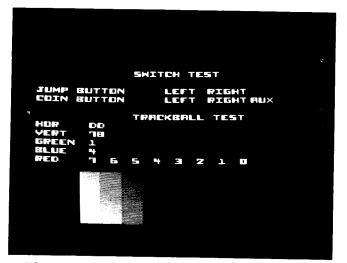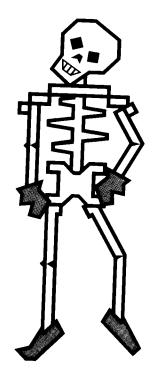
Figure 2-10 Switch Test Video Display

Reset Hall-of-Fame

When you select this from the main menu, the entire hall-of-fame table is reset to initials and scores that are within the program memory. The scores in this table range from 27,000 to 30,000 points. We suggest you reset these after any changes are made to the options that may affect the average game time.
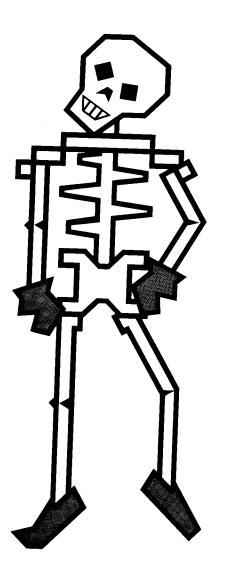
Troubleshooting

This chapter contains a discussion of troubleshooting aids and techniques to assist the service technician when a trouble is suspected in this game. Most troubles can be located quickly by following the information in this chapter. However, if problems persist, contact your nearest Atari Customer Service office listed on the inside front cover of this manual for assistance.

A thorough knowledge of game operation is desirable for effective troubleshooting. In addition to the operation and service information in the Schematic Package Supplement included with this manual, refer to *The Book, A Guide To Electronic Game Operation and Servicing,* available from Atari, Inc., for more information on coin-operated electronic games.

NOTE

We recommend that troubleshooting and repair procedures be performed by a qualified electronic technician.

Chapter 3

Troubleshooting Aids

Troubleshooting aids are provided throughout this manual and the Schematic Package Supplement. The following information is intended to acquaint the service technician with the portions of these documents that contain useful troubleshooting and repair information.

Assembly and Component Locations

The illustrated parts lists in Chapter 5 illustrate the locations of assemblies and components. Printed-circuit board (PCB) illustrations aid in rapidly locating components contained on the corresponding schematic diagram(s).

Schematic Diagrams

Complete schematic diagrams are provided in the Schematic Package Supplement. Component designations and their electrical values are included on the schematic diagrams. A memory map and a key to the schematic reference designators and symbols are also included in the Schematic Package Supplement.

Troubleshooting Procedures

This game will test itself and provide data to aid in localizing troubles to a major circuit. Self-test procedures are provided in Chapter 2. Refer to the following section on Troubleshooting Techniques for a suggested troubleshooting sequence that uses the self-test procedures. Detailed troubleshooting procedures for locating defective components are provided in the Schematic Package Supplement. These procedures use the ATARI CAT Box to troubleshoot the game PCB.

Troubleshooting Techniques

The following troubleshooting steps are arranged in a sequence recommended for locating a defective component. The procedure begins with a check of the simple trouble possibilities and progresses to more extensive procedures for localizing the trouble to an assembly or major circuit, and then to a defective component.

Check Switch Settings

Incorrect switch settings can sometimes indicate a problem that does not exist. Refer to Chapter 1 Set-Up, to verify that the game has been installed properly and that the switches are set to their correct positions. Check for proper operation in all game-play modes.

Check Fuses

Check for open fuses. Refer to the Power Supply Assembly Parts List in Chapter 5, Illustrated Parts Lists, and to the Display Manual, for the location and rating of each fuse used in this game. Make sure that replacement fuses are the proper type and rating.

Check Power-Supply Voltages

Improper operation of all circuits usually indicates a power supply problem. Check that the proper line voltage is available to the power supply.
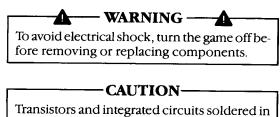
Localize Trouble

Determine the trouble symptom. Use the wiring diagrams in the Schematic Package Supplement to determine which assemblies or major circuits could cause the trouble. Perform the self-test procedure provided in Chapter 2.

Visual Check

Visually check for obvious problems in the portion of the game where a trouble is suspected. For example, check for loose or defective solder connections, integrated circuits loose in their sockets, loose cable connections, broken wires, damaged printed-circuit boards or components.

Check Individual Components

> **⚠ — WARNING — ⚠**
> To avoid electrical shock, turn the game off before removing or replacing components.

> **CAUTION**
> Transistors and integrated circuits soldered in place are difficult to remove without damaging the printed circuit board or component. Be extremely careful when removing these components.

Check soldered-in components by disconnecting one end to isolate the measurement from the affects of the surrounding circuitry. Often, direct substitution is the most practical way to determine if a component is faulty. However, eliminate the possibility of some other circuit problem existing which could damage the substitute component.

Repair the Assembly
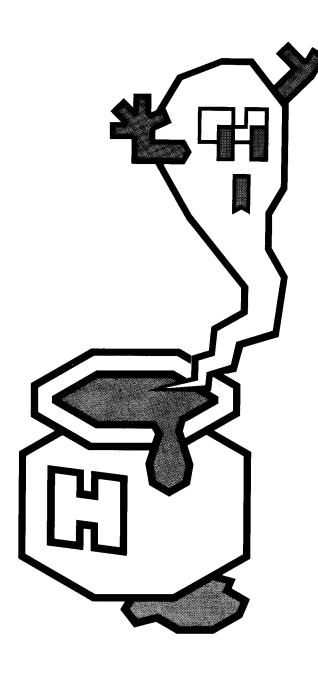
Repair or replace the defective part. Refer to Chapter 4, Maintenance and Repair for special repair and replacement procedures. Check for proper operation of any repaired circuit.

Maintenance

The maintenance procedures provided in this chapter are for those items which are subject to the most severe use. To assure the maximum trouble-free operation from this game, Atari recommends that periodic routine maintenance be performed on the game components described in the following procedures. How often routine maintenance is performed depends upon the game environment and frequency of play.

> ⚠ ——— **WARNING** ——— ⚠
>
> To avoid possible electrical shock hazard, unplug the game prior to performing any maintenance.

Chapter 4

Cleaning Requirements

The game cabinet and display shield may be cleaned with any non-abrasive household cleaner. The coin mechanism should be cleaned periodically with hot or boiling water and a mild detergent. A toothbrush may be used to remove any stubborn build-up of residue in the coin path. After cleaning the coin mechanism, flush thoroughly with hot or boiling water and blow out all the water with compressed air. Compressed air is also recommended for cleaning dust from the interior of the cabinet.

Opening the Control Panel

1. Unlock and open the coin door. Reach up through the opening to the top of the control panel and release the two spring-draw latches.

2. Close the coin door.

3. Lift the control panel at the top edge and tilt it toward you. The control panel has foam tape on it. Make sure the tape is in good condition.

Pushbutton Leaf Switches

1. With the control panel open, adjust the leaf switch contacts for a narrow gap. When a pushbutton is depressed, the resulting wiping action of the cross-bar contacts provides a self-cleaning feature. *Don't burnish the contacts.* To clean them, use electrical contact cleaner.

2. To replace a leaf switch, remove the screw with a Phillips-head screwdriver.

3. To replace the switch pushbutton, turn the stamped nut with a wrench in a counterclockwise direction, as seen from the inside of the control panel. The ring on the outside of the control panel should not spin.

4. Reinstall the pushbutton switch. Reconnect the harness wires to the switch terminals.

Lighted Midi Trak-Ball Assembly

Routine maintenance of the Midi Trak-Ball assembly consists primarily of inspecting the roller shafts for excessive wear and periodically lubricating the bearings.

Removing the Midi Trak-Ball

1. Open the control panel as previously described and disconnect the wires from the Midi Trak-Ball lamp socket. Disconnect the harness at the six-pin connector.

2. Remove the four nuts and carriage bolts that secure the Midi Trak-Ball assembly to the control panel (see Figure 4-1).

Disassembling the Midi Trak-Ball

To disassemble the Midi Trak-Ball after it has been removed from the control panel, remove the six screws that secure the upper and lower frames (see Figure 4-1). Lift off the upper frame. The Midi Trak-Ball can now be disassembled.

Inspecting the Midi Trak-Ball

1. With the Midi Trak-Ball disassembled, inspect the roller shafts and the idler shaft for excessive wear (see Figure 4-2). If the wear band exceeds $\frac{3}{8}$ inch, replace the roller shaft as described in steps 2–6 or replace the idler shaft as described in steps 7–10.

2. To replace a roller shaft, first remove the roller shaft from the lower frame.

3. Remove the metal encoding wheel by loosening the socket-head screw, flat washer, and split-lock washer. Remove the encoding wheel and bearings.

4. Remount the bearings and encoding wheel on a new roller shaft.

5. Tighten the encoding wheel by inserting a $\frac{1}{8}$-inch diameter pin or screwdriver through the hole in the shaft. Tighten the socket-head screw with an Allen wrench.

6. Reinstall the roller shaft in the lower frame.

7. To replace the idler shaft, first remove the idler shaft from the lower frame.

8. Remove the bearings from the ends of the idler shaft.

9. Remount the bearings on a new idler shaft.

10. Reinstall the idler shaft in the lower frame.

Lubricating the Midi Trak-Ball

Lubrication of the Midi Trak-Ball assembly should be performed every three months or 6,000 credits (as counted on the coin counter). To lubricate, place two drops of a light-duty oil, such as 3-In-One oil, on each of the six ball bearings shown in Figure 4-1.

Replacing the Coupler PCB

1. To remove the Coupler PCB, first disassemble the Midi Trak-Ball. Lift the PCB out of its slot. Carefully disconnect the red connector and remove the PCB.

2. To reinstall the Coupler PCB, place the PCB in the slot in the lower frame and reconnect the red connector.

```
┌──────────────NOTE──────────────┐
│ When you reinstall the Coupler PCB, make │
│ sure that the metal encoding wheel is not bent │
│ or damaged. Be sure the encoding wheel turns │
│ freely between the two halves of the radial op- │
│ tical coupler. │
└────────────────────────────────┘
```

Screw

Upper Frame

Screwdriver
or Pin

Hole in
Roller Shaft

Lubricate Here
Six Places

Midi Trak-Ball

Encoding
Wheel

Idler Shaft

Bearing

Allen Wrench

Roller Shaft

Socket-Head
Screw

Encoding Wheel

Vertical-Motion PCB:
Black, Red, Yellow,
and Green Wires

Flat Washer

Red Connector

Split-Lock
Washer

Screw

Horizontal-Motion PCB:
Blue, Violet, Red,
and Black Wires

Optical Coupler
Not Shown

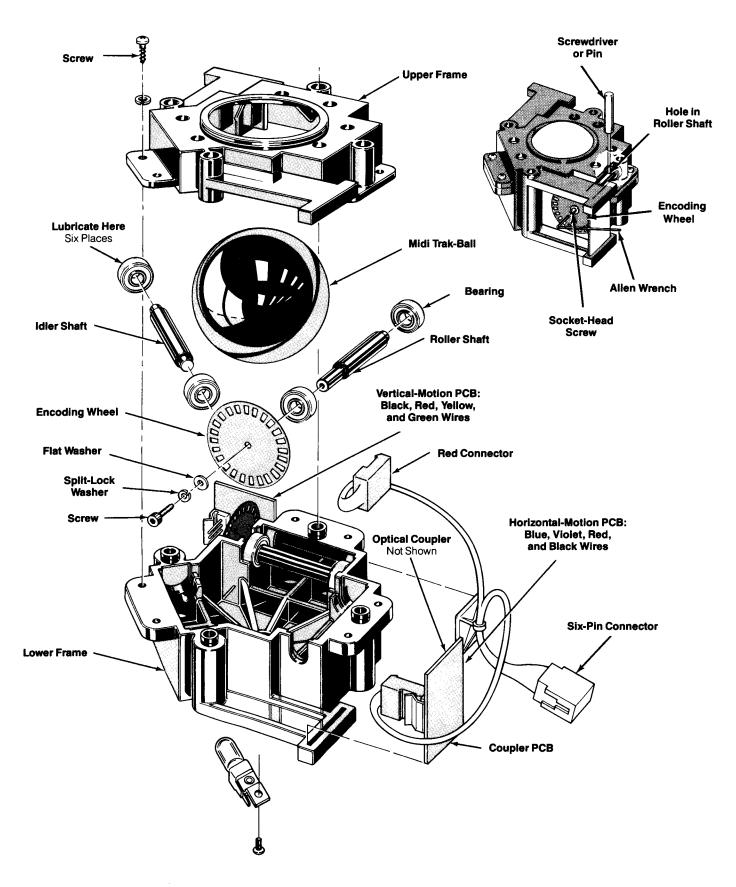Six-Pin Connector

Lower Frame

Coupler PCB

Figure 4-1   Midi Trak-Ball™ Assembly and Lubrication

Reassembling the Midi Trak-Ball

1. Install the upper frame of the Midi Trak-Ball over the assembly. Be sure that each Coupler PCB is engaged in the slots of the upper frame.

2. Replace the six screws that secure the upper and lower frames together.

3. Remount the Midi Trak-Ball assembly to the control panel using the four nuts and carriage bolts.

4. Reconnect the six-pin connector of the harness.
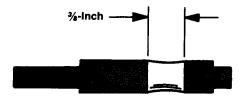
5. Reconnect the wires to the lamp.

Figure 4-2   Excessive Shaft Wear

Video Display Shield

To remove the video display shield, first open the control panel as previously described. Then, grasp the lower edge of the shield and slide it down into the cut-out area of the cabinet below the display. Tip the upper edge of the shield forward. Lift the shield up and out of the cabinet.

To replace the video display shield, set the bottom edge of the shield into the cut-out area of the cabinet below the display. Tip the shield back into the cabinet. Grasp the lower edge of the shield and slide it up until the upper edge engages the retaining slot. Push the shield against the bezel.

Speaker Grille Assembly

To replace either of the audio speakers in this game, you must first remove the speaker grille assembly from the game cabinet.

Removing the Speaker Grille Assembly

1. Remove the 3 socket-head screws and 6 flat washers that secure the attraction panel assembly to the cabinet (see Figure 4-3). Lift the attraction panel assembly up and out of the cabinet.

2. Disconnect the fluorescent light harness at the 3-pin connector (see Figure 4-3).

3. Remove the 2 Phillips-head screws that secure the attraction/speaker shield (see Figure 4-3). Slide the shield out of the cabinet.

4. Disconnect the speaker wires.

5. Remove the video display panel as previously described.

6. Remove the display bezel from the cabinet by removing the loose cross cleat with attached display bezel.

7. Remove the bolt and washers that secure the speaker grille assembly to the game cabinet.

8. Carefully slide the speaker grille assembly out of the cabinet.

Speaker Replacement

1. With the speaker grille assembly out of the game cabinet, remove the 4 nut/washer assemblies, washers, and carriage bolts securing each speaker to the speaker grille assembly (see Figure 4-4).

2. Mount the new speaker to the speaker grille assembly with the 4 nuts and carriage bolts. Be sure to position the speaker with its connections toward the center of the speaker grille assembly.

Reinstalling the Speaker Grille Assembly

1. Carefully reinstall the speaker grille assembly into the cabinet.

2. Secure the speaker grille assembly to the cabinet with the bolt and washer (see Figure 4-3). Align the front grille surface parallel with the leading edge of the shield retaining panel.

3. Slide the top edge of the video display bezel into the retaining slot. Lift the display bezel and position its bottom cleat into the cabinet cut-outs.

4. Replace the video display shield as previously described.

5. Reconnect the speaker wires as shown in Figure 4-4.

6. Position the attraction/speaker shield with its cut-out toward the front of the cabinet and its textured side facing down. Replace the 2 Phillips-head screws that secure the attraction/speaker panel to the cabinet.

7. Reconnect the 3-pin connector on the fluorescent light harness.

8. Reinstall the attraction panel by pushing down and forward across the top of the panel until the mounting bracket engages with the bracket on the speaker grille.

9. Replace the 3 socket-head screws and 6 flat washers.
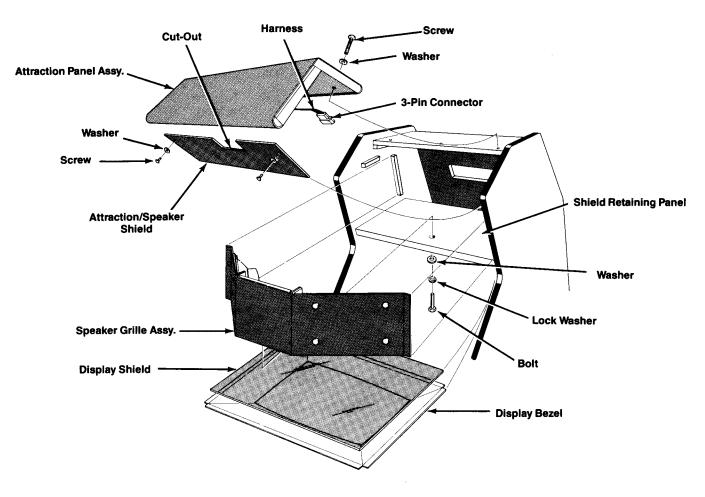
Figure 4-3 Speaker Grille Removal
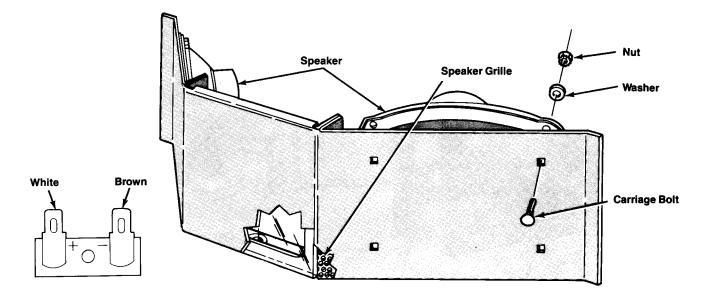
Figure 4-4 Speaker Removal

Removing the ATARI CRT Assembly

┌─────────── ⚠ ── WARNING ── ⚠ ───────────┐
│ The cathode-ray tube (CRT) assembly may im- │
│ plode if struck or dropped. Shattered glass can │
│ cause personal injury within a 6-foot radius. To │
│ reduce the risks of injury to people or of dam- │
│ age to the game components, we recommend │
│ that two people perform the following remov- │
│ al procedures. │
└───┘

1. Remove the rear access panel from the cabinet.

2. Discharge the high-voltage from the CRT before pro-
    ceeding. The video display contains a circuit for dis-
    charging the CRT high voltage to ground when power
    is removed. However, to make certain, always dis-
    charge the CRT as follows:

    a. Attach one end of a large, well-insulated, 18-gauge
        jumper wire to ground.

    b. Momentarily touch the free end of the grounded
        jumper to the anode by sliding it under the anode
        cap.

    c. Wait two minutes and repeat part b.

3. Disconnect the following wiring (see Figure 4-5):

    • Disconnect the anode lead from the CRT.

    • Disconnect the degaussing coil connector from
      the Deflection PCB.

    • Disconnect the yoke connector from the Deflec-
      tion PCB.

    • Disconnect the DAG spring connector from the
      Deflection PCB and the Neck PCB.

    • Disconnect the focus connector.

4. Carefully remove the Neck PCB from the CRT neck
    pins.

5. Remove the video display shield as previously de-
    scribed.

6. Remove the dislay bezel from the cabinet by sliding its
    lower edge and attached wood cleat out of the cabinet
    cut-out.

7. Carefully remove the 4 nut/washer assemblies that se-
    cure the CRT to the cabinet (see Figure 4-5).

8. Carefully lift the CRT from the front of the cabinet and
    remove the CRT.

9. Replace the CRT assembly in the reverse order of this
    procedure.
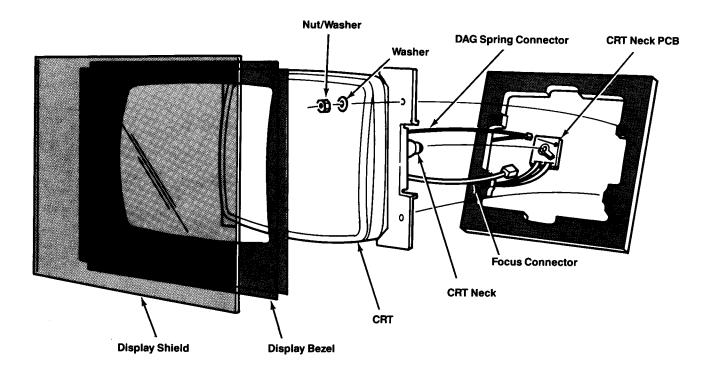
Figure 4-5   CRT Removal

Illustrated Parts Lists

This chapter provides information you need to order parts for your game. Common hardware (screws, nuts, washers, etc.) has been deleted from most of the parts lists. However, a parts list is included for the hardware to mount the printed-circuit boards (PCB) to the cabinet.

The PCB parts lists are arranged in alphabetical order by component. Each component subsection is arranged alphanumerically by reference designator.
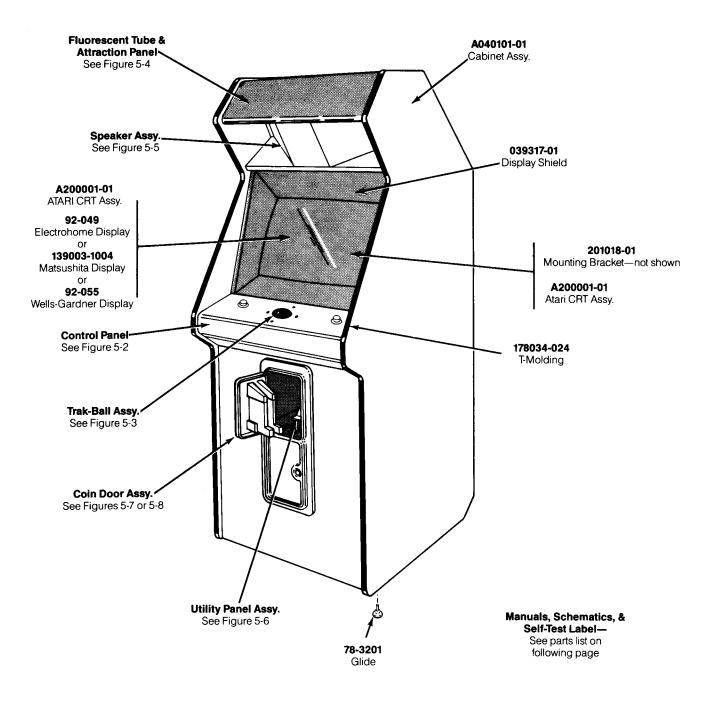
Other parts lists are arranged alphanumerically by Atari part number. In these parts lists, all A-prefix numbers come first. Following these are numbers in sequence evaluated up to the hyphen, namely 00- through 99; then 000598- through approximately 201000.
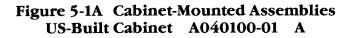
When ordering parts, please give the part number, part name, number of this manual, and serial number of your game. This will aid in filling your order rapidly and correctly. We hope the results will be less downtime and more profit from your game.

Atari Customer Service numbers are listed on the inside front cover of this manual.

Chapter 5

**Fluorescent Tube &
Attraction Panel**
See Figure 5-4

A040101-01
Cabinet Assy.

Speaker Assy.
See Figure 5-5

039317-01
Display Shield

A200001-01
ATARI CRT Assy.

92-049
Electrohome Display
or
139003-1004
Matsushita Display
or
92-055
Wells-Gardner Display

201018-01
Mounting Bracket—not shown

A200001-01
Atari CRT Assy.

Control Panel
See Figure 5-2

178034-024
T-Molding

Trak-Ball Assy.
See Figure 5-3

Coin Door Assy.
See Figures 5-7 or 5-8

Utility Panel Assy.
See Figure 5-6

**Manuals, Schematics, &
Self-Test Label—**
See parts list on
following page

78-3201
Glide

**Figure 5-1A Cabinet-Mounted Assemblies
US-Built Cabinet   A040100-01   A**

037332-01
Ventilation Grille

178034-025
T-Molding

EMI Cage
See Figure 5-9

Game PCB
See Figure 5-11

A038881-01
Lock

040129-01
Access Panel

A201022-01
Deflection PCB Assy.

EMI Shield PCB
See Figure 5-10

A040695-01
Main Harness Assy.

038870-01
Coin Box Enclosure

Regulator/Audio II PCB
See Figure 5-12

Power Supply
See Figure 5-13

A040587-01
Power On/Off Switch Assy.

009992-01
On/Off Switch Cover

A040696-01
Power Harness Assy.

A040586-01
Power Cord

178048-001
Caster

Figure 5-1A   Cabinet-Mounted Assemblies, continued
US-Built Cabinet   A040100-01   A

Cabinet-Mounted Assemblies
US-Built Cabinet
Parts List

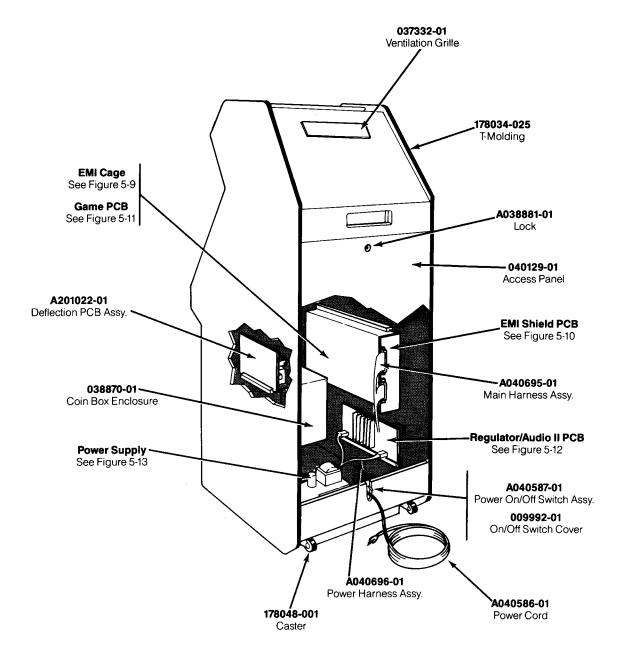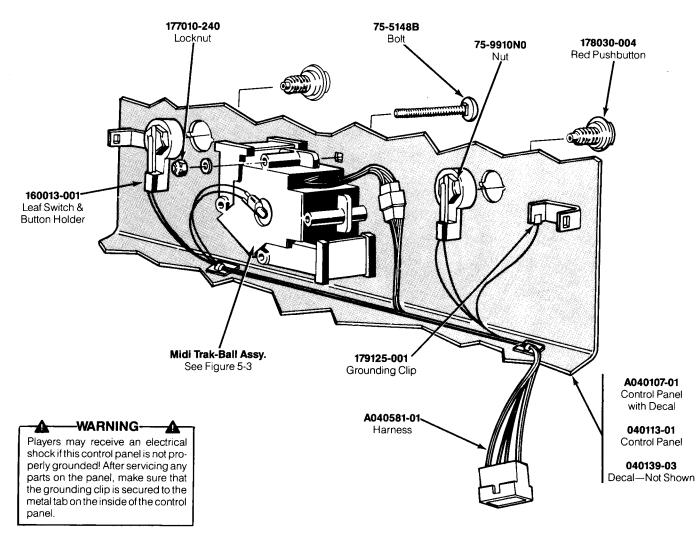| Part No.	Description
A200001-01	19-Inch ATARI Color Raster-Scan Cathode-Ray Tube (CRT) Assembly—includes:
A201020-01	Neck PCB Assembly
A201022-01	Deflection PCB Assembly
A201024-01	Color Raster Harness Assembly
A201092-01	CRT Assembly
A038881-01	Lock Assembly (for rear access panel) Acceptable substitute is part no. A038881-03
A040101-01	Cabinet Assembly (includes glides and PCB retainers, but not the rear access panel)
A040586-01	Strain-Relief Power Cord (U.S. and Canada)
A040587-01	Power On/Off Switch and Mounting Plate Assembly
A040695-01	Main Harness Assembly
A040696-01	Power Harness Assembly
	The following seven items are technical information supplements to this game:
SP-241	Crystal Castles Schematic Package
ST-241-01	Crystal Castles Label with Self-Test Procedure and Option Switch Settings
TM-241	Crystal Castles Operators Manual with Illustrated Parts List
	One of the following manuals will apply to the video display in your game:
TM-199	Service Manual for 19-Inch Atari Color-Raster Display (use with part no. A039650-01)
	or
TM-160	Service Manual for 19-Inch Electrohome Color-Raster Display (use with part no. 92-049)
	or
TM-201	Service Manual for 19-Inch Wells-Gardner Color-Raster Display (use with part no. 92-055)
	or
TM-220	Service Manual for 19-Inch Matshushita Color-Raster Display (use with part no. 139003-1004)
78-3201	Adjustable Glide
009992-01	Power On/Off Switch Cover
037332-01	Ventilation Grille
038091-01	Molded Coin Box
038870-01	Coin Box Enclosure
039317-01	Video Display Shield
040129-01	Rear Access Panel (does not include lock)
178013-001	Spring Draw Latch
178034-024	¾-Inch Black Plastic T-Molding
178034-026	$^{13}/_{16}$-Inch Black Plastic T-Molding
178048-001	2-Inch Rigid Caster
201018-01	Mounting Bracket (for ATARI display only, not shown)

177010-240
Locknut

75-5148B
Bolt

75-9910N0
Nut

178030-004
Red Pushbutton

160013-001
Leaf Switch &
Button Holder

Midi Trak-Ball Assy.
See Figure 5-3

179125-001
Grounding Clip

A040581-01
Harness

A040107-01
Control Panel
with Decal

040113-01
Control Panel

040139-03
Decal—Not Shown

```
▲ ——WARNING—— ▲
Players may receive an electrical
shock if this control panel is not pro-
perly grounded! After servicing any
parts on the panel, make sure that
the grounding clip is secured to the
metal tab on the inside of the control
panel.
```

Figure 5-2 Control Panel Assembly
A040106-01   A
Parts List

Part No.	Description
A38038-01	Lighted Midi Trak-Ball™ Assembly
A040107-01	Control Panel with Decal
A040581-01	Control Panel Harness Assembly
75-5148B	#10-24 Black Carriage Bolt
75-9910N0	⅜-Inch x 11 Stamped Nut
78-6900402	Vinyl Foam Single-Coated Adhesive Tape, ¼ -Inch Wide x ⅛-Inch Thick (24 inches required, not shown)
040113-01	Control Panel
040139-03	Control Panel Decal (not shown)
160013-001	Leaf Switch and Button Holder (leaf switch only is part no. 160012-001)
177010-240	#10-24 Hex Locknut
178030-004	Red Pushbutton Assembly
179125-001	Grounding Clip (Acceptable substitute is part no. 179074-010)

176010-106 — Screw

038039-01
Upper Frame

038043-02
Midi Trak-Ball

035937-01
Ball Bearing

038042-01
Idler Shaft

038041-01
Roller Shaft

035938-01
Encoding Wheel

A036096-01
Harness Assy.

75-014S
Flat Washer

75-044S
Split-Lock Washer

72-8406
Socket-Head Screw

139002-001
Optical Coupler—Hidden
From View

038040-01
Lower Frame

170000-002
Lamp

A035220-02
Coupler PCB Assy.

179173-001
Socket

176010-106
Screw

Figure 5-3 Lighted Trak-Ball™ Assembly
A038038-02   B

Lighted Trak-Ball™ Assembly
Parts List

| Part No.	Description
A036096-01	Harness Assembly
A035220-02	Coupler PCB Assembly (includes Radial Optical Coupler)
72-8406	#4-40 x ⅜-Inch, Hex Socket-Head Steel Machine Screw
75-014S	#4 Flat SAE-Standard, Zinc-Plated Steel Washer
75-044S	#4 Split-Lock, Zinc-Plated Steel Washer
035937-01	Ball Bearing (6 per assembly)
035938-01	Etched Encoding Wheel
038039-01	Upper Black Plastic Frame
038040-01	Lower Black Plastic Frame
038041-01	Roller Shaft
038042-01	Idler Shaft
038043-02	Midi-Trak-ball (3-inch diameter)
170000-002	Wedge-Base 6.3 V Lamp
176010-106	#8 x ⅜-Inch Cross-Recessed, Pan-Head, Zinc-Plated Steel Screw
179173-001	Wedge-Base Lamp Socket
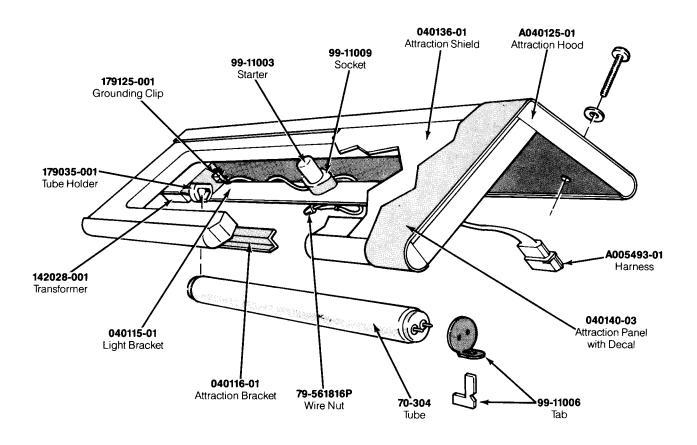
**Figure 5-4 Fluorescent Tube and Attraction Panel Assembly
A040105-01   A
Parts List**

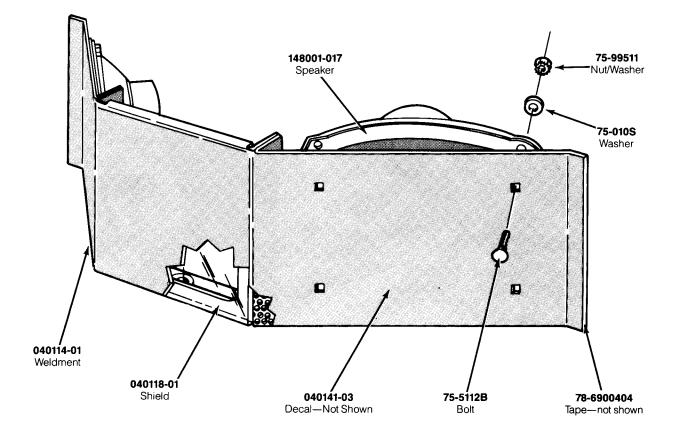| Part No.	Description
A005493-01	Fluorescent Light Harness Assembly
A037540-01	Ground Wire with Ring Lug (not shown)
A040125-01	Attraction Hood Assembly
70-304	18-Inch, 15-Watt, Cool White Fluorescent Tube
78-6900404	Vinyl Foam Single-Coated Adhesive Tape, ¼-Inch Wide x ¼-Inch Thick (24 inches required, not shown)
79-561816P	Spring-Connector Wire Nut for 16- to 18-Gauge Wires
99-11006	Fluorescent Tube Locking Tab (consists of two pieces)
99-11003	Fluorescent Tube Starter
99-11009	Starter Socket
040115-01	Fluorescent Light Mounting Bracket
040116-01	Attraction Panel Mounting Bracket
040136-01	Attraction Panel Shield
040140-03	Attraction Panel with Decal
142028-001	60 Hz, 118 V, Ballast Transformer
176015-110	#10 x ⅝-Inch, Cross-Recessed Pan-Head Screw
179035-001	2-Pin Fluorescent Tube Holder
179125-001	Grounding Clip (Acceptable substitute is part no. 179074-010)

148001-017
Speaker

75-99511
Nut/Washer

75-010S
Washer

040114-01
Weldment

040118-01
Shield

040141-03
Decal—Not Shown

75-5112B
Bolt

78-6900404
Tape—not shown

Figure 5-5 Speaker Assembly
A040108-01   A
Parts List

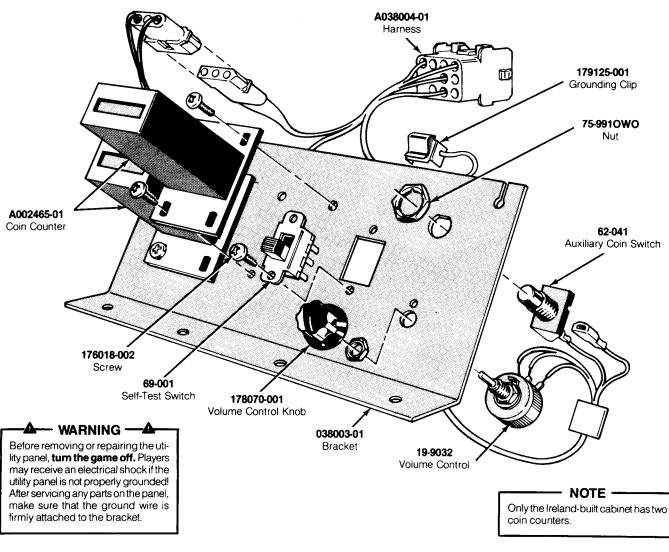| Part No.	Description
040114-01	Speaker Grille Weldment
040118-01	Glass Shield for Decal
040141-03	Decal (not shown)
75-010S	#10 Flat Washer
75-5112B	#10-24 x 0.75-Inch Black Carriage Bolt
75-99511	#10-24 Nut/Washer
78-6900404	Vinyl Foam Single-Coated Adhesive Tape, ¼-Inch Wide x ¼-Inch Thick (13 inches required, not shown)
148001-017	6 x 9-Inch Oval, 8 Ω, 6-Ounce, Shielded High-Fidelity Speaker

A038004-01
Harness

179125-001
Grounding Clip

75-9910WO
Nut

62-041
Auxiliary Coin Switch

A002465-01
Coin Counter

176018-002
Screw

69-001
Self-Test Switch

178070-001
Volume Control Knob

038003-01
Bracket

19-9032
Volume Control

△— WARNING —△
Before removing or repairing the utility panel, **turn the game off.** Players may receive an electrical shock if the utility panel is not properly grounded! After servicing any parts on the panel, make sure that the ground wire is firmly attached to the bracket.

NOTE
Only the Ireland-built cabinet has two coin counters.

**Figure 5-6 Utility Panel Assembly
A038002-01   H
Parts List**

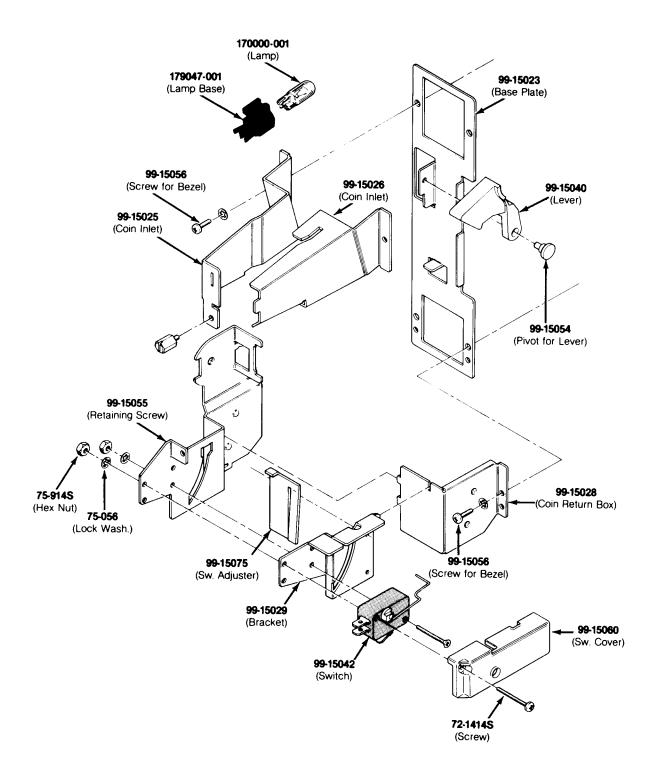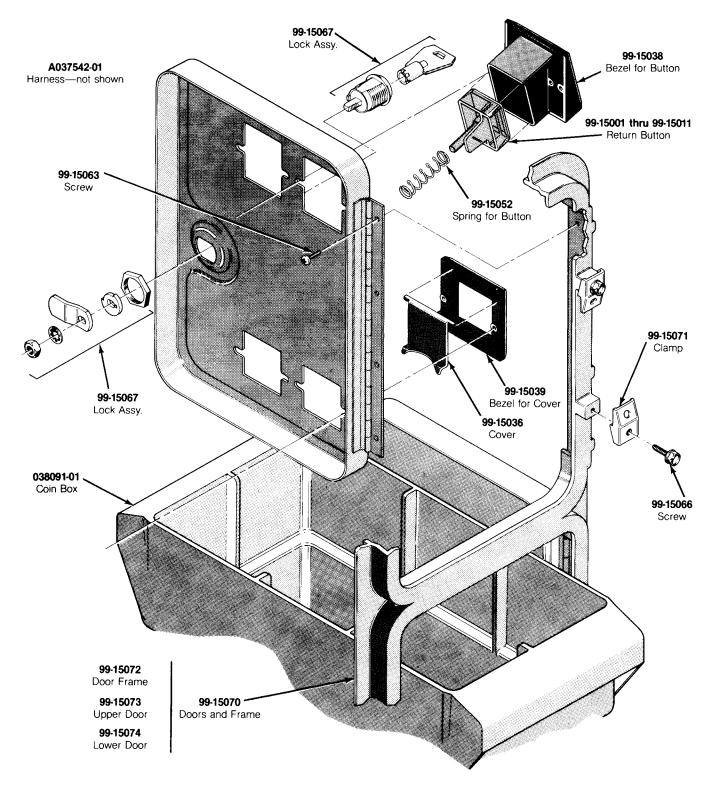| Part No.	Description
A002465-01	6 V Coin Counter
A037779-03	Weldment Enclosure Assembly (not shown)
A038004-01	Utility Panel Harness
19-9032	Volume Control
62-041	SPDT Momentary-Contact Pushbutton Auxiliary Coin Switch with Black Cap
69-001	DPDT Self-Test Switch
75-915S	#6-32 Hexagon Machine Nut
75-9910WO	$^{15}\!\!/_{32}$-Inch Stamped Nut
038003-01	Utility Panel
038781-01	Weldment (not shown)
176018-002	#6-32 x ½-Inch Thread-Forming Pan-Head Screw
178070-001	Volume Control Knob
179125-001	Grounding Clip

170000-001
(Lamp)

179047-001
(Lamp Base)

99-15023
(Base Plate)

99-15056
(Screw for Bezel)

99-15026
(Coin Inlet)

99-15040
(Lever)

99-15025
(Coin Inlet)

99-15054
(Pivot for Lever)

99-15055
(Retaining Screw)

75-914S
(Hex Nut)

75-056
(Lock Wash.)

99-15028
(Coin Return Box)

99-15075
(Sw. Adjuster)

99-15056
(Screw for Bezel)

99-15029
(Bracket)

99-15060
(Sw. Cover)

99-15042
(Switch)

72-1414S
(Screw)

Figure 5-7 Vertically Mounted Coin Door
171034-xxx   A

99-15067
Lock Assy.

A037542-01
Harness—not shown

99-15038
Bezel for Button

99-15001 thru 99-15011
Return Button

99-15063
Screw

99-15052
Spring for Button

99-15071
Clamp

99-15067
Lock Assy.

99-15039
Bezel for Cover

99-15036
Cover

99-15066
Screw

038091-01
Coin Box

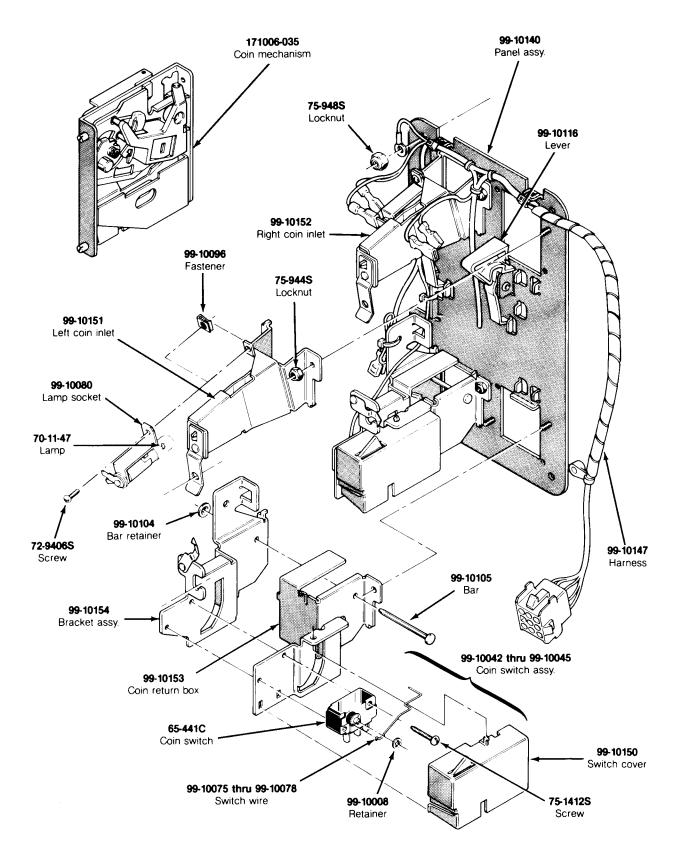99-15072
Door Frame

99-15073
Upper Door

99-15074
Lower Door

99-15070
Doors and Frame

171034-001 — U.S. 25¢/25¢ Coin Door
171034-003 — Canadian 25¢/25¢ Coin Door
171034-005 — U.K. 10 P/50 P Coin Door

171034-006 — U.K. 20 P/50 P Coin Door
171034-009 — German 2 DM/1 DM Coin Door
171034-010 — German 2 DM/5 DM Coin Door
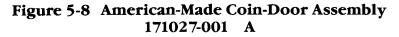
171034-011 — German 1 DM/5 DM Coin Door
171034-015 — French 2 Fr/1 Fr Coin Door

Figure 5-7   Vertically Mounted Coin Door, continued
171034-xxx   A

Vertically Mounted Coin Door
Parts List

Part No.	Description
A037542-01	Harness Assembly
72-1412S	#4-40 × ⅞-Inch Cross-Recessed Pan-Head Steel Machine Screw
75-056	#6 Internal-Tooth Zinc-Plated Steel Lock Washer
75-914S	#4-40 Steel Machine Hex Nut
75-3414S	#4-40 × ⅞-Inch 82° Cross-Recessed Flat-Head Steel Machine Screw
99-15001	Coin Return Button with U.S. 25¢ Price Plate
99-15002	Coin Return Button with U.S. $1 Price Plate
99-15003	Coin Return Button with German 1 DM Price Plate
99-15004	Coin Return Button with German 2 DM Price Plate
99-15005	Coin Return Button with German 5 DM Price Plate
99-15006	Coin Return Button with Belgian 5 Fr Price Plate
99-15007	Coin Return Button with French 1 Fr Price Plate
99-15008	Coin Return Button with Japanese 100 Yen Price Plate
99-15009	Coin Return Button with British 10 Pence Price Plate
99-15010	Coin Return Button with Australian 20¢ Price Plate
99-15011	Coin Return Button with Italian 100 Lire Price Plate
99-15023	Base Plate
99-15025	Left Half of Coin Inlet
99-15026	Right Half of Coin Inlet
99-15027	Side Plate of Coin Return Box
99-15028	Base Plate of Coin Return Box
99-15029	Switch Bracket
99-15036	Metal Coin Return Cover
99-15038	Bezel for Coin Return Button
99-15039	Metal Bezel for Coin Return Cover
99-15040	Coin Return Lever
99-15042	Coin Switch for U.S. 25¢
99-15052	Spring for Coin Return Button
99-15054	Pivot for Coin Return Lever
99-15055	Retaining Screw
99-15056	#4-40 × ⁵⁄₁₆-Inch Cross-Recessed Pan-Head Steel Machine Screw
99-15060	Switch Cover
99-15063	Screw for Hinge
99-15066	Screw for Clamp
99-15067	Lock Assembly
99-15070	Doors and Frame
99-15071	Clamp for Frame
99-15072	Door Frame
99-15073	Upper Door
99-15074	Lower Door
99-15075	Switch Adjuster
038091-01	Coin Box (Not included in assembly—Acceptable substitute is part number A037491-01)
170000-001	6.3 V Miniature Wedge-Base Incandescent Lamp
171006-035	Metal Coin Mechanism
179047-001	Lamp Base

171006-035
Coin mechanism

99-10140
Panel assy.

75-948S
Locknut

99-10116
Lever

99-10152
Right coin inlet

99-10096
Fastener

75-944S
Locknut

99-10151
Left coin inlet

99-10080
Lamp socket

70-11-47
Lamp

72-9406S
Screw

99-10104
Bar retainer

99-10147
Harness

99-10105
Bar

99-10154
Bracket assy.

99-10042 thru 99-10045
Coin switch assy.

99-10153
Coin return box

65-441C
Coin switch

99-10150
Switch cover

99-10075 thru 99-10078
Switch wire

99-10008
Retainer

75-1412S
Screw

**Figure 5-8 American-Made Coin-Door Assembly
171027-001   A**

99-10148
(Lock assy.)

72-HA1404C
(Screw)

99-10142
(Button housing)

99-10139
(Coin door)

99-10134
(Cover)

99-10119
(Button assy.)

99-10118
(Button)

99-10115
(Spring)

99-10145
(Cam)

99-10141
(Coin return cover)

99-10117
(Coin return door)

99-10144
(Channel clip)

72-JA1405B
(Screw)

99-10149
(Service door)

038091-01
(Coin box)

99-10143
(Frame)

Figure 5-8 American-Made Coin-Door Assembly, continued
171027-001   A

NOTE

The Federal Communications Commission requires that the game PCB be housed in the EMI cage with the EMI Shield PCB attached.

037873-01
Spacer

Game PCB

72-1604F
Screw

72-1404F
Screw

EMI Shield PCB

176015-112
Screw

Crystal Castles Game PCB
See Figure 5-11

A037701-02
EMI Cage

Guide

EMI Shield PCB
See Figure 5-10

Grounding clip not shown

175009-221
Washer

178044-242
Grommet

178045-442
Fastener

175004-708
Washer

176015-112
Screw

Regulator/Audio II PCB
See Figure 5-12

176015-112
Screw

175004-708
Washer

A201022-01
Deflection PCB—used only with the Atari Video Display

Figure 5-9 Electromagnetic Interference (EMI) Cage Assemblies and PCB Mounting Hardware

EMI Cage Assemblies and PCB Mounting Hardware
Parts List

Part No.	Description
A201022-01	Deflection PCB–used only with the Atari Video Display
A035435-01	Regulator/Audio II PCB (Acceptable substitute is part no. A035435-02)
A037701-02	EMI Cage (includes guide)
A037430-06	EMI Shield PCB–includes:
72-1404F	#4-40 x ¼ -Inch Cross-Recessed Steel Screw
037873-01	Spacer
175009-221	Plastic Washer
178044-242	Grommet
178045-442	Snap-In Fastener
A039574-21	Crystal Castles Game PCB
72-1604F	#6-32 x ¼ -Inch Cross-Recessed Pan-Head Screw
175004-708	#8 Flat Fiber Washer
176015-112	#10 x ¾ -Inch Cross-Recessed Pan-Head Screw
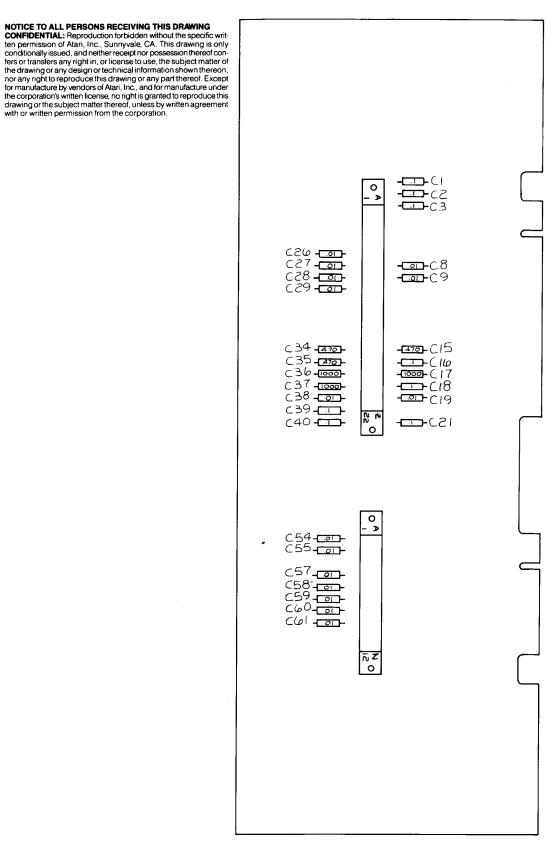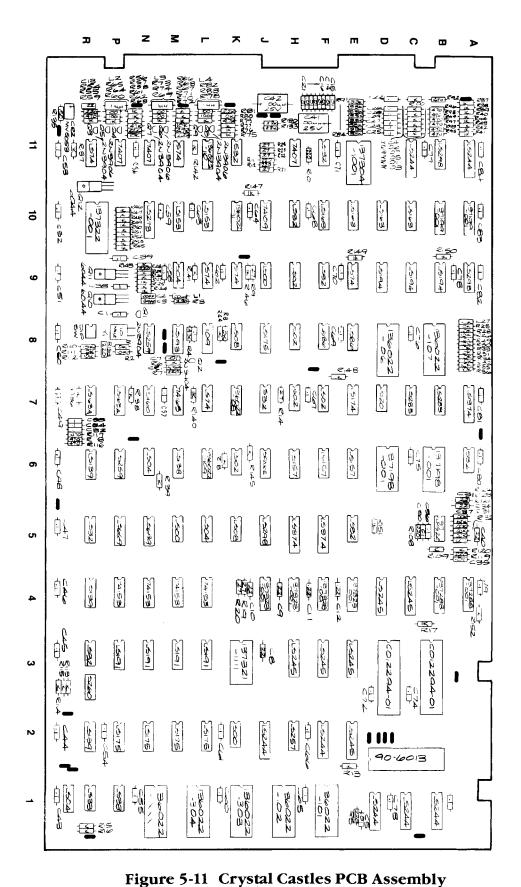
Figure 5-10 EMI Shield PCB Assembly
A037430-06   A

Electromagnetic Interference Shield PCB
Parts List

Designator	Description	Part No.
Capacitors		
C1–C3	0.1 μF, +80%, -20%, 50 V Ceramic Capacitor	122002-104
C8,C9	0.01 μF, +80%, -20%, 25 V Minimum, Axial-Lead Ceramic Capacitor	122005-103
C15	470 pF, 100 V Ceramic Capacitor (Acceptable substitute is part no. 122013-471)	122016-471
C16	0.1 μF, +80%, -20%, 50 V Ceramic Capacitor	122002-104
C17	1000 pF, ±5%, 100 V Axial-Lead Ceramic Capacitor (Acceptable substitute is part no. 122002-102)	122016-102
C18	0.1 μF, +80%, -20%, 50 V Ceramic Capacitor	122002-104
C19	0.01 μF, +80%, -20%, 25 V Minimum, Axial-Lead Ceramic Capacitor	122005-103
C21	0.1 μF, +80%, -20%, 50 V Ceramic Capacitor	122002-104
C26–C29	0.01 μF, +80%, -20%, 25 V Minimum, Axial-Lead Ceramic Capacitor	122005-103
C34, C35	470 pF, 100 V Ceramic Capacitor (Acceptable substitute is part no. 122013-471	122016-471
C36, C37	1000 pF, ±5%, 100 V Axial-Lead Ceramic Capacitor (Acceptable substitute is part no. 122002-102)	122016-102
C38	0.01 μF, +80%, -20%, 25 V Minimum, Axial-Lead Ceramic Capacitor	122005-103
C39,C40	0.1 μF, +80%, -20%, 50 V Ceramic Capacitor	122002-104
C43–C48	0.01 μF, +80%, -20%, 25 V Minimum, Axial-Lead Ceramic Capacitor	122005-103
C50	0.01 μF, +80%, -20%, 25 V Minimum, Axial-Lead Ceramic Capacitor	122005-103
C54,C55	0.01 μF, +80%, -20%, 25 V Minimum, Axial-Lead Ceramic Capacitor	122005-103
C57–C61	0.01 μF, +80%, -20%, 25 V Minimum, Axial-Lead Ceramic Capacitor	122005-103
Connectors		
P19	24-Pin Connector	179073-024
P20	44-Pin Connector (Acceptable substitute is part no. 179046-044)	179073-044
Miscellaneous		
	Spacer	037873-01
	#4-40 x ¼-Inch Cross-Recessed, Pan-Head Steel Machine Screw	72-1404F
	Plastic Washer	175009-221
	Grommet	178044-242
	Snap-In Fastener	178045-442

Figure 5-11 Crystal Castles PCB Assembly
A039574-21   G

Crystal Castles PCB Assembly
Parts List

Designator	Description	Part No.
Capacitors		
C1	0.1 μF, +80%, -20%, 50 V, Ceramic Capacitor	122002-104
C2	100 pF, 100 V, Dipped Fixed Mica Capacitor	128002-101
C3	39 pF, 100 V, Dipped Fixed Mica Capacitor	128002-390
C4	0.1 μF, +80%, -20%, 50 V, Ceramic Capacitor	122002-104
C5	0.01 μF, +80%, -20%, 25 V Minimum, Axial-Lead Ceramic Capacitor	122005-103
C7	0.01 μF, +80%, -20%, 25 V Minimum, Axial-Lead Ceramic Capacitor	122005-103
C8–C13	0.22 μF, ±20%, 25 V, Axial-Lead Ceramic Capacitor	122004-224
C14–C21	0.01 μF, +80%, -20%, 25 V Minimum, Axial-Lead Ceramic Capacitor	122005-103
C22, C23	0.1 μF, +80%, -20%, 50 V, Ceramic Capacitor	122002-104
C25–C29	0.1 μF, +80%, -20%, 50 V, Ceramic Capacitor	122002-104
C30	0.01 μF, +80%, -20%, 25 V Minimum, Axial-Lead Ceramic Capacitor	122005-103
C31	0.22 μF, ±20%, 25 V, Axial-Lead Ceramic Capacitor	122004-224
C32–C34	0.1 μF, +80%, -20%, 50 V, Ceramic Capacitor	122002-104
C35	0.01 μF, +80%, -20%, 25 V Minimum, Axial-Lead Ceramic Capacitor	122005-103
C36	0.1 μF, +80%, -20%, 50 V, Ceramic Capacitor	122002-104
C37	0.22 μF, ±20%, 25 V, Axial-Lead Ceramic Capacitor	122004-224
C38, C39	0.1 μF, +80%, -20%, 50 V, Ceramic Capacitor	122002-104
C40	0.22 μF, 25 V, ±20%, Axial-Lead Ceramic Capacitor	122004-224
C41, C42	100 μF, 25 V, Axial-Lead Aluminum Electrolytic Capacitor	24-250107
C43–C85	0.1 μF, +80%, -20%, 50 V, Ceramic Capacitor	122002-104
Diodes		
CR1	500 mW, ±5%, 8.2 V, Zener Diode	32-1N756A
CR2	Red Light-Emitting Diode	38-MV5053
Integrated Circuits		
1B, 1C, 1D	Line Driver/Receiver Integrated Circuit	37-74LS244
1F	EPROM Integrated Circuit	136022-101
1J	EPROM Integrated Circuit	136022-102
1K	EPROM Integrated Circuit	136022-303
1L	EPROM Integrated Circuit	136022-304
1N	EPROM Integrated Circuit (English)	136022-305
	Acceptable substitutes are as follows:	
	German—part no. 136022-112	
	Spanish—part no. 136022-113	
	French—part no. 136022-114	
1P, 1R	Type-74LS33 Integrated Circuit	137239-001
1S	Hex Inverter Integrated Circuit	37-74LS04
2D	Microprocessor Integrated Circuit	90-6013
2E	Tri-State Octal Bus Transceiver Integrated Circuit	37-74LS245
2F	Line Driver/Receiver Integrated Circuit	37-74LS244
2H	Quad Data Selector/Multiplexer Integrated Circuit	37-74LS257
2J	Line Driver/Receiver Integrated Circuit	37-74LS244
2K	Quad 2-Input NAND Gate Integrated Circuit	37-74S00

Crystal Castles PCB Assembly
Parts List, continued

Designator	Description	Part No.
2L–2P	Quad Data Selector/Multiplexer Integrated Circuit	37-74LS157
2R	Dual 2-4 Decoder/Multiplexer Integrated Circuit	37-74LS139
3B	Custom Audio Integrated Circuit	C012294-01
3D	Custom Audio Integrated Circuit	C012294-01
3E, 3F, 3H	Tri-State Octal Bus Transceiver Integrated Circuit	37-74LS245
3K	Vertical Scroll Integrated Circuit	137321-1111
3L–3P	Up/Down Counter Integrated Circuit	37-74LS191
3R	Quad 2-Input OR Gate Integrated Circuit	37-74LS32
4A, 4B	Non-Volatile RAM Integrated Circuit	137288-001
4C, 4D	Tri-State Octal Bus Transceiver Integrated Circuit	37-74LS245
4E, 4F	16K × 4 RAM Integrated Circuit	137323-001
4H, 4J	16K × 4 RAM Integrated Circuit	137323-001
4L–4P	Dual Data Selector/Multiplexer Integrated Circuit	37-74153
4R	Dual 2-4 Decoder/Multiplexer Integrated Circuit	37-74LS139
5B	Quad Op-Amp Integrated Circuit	37-LM324
5E	Quad 2-Input OR Gate Integrated Circuit	37-74LS32
5F, 5H	Octal D-Type Flip-Flop Integrated Circuit	37-74LS374
5J	Quad 2-Input, with Storage Multiplexer Integrated Circuit	137201-001
5K	Quad 2-Input AND Gate Integrated Circuit	37-74LS08
5L	Hex Inverter Integrated Circuit	37-74LS04
5M	Quad 2-Input NAND Gate Integrated Circuit	37-74LS00
5N, 5P	Up/Down Binary, Synchronous 4-Bit Counter Integrated Circuit	137109-001
5R	Quad 2-Input OR Gate Integrated Circuit	37-74LS32
6A	Quad 2-Input OR Gate Integrated Circuit	37-74S32
6B, 6D	200 ns Tri-State Static RAM Integrated Circuit	137198-001
6E, 6F, 6H	Quad Data Selector/Multiplexer Integrated Circuit	37-74LS157
6K	Quad 2-Input NOR Gate Integrated Circuit	37-74LS02
6L	Bus PROM Integrated Circuit	136022-109
6M	3-8 Line Decoder/Multiplexer Integrated Circuit	137177-001
6N	Hex Inverter Integrated Circuit	37-74LS04
6P	8-Bit Latch Integrated Circuit	37-74LS259
6R	Dual 2-4 Decoder/Multiplexer Integrated Circuit	37-74LS139
7A	Octal D-Type Flip-Flop Integrated Circuit	37-74LS374
7B, 7C	4-Bit Binary, Full Adder Integrated Circuit	137204-001
7D	Dual 4-Input NAND Gate Integrated Circuit	37-74LS20
7E	Hex D-Type Flip-Flop Integrated Circuit	37-74LS174
7F	Hex Inverter Integrated Circuit	37-74LS04
7H	Quad 2-Input NOR Gate Integrated Circuit	37-74S02
7J	Quad 2-Input OR Gate Integrated Circuit	37-74S32
7K	Synchronous PROM Integrated Circuit	136022-108
7L	Dual D-Type Flip-Flop Integrated Circuit	37-74LS74
7M	4-Bit Decade Counter Integrated Circuit	37-74163
7N	4-Bit Decade Counter Integrated Circuit	37-74LS160
7P, 7R	4-Bit Synchronous Counter Integrated Circuit	37-74LS163A
8B	EPROM Integrated Circuit	136022-107
8D	EPROM Integrated Circuit	136022-106
8E, 8F	Quad 2-Input Exclusive OR Gate Integrated Circuit	37-74LS86
8H	Quad 2-Input NOR Gate Integrated Circuit	37-74S02

Crystal Castles PCB Assembly
Parts List, continued

Designator	Description	Part No.
8J	Quad D-Type Flip-Flop Integrated Circuit	37-74LS175
8K	Quad 2-Input AND Gate Integrated Circuit	37-74LS08
8L	Dual J-K Flip-Flop Integrated Circuit	37-74109
8M	Up/Down Counter Integrated Circuit	37-74LS193
8N	8-Bit Latch Integrated Circuit	37-74LS259
9A	Quad 2-Input, with Storage Multiplexer Integrated Circuit	137201-001
9B–9D	Shift Register Integrated Circuit	37-74LS194
9E	Dual D-Type Flip-Flop Integrated Circuit	37-74LS74
9F	Quad 2-Input OR Gate Integrated Circuit	37-74LS32
9H	Quad 2-Input NOR Gate Integrated Circuit	37-74LS02
9J	Quad 2-Input NAND Gate Integrated Circuit	37-74LS00
9K, 9L	Dual D-Type Flip-Flop Integrated Circuit	37-74S74
9M	Hex Inverter Integrated Circuit	37-74S04
10A, 10B	55 ns Tri-State Static RAM Integrated Circuit	137199-001
10C–10F	4-Bit Synchronous Counter Integrated Circuit	37-74LS163A
10H	Quad 2-Input OR Gate Integrated Circuit	37-74LS32
10J	Dual J-K Flip-Flop Integrated Circuit	37-74109
10K	Color PROM Integrated Circuit	136022-111
10L, 10M	4 to 1 Data Selector/Multiplexer Integrated Circuit	37-74LS153
10N	Octal D-Type Flip-Flop Integrated Circuit	37-74LS273
10R	64 × 9 RAM Integrated Circuit	137322-001
11A	Line Driver/Receiver Integrated Circuit	37-74LS244
11B	Quad 2-Input, with Storage Multiplexer Integrated Circuit	137201-001
11C	Line Driver/Receiver Integrated Circuit	37-74LS244
11E	Trak-Ball Interface Integrated Circuit	137304-1001
11F	Quad 2-Input OR Gate Integrated Circuit	37-74LS32
11H	Hex Buffer/Driver Integrated Circuit	37-7407
11K	Quad 2-Input OR Gate Integrated Circuit	37-74S32
11L	Write PROM Integrated Circuit	136022-110
11M	Dual D-Type Flip-Flop Integrated Circuit	37-74S74
11N, 11P	Hex Buffer/Driver Integrated Circuit	37-7407
2/3R	Dual 5-Input NOR Gate Integrated Circuit	37-74S260
11R	Dual D-Type Flip-Flop Integrated Circuit	37-74LS74

Resistors

Designator	Description	Part No.
R1, R2	10 kΩ, ±5%, ¼ W Resistor	110000-103
R3	220 Ω, ±5%, ¼ W Resistor	110000-221
R4	4.7 kΩ, ±5%, ¼ W Resistor	110000-472
R5	220 Ω, ±5.%, ¼ W Resistor	110000-221
R6	1 kΩ, ±5%, ¼ W Resistor	110000-102
R7	220 Ω, ±5%, ¼ W Resistor	110000-221
R8	10 kΩ, ±5%, ¼ W Resistor	110000-103
R9	27 Ω, ±5%, ¼ W Resistor	110000-270
R10–R12	220 Ω, ±5%, ¼ W Resistor	110000-221
R13	1 kΩ, ±5%, ¼ W Resistor	110000-102
R14	27 Ω, ±5%, ¼ W Resistor	110000-270
R15–R18	1 kΩ, ±5%, ¼ W Resistor	110000-102

Crystal Castles PCB Assembly
Parts List, continued

Designator	Description	Part No.
R19–R24	27 Ω, ±5%, ¼ W Resistor	110000-270
R25–R36	10 kΩ, ±5%, ¼ W Resistor	110000-103
R37–R53	1 kΩ, ±5%, ¼ W Resistor	110000-102
R54	220 Ω, ±5%, ¼ W Resistor	110000-221
R55	1.2 kΩ, ±5%, ¼ W Resistor	110000-122
R56–R60	1 kΩ, ±5%, ¼ W Resistor	110000-102
R61	4.7 kΩ, ±5%, ¼ W Resistor	110000-472
R62	22 kΩ, ±5%, ¼ W Resistor	110000-223
R63	10 kΩ, ±5%, ¼ W Resistor	110000-103
R64,R65	100 Ω, ±5%, ¼ W Resistor	110000-101
R66–R69	1 kΩ, ±5%, ¼ W Resistor	110000-102
R70	4.7 kΩ, ±5%, ¼ W Resistor	110000-472
R71	10 kΩ, ±5%, ¼ W Resistor	110000-103
R72	22 kΩ, ±5%, ¼ W Resistor	110000-223
R73,R74	100 Ω, ±5%, ¼ W Resistor	110000-101
R75–R78	1 kΩ, ±5%, ¼ W Resistor	110000-102
R79	4.7 kΩ, ±5%, ¼ W Resistor	110000-472
R80	10 kΩ, ±5%, ¼ W Resistor	110000-103
R81	22 kΩ, ±5%, ¼ W Resistor	110000-223
R82, R83	100 Ω, ±5%, ¼ W Resistor	110000-101
R84–R91	3.3 kΩ, ±5%, ¼ W Resistor	110000-332
R92, R93	470 Ω, ±5%, ¼ W Resistor	110000-471
R95–R99	470 Ω, ±5%, ¼ W Resistor	110000-471
R100, R101	1 kΩ, ±5%, ¼ W Resistor	110000-102
R103–R107	1 kΩ, ±5%, ¼ W Resistor	110000-102
R108	220 Ω, ±5%, ¼ W Resistor	110000-221
R109	1 kΩ, ±5%, ¼ W Resistor	110000-102
R110–R112	10 kΩ, ±5%, ¼ W Resistor	110000-103
R113–R115	1 kΩ, ±5%, ¼ W Resistor	110000-102
R116–R118	470 Ω, ±5%, ¼ W Resistor	110000-471
R119	220 Ω, ±5%, ¼ W Resistor	110000-221
R120	1 kΩ, ±5%, ¼ W Resistor	110000-102
R121, R122	100 kΩ, ±5%, ¼ W Resistor	110000-104
R123	62 kΩ, ±5%, ¼ W Resistor	110000-623
R124–R127	1 kΩ, ±5%, ¼ W Resistor	110000-102
R128	220 Ω, ±5%, ¼ W Resistor	110000-221
R129	1 kΩ, ±5%, ¼ W Resistor	110000-102
R130	2.2 kΩ, ±5%, ¼ W Resistor	110000-222
R131, R132	100 kΩ, ±5%, ¼ W Resistor	110000-104
R133	2.2 kΩ, ±5%, ¼ W Resistor	110000-222
R134	100 kΩ, ±5%, ¼ W Resistor	110000-104
R135	150 Ω, ±5%, ¼ W Resistor	110000-151
R136–R152	1 kΩ, ±5%, ¼ W Resistor	110000-102
R153	220 Ω, ±5%, ¼ W Resistor	110000-221

Crystal Castles PCB Assembly
Parts List, continued

Designator	Description	Part No.
	Sockets	
1F	28 Contact, Medium-Insertion-Force IC Socket	79-42C28
1J, 1K, 1L	28 Contact, Medium-Insertion-Force IC Socket	79-42C28
1N	28 Contact, Medium-Insertion-Force IC Socket	79-42C28
2D	40 Contact, Medium-Insertion-Force IC Socket	79-42C40
3B	40 Contact, Medium-Insertion-Force IC Socket	79-42C40
3D	40 Contact, Medium-Insertion-Force IC Socket	79-42C40
4A, 4B	18 Contact, Medium-Insertion-Force IC Socket	79-42C18
8B	28 Contact, Medium-Insertion-Force IC Socket	79-42C28
8D	28 Contact, Medium-Insertion-Force IC Socket	79-42C28
	Transistors	
Q1–Q3	350 mW, 60 V, Switching NPN Transistor	34-2N3904
Q4	1 W, 40 V, PNP Transistor	33-2N3906
Q5	350 mW, 60 V, Switching NPN Transistor	33-2N3904
Q6	1 W, 40 V, PNP Transistor	33-2N3906
Q7	350 mW, 60 V, Switching NPN Transistor	34-2N3904
Q8	1 W, 40 V, PNP Transistor	33-2N3906
Q9	350 mW, 60 V, Switching NPN Transistor	34-2N3904
Q10–Q12	8A, 80 V, Darlington, NPN Transistor	34-2N6044
	Miscellaneous	
	Test Points (Acceptable substitute is part number 020670-01)	179051-002
	Nylon Snap-In Fastener	81-4302
Y1	10-MHz Crystal	90-123
8R	4-Toggle DIP Switch	66-114P1T
L1	100 μH, $\pm$10% Inductor	141002-001
L2–L4	0.29 Ω, 1.0 μH, $\pm$10% Peaking Coil Inductor	141007-001

**Figure 5-12   Regulator/Audio II PCB Assembly
A035435-01   K**

Regulator/Audio II PCB Assembly
Parts List

Designator	Description	Part No.
Capacitors		
C1	470 μF, 25 V, Aluminum Electrolytic Fixed Axial-Lead Capacitor	24-250477
C2	0.001 μF, 35 V, Ceramic-Disc Axial-Lead Capacitor	122002-102
C3	0.1 μF, 50 V, Ceramic-Disc Axial-Lead Capacitor	122002-104
C4	470 μF, 25 V, Aluminum Electrolytic Fixed Axial-Lead Capacitor	24-250477
C5	.01 μF, 25 V Ceramic-Disc Axial-Lead Capacitor (Acceptable substitute is part no. 122005-103)	100015-103
C6	0.22 μF, 25 V, Ceramic-Disc Axial-Lead Capacitor	122004-224
C7	0.001 μF, 35 V, Ceramic-Disc Axial-Lead Capacitor	122002-102
C8	0.22 μF, 25 V, Ceramic-Disc Axial-Lead Capacitor	122004-224
C9, C10	3300 μF, 35 V, Aluminum Electrolytic Fixed Axial-Lead Capacitor	24-350338
C11	0.1 μF, 50 V, Ceramic-Disc Axial-Lead Capacitor	122002-104
C12	470 μF, 25 V, Aluminum Electrolytic Fixed Axial-Lead Capacitor	24-250477
C13	1000 μF, 25 V, Aluminum Electrolytic Fixed Axial-Lead Capacitor	24-250108
C14	.01 μF, 25 V Ceramic-Disc Axial-Lead Capacitor (Acceptable substitute is part no. 122005-103)	100015-103
C15	0.22 μF, 25 V, Ceramic-Disc Axial-Lead Capacitor	122004-224
C16	0.001 μF, 35 V, Ceramic-Disc Axial-Lead Capacitor	122002-102
C17	0.22 μF, 25 V, Ceramic-Disc Axial-Lead Capacitor	122004-224
Diodes		
CR1, CR4	Type-1N4002, 1 A, 100 V Silicon Rectifier Diode	31-1N4002
Resistors		
R1	270 Ω, ±5%, ¼ W Resistor	110000-271
R3	33 Ω, ±5%, ¼ W Resistor	110000-330
R4	100 Ω, ±5%, ¼ W Resistor	110000-101
R5	2.7 Ω, ±5%, 1 W Resistor	110009-027
R6	3.9 kΩ, ±5%, ¼ W Resistor	110000-392
R7	7.5 kΩ, ±5%, ¼ W Resistor	110000-752
R8	1 kΩ Vertical PCB-Mounting Cermet Potentiometer (Acceptable substitute is part no. 19-315102)	119002-102
R9	220 Ω, ±5%, ½ W Resistor	110001-221
R10	1 Ω, ±5%, ¼ W Resistor	110000-010
R11	10 Ω, ±5%, ¼ W Resistor	110000-100
R12	100 Ω, ±5%, ¼ W Resistor	110000-101
R13, R14	10 kΩ, ±5%, ¼ W Resistor	110000-103
R19	1 Ω, ±5%, ¼ W Resistor	110000-010
R20	10 Ω, ±5%, ¼ W Resistor	110000-100
R21	220 Ω, ±5%, ½ W Resistor	110001-221
R22	100 Ω, ±5%, ¼ W Resistor	110000-101
R24	0.1 Ω, ±3%, 7 W Wirewound Resistor	19-100P1015
R27, R28	1 kΩ, ±5%, ¼ W Resistor	110000-102
R29, R30	10 Ω, ±5%, ¼ W Resistor	110000-100

Regulator/Audio II PCB Assembly
Parts List, continued

Designator	Description	Part No.
	Transistors	
Q2	Type-TIP32 PNP Power Transistor	33-TIP32
Q3	Type-2N3055 NPN Silicon Transistor	34-2N3055
	Miscellaneous	
J6	6-Position Connector Receptacle	79-58306
J7	9-Position Connector Receptacle	79-58308
J8	4-Position Connector Receptacle	79-58354
Q2	Thermally Conductive Silicon Insulator	78-16014
Q3	Thermally Conductive Silicon Insulator	78-16008
	Heat Sink	034531-01
	Test Point (Acceptable substitute is part no. 179051-001)	179051-002

WARNING
Fuse block cover must be in place during game operation.

29-053
Capacitor

78-70501SC
Capacitor Bracket

A035891-02
Fuse Harness
Assembly

46-301203
Fuse

78-2708
Bushing

79-3206
Fuse Block

037641-01
Label

79-15021001
Terminal Block

3A-MDA3501
Rectifier

A035888-01
Transformer Assembly

A021084-xx
Voltage Plugs

034544-01
Fuse Block Cover

79-4411001
Fuse Post

46-2017002
Fuse

034482-02
Chassis

037639-01
Label

A034630-01
Filter Assembly

46-2014002
Fuses

A035890-01
Power Harness

A034629-01
AC Harness

**Figure 5-13 Power Supply Assembly
A037671-01   J**

Power Supply Assembly
Parts List

Designator	Description	Part No.
C1	27,000 μF, 15 VDC Electrolytic Capacitor	29-053
C1	2-Inch Diameter Capacitor Mounting Bracket	78-70501SC
CR1	Type-MDA 3501 Bridge Rectifier	3A-MDA3501
F1	Panel-Mounting Non-Indicating 3AG Cartridge-Type Fuse Post	79-4411001
F1	7 A, 250 V, 3AG Slow-Blow Glass Cartridge-Type Fuse	46-2017002
F1	Label for Fuse Value	037639-01
F2	4 A, 250 V, 3AG Slow-Blow Glass Cartridge-Type Fuse	46-2014002
F2–F6	5-Position 3AG Fuse Block with ¼-Inch Quick-Disconnect Terminals	79-3206
F2–F6	Fuse Harness Assembly	A035891-02
F2–F6	Fuse Block Cover	034544-01
F2–F6	Label for Fuse Values	037641-01
F3	20 A, 32 V, 3AG Slow-Blow Glass Cartridge-Type Fuse	46-301203
F4	2-Circuit Single-Row Terminal Block (located under **F4**)	79-15021001
F4–F6	4 A, 250 V, 3AG Slow-Blow Glass Cartridge-Type Fuse	46-2014002
FL1	RFI Filter Assembly (designation not marked)	A034630-01
J2	Power Harness Assembly	A035890-01
J3	Voltage Plug for 120 V (105–135 VAC. Yellow wire color—plugs into **J3**.)	A021084-02
J4A	AC Harness Assembly	A034629-01
T1	Transformer Assembly (designation covered. Acceptable substitute is part no. A035888-02.)	A035888-01
	Nylon Type 6/6 Hole Bushing with ⅝-Inch Inside Diameter x $^{5}\!\%_{64}$-Inch Outside Diameter x ¼-Inch Thick	78-2708
	Power Supply Chassis Base	034482-02
	Metal Base Plate (not shown in illustration)	037243-01

Glossary

AC
Alternating current; from zero it rises to a maximum positive level, then passes through zero again to a maximum negative level.

ACTIVE STATE
The true state of a signal. For example: The active state for START is low.

ADDRESS
A value that identifies a specific location of data in memory; normally expressed in hexadecimal notation.

ANALOG
Measurable in an absolute quantity (as opposed to on or off). Analog devices are volume controls, light dimmers, stereo amplifiers, etc.

ANODE
The positive (arrow) end of a diode.

AMPLIFIER
A device used to increase the strength of an applied signal.

AMPLITUDE
The maximum instantaneous value of a waveform pulse from zero.

ASTABLE
Having no normal state. An astable device will free-run or oscillate as long as operating voltage is applied. The oscillation frequency is usually controlled by external circuitry.

AUXILIARY COIN SWITCH
A momentary-contact pushbutton switch with a black cap located on the utility panel. The auxiliary coin switch adds credits to the game without activating the coin counter.

BEZEL
A cut, formed, or machined retention device, such as the conical device used to mount a pushbutton switch to a control panel, or the formed device used to frame the video display screen.

BIDIRECTIONAL
Able to send or receive data on the same line (e.g., the data bus of a microprocessor).

BINARY
A number system that expresses all values by using two digits (0 and 1).

BIT
A binary digit; expressed as a 1 or a 0.

BLANKING
Turning off the beam on a cathode-ray tube during retrace.

BLOCK DIAGRAM
A drawing in which functional circuitry units are represented by blocks. Very useful during initial troubleshooting.

BUFFER
1. An isolating circuit designed to eliminate the reaction of a driven circuit on the circuits driving it (e.g., a buffer amplifier).

2. A device used to supply additional drive capability.

BUS
An electrical path over which information is transferred from any of several sources to any of several destinations.

CAPACITOR
A device capable of storing electrical energy. A capacitor blocks the flow of DC current while allowing AC current to pass.

CATHODE
The negative end of a diode.

CHIP
An integrated circuit comprising many circuits on a single wafer slice.

CLOCK
A repetitive timing signal for synchronizing system functions.

COINCIDENCE
Occurring at the same time.

COIN COUNTER
A 6-digit electro-mechanical device that counts the coins inserted in the coin mechanism(s).

COIN MECHANISM
A device on the inside of the coin door that inspects the coin to determine if the correct coin has been inserted.

COMPLEMENTARY
Having opposite states, such as the outputs of a flip-flop.

COMPOSITE SYNC
Horizontal and vertical synchronization pulses that are bused together into a single signal. This signal provides the timing necessary to keep the display in synchronization with the game circuitry.

COMPOSITE VIDEO
Complete video signal from the game system to drive the display circuitry, usually comprising H SYNC, V SYNC, and the video.

CREDIT
One play for one person based on the game switch settings.

CRT
Cathode-ray tube.

DATA
General term for the numbers, letters, and symbols that serve as input for device processing.

DARLINGTON
A two-transistor amplifier that provides extremely high gain.

DC
Direct current, meaning current flowing in one direction and of a fixed value.

DEFLECTION YOKE
Electro-magnetic coils around the neck of a cathode-ray tube. One set of coils deflects the electron beam horizontally and the other set deflects the beam vertically.

DIAGNOSTICS
A programmed routine for checking circuitry. For example: the self-test is a diagnostic routine.

DIODE
A semiconductor device that conducts in only one direction.

DISCRETE
Non-integrated components, such as resistors, capacitors, and transistors.

DMA
Direct memory access. DMA is a process of accessing memory that bypasses the microprocessor logic. DMA is normally used for transferring data between the input/output ports and memory.

DOWN TIME
The period during which a game is malfunctioning or not operating correctly due to machine failure.

EAROM
Electrically alterable read-only memory (see ROM). The EAROM is a memory that can be changed by the application of high voltage.

FLYBACK
A step-up transformer used in a display to provide the high voltage.

GATE
1. A circuit with one output that responds when and only when a certain combination of pulses is present at the inputs.

2. A circuit in which one signal switches another signal on and off.

3. To control the passage of a pulse or signal.

HARNESS

A prefabricated assembly of insulated wires and terminals ready to be attached to a piece of equipment.

HEXADECIMAL

A number system using the equivalent of the decimal number 16 as a base. The symbols 0–9 and A–F are usually used.

IMPLODE

To burst inward; the inward collapse of a vacuum tube.

I/O

Input/Output.

IRQ

Interrupt request. IRQ is a control signal to the microprocessor that is generated by external logic. This signal tells the microprocessor that external logic needs attention. Depending on the program, the processor may or may not respond.

LED

The abbreviation for a light-emitting diode.

LOCKOUT COIL

Directs coins into the coin return box when there is no power to the game.

LOGIC STATE

The binary (1 or 0) value at the node of a logic element or integrated circuit during a particular time. Also called the logic level. The list below shows the voltage levels corresponding to the logic states (levels) in a TTL system.

Logic 0, Low = 0 VDC to +0.8 VDC
Grey Area (Tri-State Level) =
+0.8 VDC to +2.4 VDC
Logic 1, High =
+2.4 VDC to +5 VDC

MULTIPLEXER

A device that takes several low-speed inputs and combines them into one high-speed data stream for simultaneous transmission on a single line.

NMI

Non-maskable interrupt. NMI is a request for service by the microprocessor from external logic. The microprocessor cannot ignore this interrupt request.

PAGE

A subsection of memory. A read-only memory device (see ROM) is broken into discrete blocks of data. These blocks are called pages. Each block has X number of bytes.

PCB

The abbreviation for a printed-circuit board.

PHOTOTRANSISTOR

A transistor that is activated by an external light source.

POTENTIOMETER

1. A resistor that has a continuously moving contact which is generally mounted on a moving shaft. Used chiefly as a voltage divider. Also called a *pot* (slang).

2. An instrument for measuring a voltage by balancing it against a known voltage.

RAM

Random-access memory. A device for the temporary storage of data.

RASTER-SCAN DISPLAY

A display system whereby images are displayed by continuously scanning the cathode-ray tube horizontally and vertically with an electron beam. The display system controls the intensity of the electron beam.

RETRACE

In a raster-scan display, retrace is the time during which the cathode-ray tube electron beam is resetting either from right to left or from bottom to top.

RESISTOR

A device designed to have a definite amount of resistance. Used in circuits to limit current flow or to provide a voltage drop.

ROM

Read-only memory. A device for the permanent storage of data.

SIGNATURE ANALYSIS

A process of isolating digital logic faults at the component level by means of special test equipment called signature analyzers. Basically, signature analyzers (e.g., the ATARI® CAT Box) convert lengthy bit streams into four-digit hexadecimal signatures. The signature read by the analyzer at each circuit node is then compared with the known good signature for that node. This process continues until a fault is located.

TROUBLESHOOT

The process of locating and repairing a fault.

VECTOR

A line segment drawn between specific X and Y coordinates on a cathode-ray tube.

WATCHDOG

A counter circuit designed to protect the microprocessor from self-destruction if a program malfunction occurs. If a malfunction does occur, the counter applies continuous pulses to the reset line of the microprocessor, which causes the microprocessor to keep resetting.

X-Y DISPLAY

A display system whereby images are displayed with vectors.

ZENER DIODE

A special diode used as a regulator. Its main characteristic is breaking down at a specified reverse-bias (Zener) voltage.

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 video displays (in games supplied with displays) 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.

If the products described in this manual fail to conform to this warranty, Seller's sole liability shall be, at its option, to repair, replace, or credit Buyer's account for such products which are returned to Seller during said warranty period, provided:
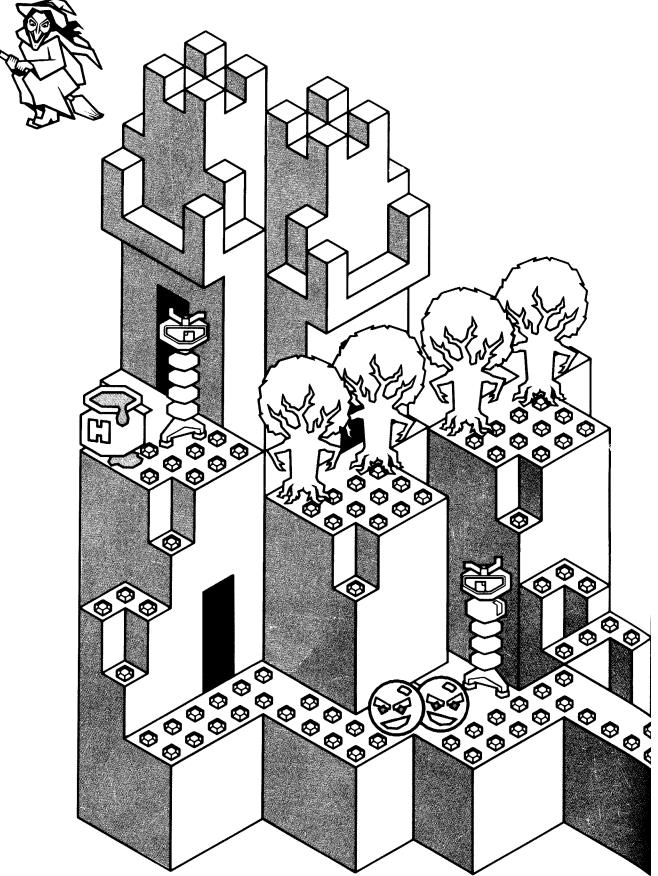
    (a) Seller is promptly notified in writing upon discovery by Buyer that said products are defective;

    (b) Such products are returned prepaid to Seller's plant; and

    (c) Seller's examination of said products discloses to Seller's satisfaction that such alleged defects existed and were not caused by accident, misuse, neglect, alteration, improper repair, installation, or improper testing.

In no event shall Seller be liable for loss of profits, loss of use, incidental or consequential damages.

Except for any express warranty set forth in a written contract between Seller and Buyer which contract supersedes the terms herein, this warranty is expressed in lieu of all other warranties expressed or implied, including the implied warranties of merchantability and fitness for a particular purpose, and of all other obligations or liabilities on the Seller's part, and it neither assumes nor authorizes any other person to assume for the Seller any other liabilities in connection with the sale of products by Seller.

The use of any non-Atari parts may void your warranty, according to the terms of the warranty. The use of any non-Atari parts may also adversely affect the safety of your game and cause injury to you and others. Be very cautious in using non-Atari-supplied components with our games, in order to insure your safety.

Atari distributors are independent, being privately owned and operated. In their judgment they may sell parts or accessories other than Atari parts or accessories. Atari cannot be responsible for the quality, suitability or safety of any non-Atari part or any modification including labor which is performed by such distributor.
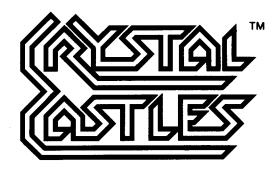
Schematic Package Supplement to

CRYSTAL CASTLES ™

Operators Manual

Includes
Troubleshooting Guide
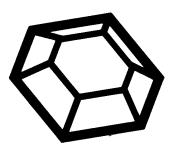
7M

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Table of Contents

Game PCB Schematics, Sheets 3B–9A
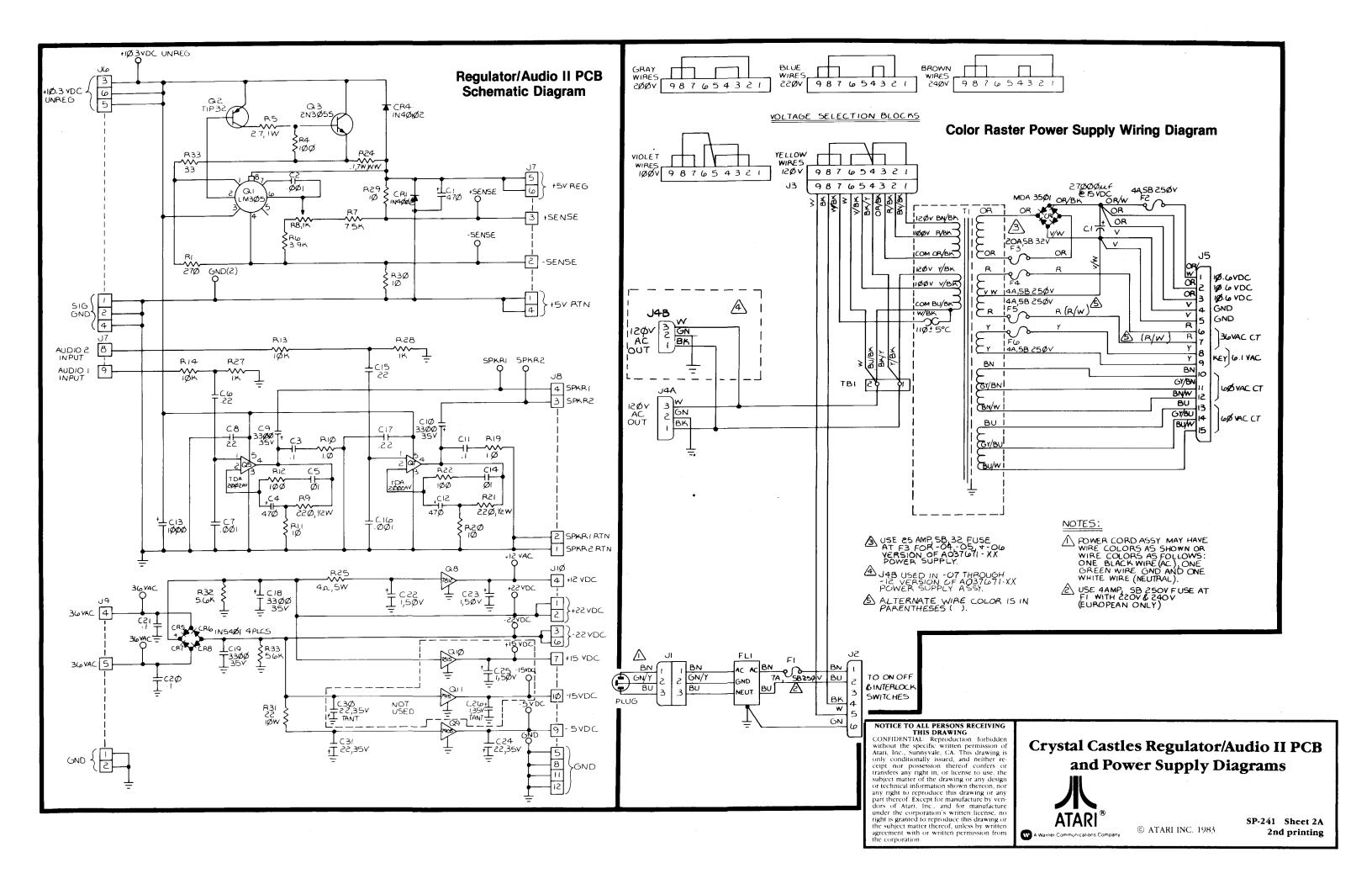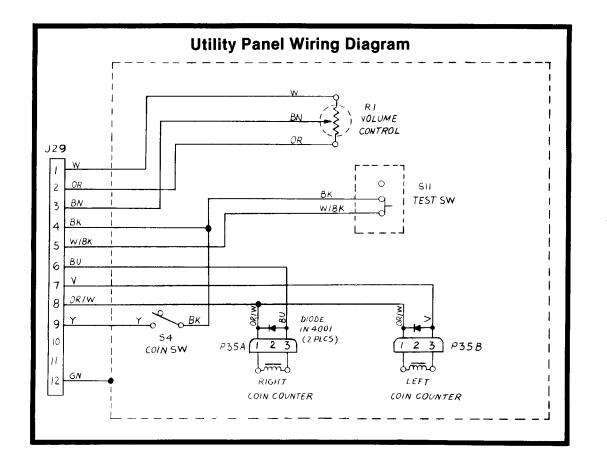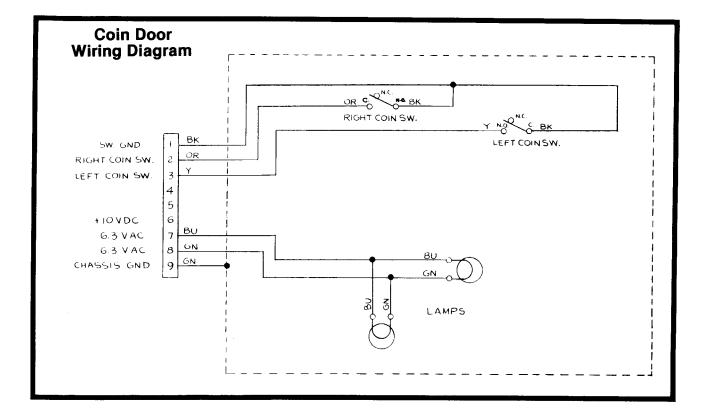
Display Schematics, Sheets 9B–11A

NOTE

A Crystal Castles Troubleshooting Guide is includ-
ed as part of this Schematic Package Supplement.
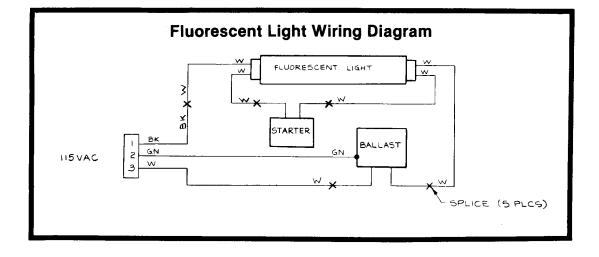The Troubleshooting Guide contains Atari CAT Box
troubleshooting procedures.

Crystal Castles Main Wiring Diagram

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SP-241   Sheet 1B
2nd printing

Regulator/Audio II PCB Schematic Diagram

Color Raster Power Supply Wiring Diagram

VOLTAGE SELECTION BLOCKS

NOTES:

△1 POWER CORD ASSY. MAY HAVE WIRE COLORS AS SHOWN OR WIRE COLORS AS FOLLOWS: ONE BLACK WIRE (AC), ONE GREEN WIRE GND AND ONE WHITE WIRE (NEUTRAL).

△2 USE 4AMP, SB 250V FUSE AT F1 WITH 220V & 240V (EUROPEAN ONLY)

△3 USE 25 AMP SB 32 FUSE AT F3 FOR -04, -05, & -06 VERSION OF A037671-XX POWER SUPPLY.

△4 J4B USED IN -07 THROUGH -12 VERSION OF A037671-XX POWER SUPPLY ASSY.

△5 ALTERNATE WIRE COLOR IS IN PARENTHESES ( ).

Crystal Castles Regulator/Audio II PCB and Power Supply Diagrams

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SP-241 Sheet 2A
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Utility Panel Wiring Diagram

R1
VOLUME
CONTROL

W
BN
OR

J29

1	W
2	OR
3	BN
4	BK
5	W/BK
6	BU
7	V
8	OR/W
9	Y
10	
11	
12	GN

S11
TEST SW

BK
W/BK

S4
COIN SW

Y   BK

DIODE
IN 4001
(2 PLCS)

P35A 1 2 3

RIGHT
COIN COUNTER

P35B 1 2 3

LEFT
COIN COUNTER

Coin Door Wiring Diagram

SW GND	1	BK
RIGHT COIN SW.	2	OR
LEFT COIN SW.	3	Y
	4	
	5	
+10 VDC	6	
6.3 VAC	7	BU
6.3 VAC	8	GN
CHASSIS GND	9	GN

RIGHT COIN SW.
OR C   N.C. BK

LEFT COIN SW.
Y N.O.   N.C. BK

BU
GN

LAMPS

BU
GN

Fluorescent Light Wiring Diagram

FLUORESCENT LIGHT

STARTER

BALLAST

115 VAC

1	BK
2	GN
3	W

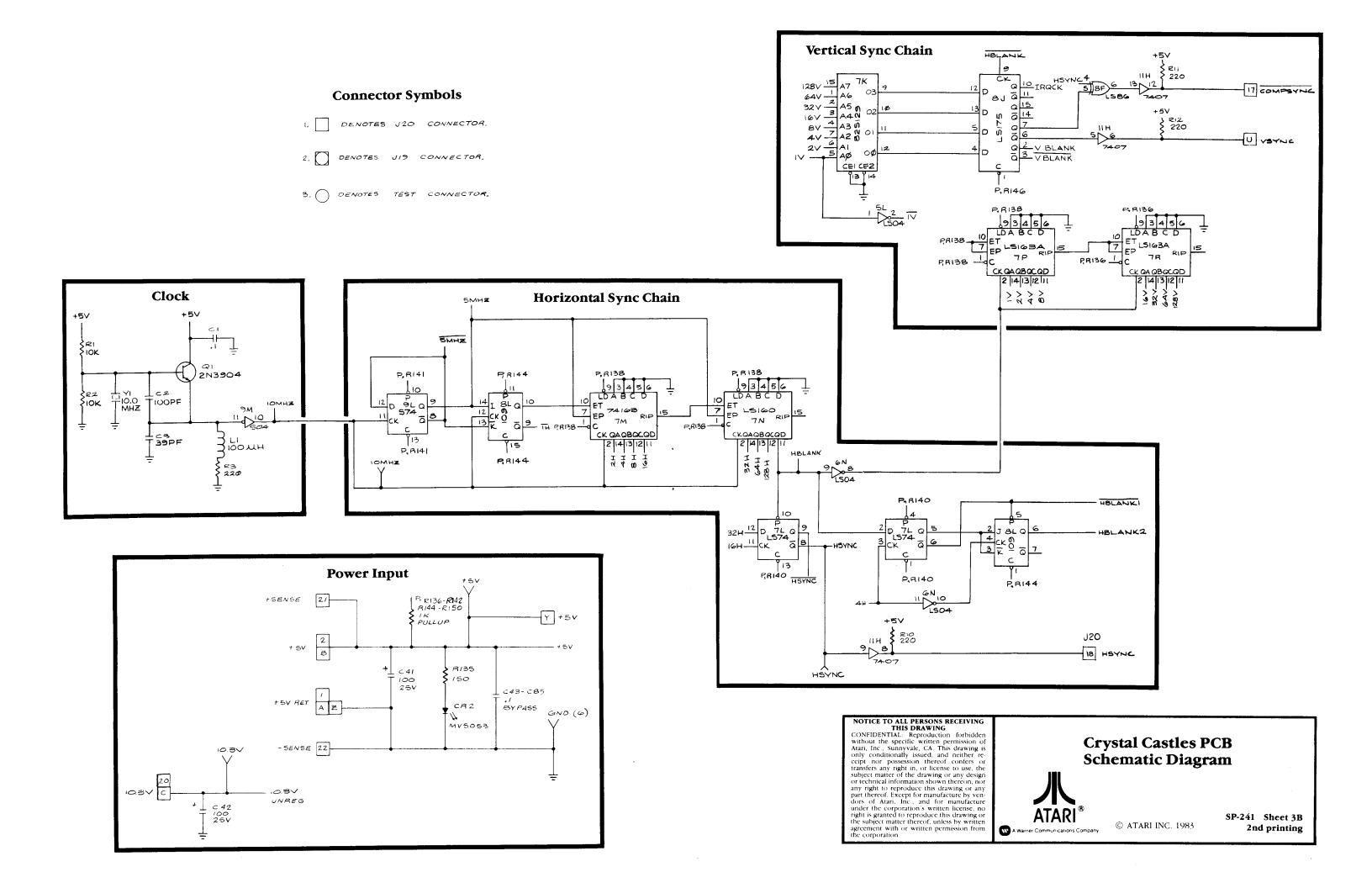SPLICE (5 PLCS)

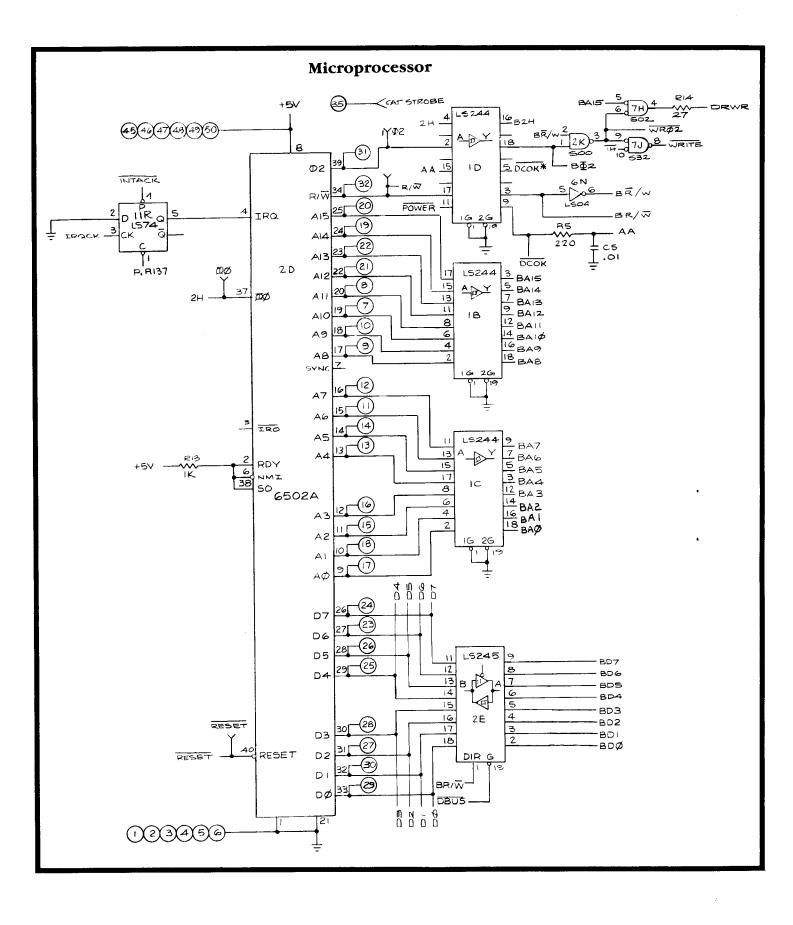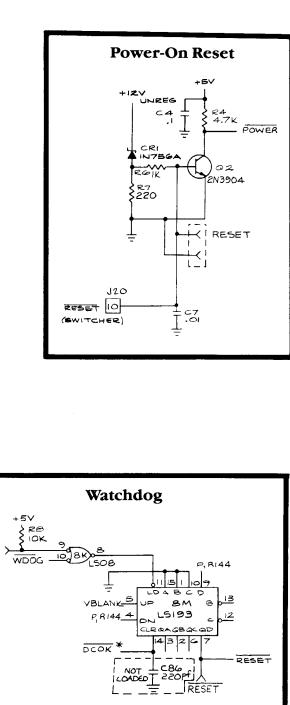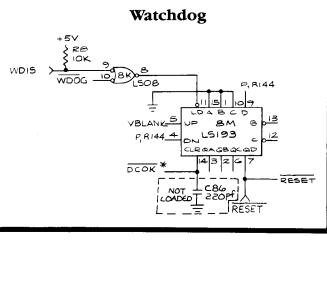# Crystal Castles Game Interfaces

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SP-241   Sheet 2B
2nd printing

Crystal Castles Memory Map

HEXA-DECIMAL ADDRESS	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	READ/WRITE	D7	D6	D5	D4	D3	D2	D1	D0	FUNCTION
0000	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1	W	X	X	X	X	X	X	X	X	X COORDINATE
0001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	W	D	D	D	D	D	D	D	D	Y COORDINATE
0002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	R/W	D	D	D	D					BIT MODE
0003–0BFF	0	0	0	0	A	A	A	A	A	A	A	A	A	A	A	A	R/W	D	D	D	D	D	D	D	D	WORKING RAM (DRAM)
0C00–7FFF	0	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	R/W	D	D	D	D	D	D	D	D	SCREEN RAM
8000–8DFF	1	0	0	0	A	A	A	A	A	A	A	A	A	A	A	A	R/W	D	D	D	D	D	D	D	D	WORKING RAM (STATIC)
8E00–8EFF	1	0	0	0	1	1	1	0	A	A	A	A	A	A	A	A	R/W	D	D	D	D	D	D	D	D	MOTION OBJECT BUF 2
8F00–8FFF	1	0	0	0	1	1	1	1	A	A	A	A	A	A	A	A	R/W	D	D	D	D	D	D	D	D	MOTION OBJECT BUF1
															0	0	R/W	D	D	D	D	D	D	D	D	MOTION OBJECT PICTURE
															0	1	R/W	D	D	D	D	D	D	D	D	MOTION OBJECT VERTICAL
															1	0	R/W	D								MOTION OBJECT PRIORITY
															1	1	R/W	D	D	D	D	D	D	D	D	MOTION OBJECT HORIZONTAL
9000–90FF	1	0	0	1	0	0	X	X	A	A	A	A	A	A	A	A	R/W	D	D	D	D	D	D	D	D	NOVRAM
9400–9403	1	0	0	1	0	1	0	X	X	X	X	X	X	X	A	A	R									TRAK-BALL
4600	1	0	0	1	0	1	1	X	X	X	X	X	X	X	X	X	R									IN0
																	R								D	COIN R
																	R							D		COIN L
																	R						D			COIN AUX
																	R					D				SLAM
																	R				D					SELF TEST
																	R			D						SPARE
																	R		D							JMP 1
																	R	D								JMP 2
9800–980F	1	0	0	1	1	0	0	X	X	X	X	X	A	A	A	A	R/W	D	D	D	D	D	D	D	D	CI/O 0
9A00–9A0F	1	0	0	1	1	0	1	X	X	X	X	X	A	A	A	A	R/W	D	D	D	D	D	D	D	D	CI/O 1
9A08																							D	D	D	OPTION SW
																						D				SPARE
																					D					SPARE
																				D						COCKTAIL
9C00	1	0	0	1	1	1	0	0	0	X	X	X	X	X	X	X	W									RECALL
9C80	1	0	0	1	1	1	0	0	1	X	X	X	X	X	X	X	W	D	D	D	D	D	D	D	D	HOR SCROLL CNTR LOAD
9D00	1	0	0	1	1	1	0	1	0	X	X	X	X	X	X	X	W	D	D	D	D	D	D	D	D	VERT SCROLL CNTR LOAD
9D80	1	0	0	1	1	1	0	1	1	X	X	X	X	X	X	X	W									INTERRUPT ACKNOWLEDGE
9E00	1	0	0	1	1	1	1	0	0	X	X	X	X	X	X	X	W									WDOG
	1	0	0	1	1	1	1	0	1	X	X	X	X	A	A	A	W								D	OUT 0
9E80														0	0	0	W								D	TRAK-BALL LIGHT
9E81														0	0	1	W								D	
9E82														0	1	0	W								D	STORE LOW
9E83														0	1	1	W								D	STORE HIGH
9E84														1	0	0	W								D	SPARE
9E85														1	0	1	W								D	COIN CNTR R
9E86														1	1	0	W								D	COIN CNTR L
9E87														1	1	1	W								D	BANK0–BANK 1
	1	0	0	1	1	1	1	1	0	X	X	X	X	A	A	A	W							D		OUT 1
9F00														0	0	0	W							D		AX
9F01														0	0	1	W							D		AY
9F02														0	1	0	W							D		XINC
9F03														0	1	1	W							D		YINC
9F04														1	0	0	W							D		PLAYER 2
9F05														1	0	1	W							D		SIRE
9F06														1	1	0	W							D		BOTHRAM
9F07														1	1	1	W							D		BUF1/BUF2
9F80–9FBF	1	0	0	1	1	1	1	1	1	X	A	A	A	A	A	A	W	D	D	D	D	D	D	D	D	COLORAM
A000–FFFF	1	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	R	D	D	D	D	D	D	D	D	PROGRAM ROM

Crystal Castles Memory Map

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Connector Symbols

1. ☐ DENOTES J20 CONNECTOR.
2. ◻ DENOTES J19 CONNECTOR.
3. ◯ DENOTES TEST CONNECTOR.

Vertical Sync Chain

HBLANK

7K
128V 15 A7
64V 1 A6
32V 2 A5
16V 3 A4
8V 4 A3
4V 6 A2
2V 7 A1
1V 5 A0
CE1 CE2

8J LS175
P,R146

8F LS86
HSYNC

+5V
R11 220
11H 7407
17 COMPSYNC

+5V
R12 220
11H 7407
U VSYNC

V BLANK
V BLANK

5L LS04 IV

P,R138 LS163A 7P
P,R136 LS163A 7R

Clock

+5V R1 10K
+5V
C1 .1
R2 10K
Q1 2N3904
Y1 10.0 MHZ
C2 100PF
C3 39PF
9M LS04
10MHZ
L1 100μH
R3 220

Horizontal Sync Chain

5MHZ
5MHZ
10MHZ

P,R141
S74 9L
P,R141
10MHZ

P,R144
109 8L
TH P,R138
P,R144

P,R138
74163 7M
P,R138

P,R138
LS160 7N
P,R138

HBLANK
6N LS04

P,R140
LS574 7L
HSYNC
P,R140 HSYNC

32H
16H

P,R140
LS574 7L
P,R140

P,R144
109 8L
P,R144

HBLANK1
HBLANK2

4H
6N LS04

+5V R10 220
11H 7407
HSYNC

J20 18 HSYNC

Power Input

+5V
P,R136-R142 R144-R150 1K PULLUP
Y +5V

+SENSE 21

+5V 2 B
+5V

C41 100 25V
R135 150
C43-C85 .1 BYPASS

+5V RET 1 A Z
CR2 MV5053
GND (6)

-SENSE 22

10.3V 20 C
10.3V
C42 100 25V
10.3V UNREG

Crystal Castles PCB Schematic Diagram

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Microprocessor

Power-On Reset

Watchdog

**Crystal Castles PCB
Schematic Diagram**

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Program Memory

+5V

VPP	PGM	VPP	PGM	VPP	PGM	VPP	PGM	VPP	PGM
2764		2764		2764		2764		2764	
1F		1J		1K		1L		1N	

BA12
BA11
BA10
BA9
BA8
BA7
BA6
BA5
BA4
BA3
BA2
BA1
BA0

A12 A11 A10 A9 A8 A7 A6 A5 A4 A3 A2 A1 A0

D7 D6 D5 D4 D3 D2 D1 D0

2F LS244
1G 2G

3E LS245
DIR G

SBD7 SBD6 SBD5 SBD4 SBD3 SBD2 SBD1 SBD0

SBUS
BR/W

1S — BA0 — LS04
5L — BA9 — LS04

CE OE CE OE CE OE CE OE CE OE

BANK0
BANK1

ROM0   ROM1   ROM2

BANK0 BANK1
ROM0 ROM1 ROM2

BØ2 — 2K — SOO
BA15 — 5K — LS08
NR

Address Decoders

PLAYER2 — 6N 3 4 — PLAYER2 — LS04

OUT1 — 14 G Q7 12 — BUF1/BUF2 — R153 220 — J20 START LED1
BD3 — 13 D 6P Q6 10
       C Q5 — SIRE
BA2 — 3 C LS259 Q4 — PLAYER2
BA1 — 2 B Q3 — YINC
BA0 — 1 A Q2 — XINC
       Q1 — AY
       Q0 — AX
C 15
RESET

BA15 — 5L 11 10 1 — 4R G Y3 7 — ROM2
       LS04   Y2 6 — ROM1
BA14 — 3 B LS139 Y1 5 — ROM0
BA13 — 2 A Y0 4 — NR

82S129
BØ2 — A7 Q3 9 — BITRD
BA15 — A6 6L
BITMD — A5 Q2 10 — DRH
BA0 — A4
PIXB — A3 Q1 11 — DRL
BR/W — A2
       A1 Q0 12 — DBUS
       A0
CE1 CE2

BA12 — 5R 8 — SRAM — LS32

BA12 — 5L 9 8 — LS04 — 5R 12 13 11 — LS32 — 5L 5 6 — 5M 4 6 — SBUS — LS00

BA15 — 13
DRBA14 — 12   2/3R
DRBA13 — 13 — BA1520
DRBA12 — S260

R139
WRITE — 4 G2A Y7 7 — CRAM
       5 G2B Y6 9 — OUT1
       LS138 Y5 10 — OUT0
       C Y4 11 — WDOG
BA9 — 3 C 6M Y3 12 — INTACK
BA8 — 2 B Y2 13 — VSLD
BA7 — 1 A Y1 14 — HSLD
             Y0 15

BA11 — 15 G 6R Y3 9 — CI/O
BA10 — 14 B LS139 Y2 10 — IN0
       A Y1 11
          Y0 12 — NVRAM

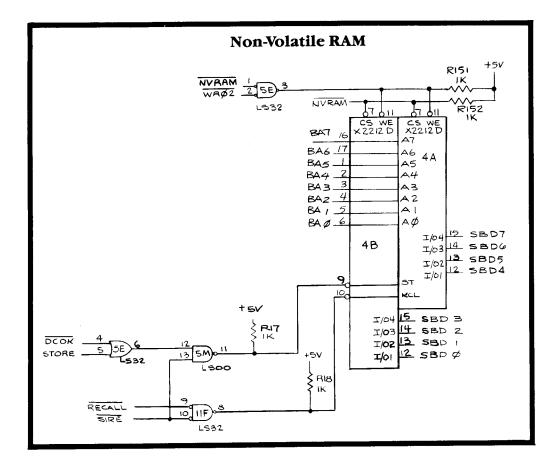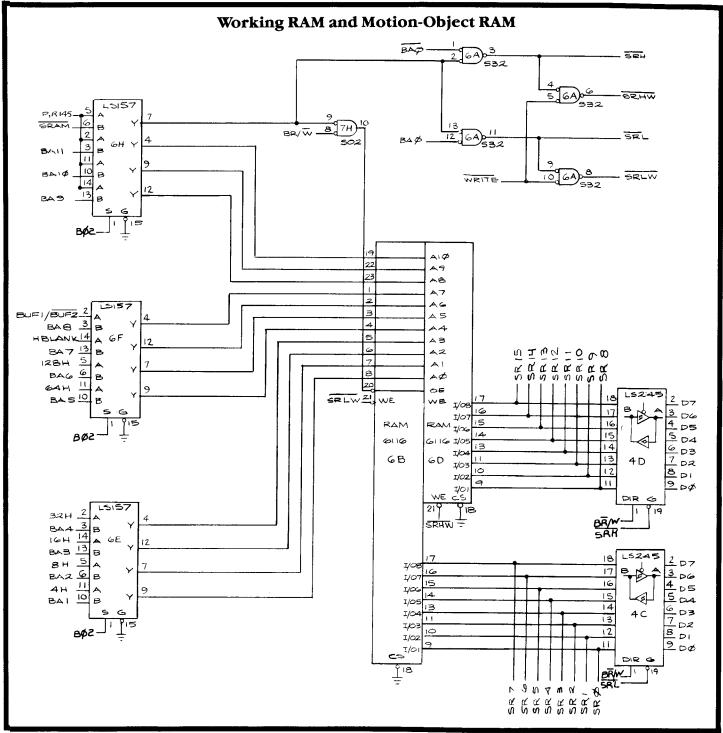**Crystal Castles PCB Schematic Diagram**

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Bit-Mode Decoder

Auto Increment

Bit-Mode Read/Write

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Horizontal Scrolling

Dynamic RAM Write Protection

Dynamic RAM Control

Crystal Castles PCB Schematic Diagram

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Address Selectors

Dynamic RAM

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Position Control

Non-Volatile RAM

Working RAM and Motion-Object RAM

Crystal Castles PCB Schematic Diagram

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Motion-Object Picture ROM

Motion-Object Vertical Control

**Crystal Castles PCB
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Motion-Object Buffer

Motion-Object Horizontal Control

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Color Memory

Color Output

**Crystal Castles PCB
Schematic Diagram**

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Trak-Ball Input

J19
HC2 3
HD2 C
VC2 4
VD2 D

R84 R85 R86 R87 R88 R89 R90 R91

3.3K
8PL

HC1 5
HD1 E
VC1 6
VD1 F

C14 C15 C16 C17 C18 C19 C20 C21
.01
8PL

LSTA 11E
1 Y4
2 X4
3 YB
4 XB
5 Y2
6 X2
7 Y1
8 X1
10 B
11 A
13 D2
14 RESOL
CE 23

D7 22 SBD7
D6 21 SBD6
D5 20 SBD5
D4 19 SBD4
D3 18 SBD3
D2 17 SBD2
D1 16 SBD1
D0 15 SBD0

BA1 10
BA0 11
16H 13

BA9 1
IN0 2 11F 3
LS32

Player Switches Input

J19
JMP2 L
JMP1 H
SELF TEST 7
SLAM K
COIN AUX 8
COIN L 9
COIN R J

R92 R93 R95 R96 R97 R98 R99
+5V
470 7PL

V BLANK

R100
R101
R103
R104
R105
R106
R107

LS244 11C
1 A
Y 19

SBD7
SBD6
SBD5
SBD4
SBD3
SBD2
SBD1
SBD0

1K 7PL
1G 2G

C22 C23 C25 C26 C27 C28 C29
.1 7PL

BA9 4
IN0 5 11F 6
LS32

Audio Output

+5V 17

BA3 33 A3
BA2 35 A2
BA1 36 A1
BA0 34 A0
CI/0 23 CS
BA9 32 CS
R/W 7 R/W
B02 28 02

SOD 24 SID

POKEY C012294-01 3D

37 R108 220
C30 .01 AREF

R109 1K
2 LM324 5B 1 C31 .22

SBD7 6 D7 P7 9
SBD6 5 D6 P6 8
SBD5 4 D5 P5 10
SBD4 2 D4 P4 11
SBD3 40 D3 P3 12
SBD2 39 D2 P2 13
SBD1 38 D1 P1 15
SBD0 37 D0 P0 14

R110 +5V
R112 10K 3PL

8R
3/4 POS DIP SW

J20
START1 H
START2 G
COCKTAIL 7

470 3PL
R116 R117 R118 C32 C34 3PL

R121 100K

R123 62K
13 LM324 5B 14
AREF 12

AUDI1
R130 2.2K
J20 W AUDIO 1

V AUD2 AUDIO RET

R131 100K
R132 100K

POKEY C012294-01 3B
BA3 33 A3
BA2 35 A2
BA1 36 A1
BA0 34 A0
CI/0 30 CS
BA9 31 CS
R/W 7 R/W
B02 28 02
SOD
SID 24

37 R119 220
C35 .01

LM324 5B
4 +12V
C36 .1 C37 .22
AREF
R120 1K

R122 100K

SBD7 6 D7 P7 9
SBD6 5 D6 P6 8
SBD5 3 D5 P5 10
SBD4 2 D4 P4 11
SBD3 40 D3 P3 12
SBD2 39 D2 P2 13
SBD1 38 D1 P1 15
SBD0 37 D0 P0 14

6 LM324 5B 7
AUD2
R133 2.2K
19 AUDIO 2 J20

+5V R134 100K
C40 .22

Coin Counter and LED Output

BANK0
13 GN 12 LS04 BANK1

Q10 2N6044
C38 .1
J20 J COIN CNTL L

Q11 2N6044
C39 .1
8 COIN CNTL R

+5V
R126 2.2K
R124 R125 1K 2PL
R111 1K 2PL

8R 1/4 POS DIP SW

LS259
OUT0 14 Q7 12
BD0 13 D Q6 11
Q5 10
BA2 3 A Q4 9 RECALL
BA1 2 B Q3 7
Q2 6 5K STORE
BA0 1 C Q1 5 LS04 LS08
Q0 4
15 C
RESET

R128 220
J20 K START LED2

+5V R143 1K
9 LIGHT BULB
R129 1K
Q12 2N6044

Crystal Castles PCB Schematic Diagram

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NOTES:

1. ✱ DENOTES NOT LOADED CAPACITOR.

Crystal Castles EMI Shield PCB

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Crystal Castles™ Troubleshooting Guide

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7M

Crystal Castles™
Troubleshooting with the CAT Box

Troubleshooting with the Read/Write Controller

A. CAT Box Preliminary Set-Up

1. Remove the electrical power from the game and the CAT Box.

2. Remove the wiring harness from the game PCB.

3. Remove the game PCB from the game cabinet.

4. Remove Microprocessor 2C from the game PCB.

5. Connect the harness from the game to the game PCB.

6. Connect together the Φ0 and Φ2 test points on the game PCB with the shortest possible jumper.

7. Connect the $\overline{\text{WDDIS}}$ test point to ground.

8. Connect the CAT Box flex cable to the game PCB edge test connector.

9. Apply power to the game and to the CAT Box.

10. Set CAT Box switches as indicated:
    a. TESTER SELF-TEST: OFF
    b. TESTER MODE: R/$\overline{\text{W}}$

11. Press TESTER RESET.

12. Connect the DATA PROBE to the CAT Box. Connect the DATA PROBE ground clip to a game PCB ground test point.

B. Checking the Address Lines

1. Perform the CAT Box preliminary set-up.

2. Set CAT Box switches as indicated:
    a. BYTES: 1
    b. PULSE MODE: UNLATCHED
    c. R/$\overline{\text{W}}$ MODE: (OFF)
    d. R/$\overline{\text{W}}$: READ

3. Key in the address pattern given in Table 1 (use AAAA to start) with the CAT Box keyboard.

4. Set R/$\overline{\text{W}}$ MODE to STATIC.

5. Probe each IC-pin listed in Table 1 with the DATA PROBE and check that the CAT Box 1 or 0 LED for the corresponding address line lights up.

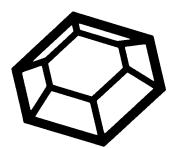6. Repeat parts 2-c through 5 using address 5555 in part 3.

Table 1   Address Lines

Logic State for Address AAAA		IC-Pin	Logic State for Address 5555
BA15	1	1B3	0
BA14	0	1B5	1
BA13	1	1B7	0
BA12	0	1B9	1
BA11	1	1B12	0
BA10	0	1B14	1
BA9	1	1B16	0
BA8	0	1B18	1
BA7	1	1C9	0
BA6	0	1C7	1
BA5	1	1C5	0
BA4	0	1C3	1
BA3	1	1C12	0
BA2	0	1C14	1
BA1	1	1C16	0
BA0	0	1C18	1

C. Checking the Data Lines

1. Perform the CAT Box preliminary set-up.

2. Set CAT Box switches as indicated:
    a. BYTES:1
    b. R/$\overline{\text{W}}$ MODE: (OFF)
    c. R/$\overline{\text{W}}$: WRITE

3. Key in address 0000 with the keyboard.

4. Press DATA SET. Key in data AA with the keyboard.

5. Set R/$\overline{\text{W}}$ MODE to STATIC.

6. Probe each IC-pin listed in Table 2 with the DATA PROBE and check that the CAT Box 1 or 0 LED for the corresponding address line lights up.

7. Set R/$\overline{\text{W}}$ MODE to (OFF).

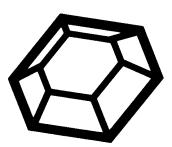8. Repeat parts 4 through 6 using data 55 in part 4.

Table 2 Data Lines

Logic State for Data AA		IC-Pin	Logic State for Data 55
D7	1	2E-11	0
D6	0	2E-12	1
D5	1	2E-13	0
D4	0	2E-14	1
D3	1	2E-15	0
D2	0	2E-16	1
D1	1	2E-17	0
D0	0	2E-18	1
BD7	1	2E-9	0
BD6	0	2E-8	1
BD5	1	2E-7	0
BD4	0	2E-6	1
BD3	1	2E-5	0
BD2	0	2E-4	1
BD1	1	2E-3	0
BD0	0	2E-2	1

D. Checking the RAM

1. Perform the CAT Box preliminary set-up.

2. Set CAT Box switches as indicated:
   a. DBUS SOURCE: ADDR
   b. BYTES:1024
   c. R/$\overline{W}$ MODE: (OFF)
   d. R/$\overline{W}$: WRITE

3. Enter address 0003 with the keyboard.

4. Set the CAT Box switches as indicated:
   a. R/$\overline{W}$ MODE to PULSE and back to (OFF)
   b. R/$\overline{W}$ to READ
   c. R/$\overline{W}$ MODE to PULSE and back to (OFF)

5. If the CAT Box reads an address that doesn't compare with that written, the COMPARE ERROR LED will light up. The ADDRESS/SIGNATURE display of the CAT Box will show the failing address location and the ERROR DATA DISPLAY switch is enabled. Using this switch, determine if the error is in the high-order or low-order RAM.

6. Repeat this test with DBUS SOURCE set to ADDR.

7. Set the CAT Box switches as indicated:
   a. BYTES: 256
   b. DBUS SOURCE: ADDR
   c. R/$\overline{W}$: (OFF)
   d. R/$\overline{W}$: WRITE

8. Repeat parts 5 through 6 to check addresses from 1000 through 8FFF.

NOTE

The two custom audio I/O chips must be tested separately by performing the self-test, substituting a known good part, or performing the following procedure.

E. Checking the Custom Audio I/O Chips

1. Perform the CAT Box preliminary set-up.

2. Set CAT Box switches as indicated:
   a. BYTES: 1
   b. R/$\overline{W}$: WRITE
   c. R/$\overline{W}$ MODE: (OFF)

3. Enter the address from Table 3 with the keyboard.

4. Press DATA SET and enter the data from Table 3 with the keyboard.

5. Set R/$\overline{W}$ to PULSE and back to (OFF).

6. Repeat parts 3 through 5 for each address and data listed in Table 3. Check for the response indicated.

Table 3 Custom Audio I/O Chips

Address	Data	Test Results
98	00	Custom Audio I/O Chip 4D
98	03	channel 1 produces pure tone.
98	55	
98	AF	
98	00	Custom Audio I/O Chip 4D channel 1 turns off.
98	55	Custom Audio I/O Chip 4D
98	AF	channel 2 produces pure tone.
98	00	Custom Audio I/O Chip 4D channel 2 turns off.
9A	00	Custom Audio I/O Chip 4B
9A	03	channel 1 produces pure tone.
9A	55	
9A	AF	
9A	00	Custom Audio I/O Chip 4B channel 1 turns off.
9A	55	Custom Audio I/O Chip 4B
9A	AF	channel 2 produces pure tone.
9A	00	Custom Audio I/O Chip 4B channel 2 turns off.

F. Checking the Player Switch, Option Switch, and Trak-Ball™ Inputs

1. Perform the CAT Box preliminary set-up.
2. Set CAT Box switches as indicated:
   a. BYTES: 1
   b. R/W̄: WRITE
   c. R/W̄ MODE: (OFF)
3. Enter address 9600 with the keyboard.
4. Press DATA SET and enter data FF with the keyboard.
5. Set R/W̄E to PULSE and back to (OFF).
6. For each entry listed in Table 4, do the following:
   a. Set R/W̄ MODE to (OFF).
   b. Set R/W̄ WRITE.
   c. Enter the first address with the keyboard.
   d. Press DATA SET and enter the data for that address with the keyboard.
   e. Set R/W̄ MODE to PULSE and back to (OFF).
   f. Set R/W̄ to READ.
   g. Enter the next address.
   h. Set R/W̄ MODE to STATIC.
   i. Activate the input switch or signal indicated in Table 4 and check the test result.
   j. Set R/W̄ MODE to (OFF).
   k. Repeat parts g through j for each subsequent address given for the entry.

Table 4 Player Switches, Option Switches, and Trak-Ball™ Inputs

Address	Input Switches/Signals	Test Results
9400	Trak-Ball™ VERT	
9401	Trak-Ball™ HORIZ	
9402	Trak-Ball™ VERT (Player 2)	
9403	Trak-Ball™ HORIZ (Player 2)	
9600	D0 COIN R	
	D1 COIN L	
	D2 COIN AUX	
	D3 SLAM	
	D4 SELF TEST	
	D5 SPARE	
	D6 JMP1	
	D7 JMP2	
00–9A0B	SW2 D0	Read switches at address 9A08. DATA display changes when any of these switches or signals are activated.
	SW3 D1	
	SW4 D2	

G. Checking the Coin Counter and Trak-Ball Light

1. Perform the CAT Box preliminary set-up.
2. Set CAT Box switches as indicated:
   a. DBUS SOURCE: DATA
   b. BYTES: 1
   c. R/W̄: WRITE
   d. R/W̄ MODE: (OFF)
3. Enter the address in Table 5 with the keyboard.

CAUTION

If you write ON data to activate a solenoid, *deactivate the solenoid immediately* by writing the OFF data. If you leave a solenoid activated for more than 10 seconds, you may have to replace the solenoid and/or its driver, due to overheating.

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4. For each address listed in Table 5, do the following:
   a. To activate the output:
      • Press DATA SET.
      • Enter the ON data with the keyboard.
      • Set R/W̄ MODE to STATIC and back to (OFF).
   b. To deactivate the output:
      • Press DATA SET.
      • Enter the OFF data with the keyboard.
      • Set R/W̄ MODE to STATIC and back to (OFF).

Table 5 LED and Coin Counter Outputs

Address	On Data	Off Data	Output Device
9E86	FF	00	Left Coin Counter
9E85	FF	00	Right Coin Counter
9E80	FF	00	Trak-Ball™ Light

Troubleshooting the Watchdog Circuit

The Watchdog circuit will send continuous reset pulses to the microprocessor if a problem exists within the microprocessor circuit. If the self-test fails to run, it is a good practice to check the RESET line.

$\overline{\text{RESET}}$ is a microprocessor input (pin 40). In a properly operating game, reset should occur during power-up or when the $\overline{\text{RESET}}$ test point is grounded. A pulsing $\overline{\text{RESET}}$ line indicates that something is causing the microprocessor to lose its place within the program. Typical causes are:

1. Open or shorted address or data bus lines.

2. Bad microprocessor chip.

3. Bad bus buffers.

4. Bad ROM.

5. Bad RAM.

6. Any bad input or output that causes an address or data line to be held in a constant high or low state.

A pulsing $\overline{\text{RESET}}$ signal indicates a problem exists somewhere within the microprocessor circuitry. To aid in troubleshooting, the $\overline{\text{WDDIS}}$ test point can be connected to a ground test point to prevent resets. This will sometimes allow the Self-Test to be used to diagnose the failure during a RESET condition.