

Owner's Manual

ENGLISH MARK DARTS® MACHINE

INTRODUCTION

This manual contains description, unpacking/assembly, operation, and troubleshooting information for the Model AD 5000 English Mark Darts Machine.

The purpose of this manual is to provide the user with a basic field service guide. If you should encounter a problem that is not covered, please call the factory, using our toll-free number, 800-435-8319. In Illinois use 815-962-3919.

SECTION I — GENERAL DESCRIPTION

The 5000 series English Mark Darts machine is a patented (Patent #4057 251) microprocessor controlled dart game where players may select one of eight different games. It is a coin operated game offering players a choice of quarter games or more challenging fifty-cent games.

Occupying only 2.5 square feet of floor space (see figure 1), this unit uses a revolutionary sealed switch matrix scoring system behind the dart face. As the darts strike the target, the machine's computerized digital scoring gives the player an instantaneous displayed score.

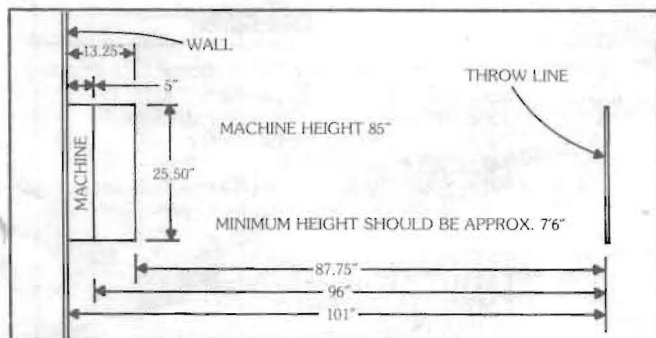


Figure 1. Plan view of 5000 Series play field.

SECTION II — UNPACKING/ASSEMBLY

2.1 Unpacking

- Using a sharp knife, slit all four corners of the shipping container from top to bottom, allowing the sides of the container to fall away from the machine.
- The top assembly is packed inside back of the base unit, and the top light is set on top of the base in a box board stabilizer. The bolts and keys are contained inside the stabilizer on top of the instruction panel.
- Remove the top from base and unpack the dart board assembly. The machine is now ready for assembly.

— CAUTION —

DO NOT lift the base unit by its instruction panel.

2.2 Assembly

- Screw top assembly onto top of dart board.
 - Plug light into top receptacle (see figure 2).
- CAUTION —
- Game warranty is void if anything other than top light is plugged into receptacle.
- Install completed top assembly into base as shown in figure 3.
 - Install carriage bolts so nuts are on inside of machine as shown in figure 4.
 - Connect coin door harness to main harness at lower left corner of upper section (figure 5).

— NOTE —

The speaker plug is connected at the factory.

- Plug the power cord into a 120V AC wall outlet. The machine is now ready for the Power Up Sequence (Section III).



SECTION III — OPERATION

3.1 Power Up Sequence

- Turn on dart machine, using ON/OFF switch at top of machine. If machine is in self test mode, the following sequence occurs:
 - Dart board will lite. ROUND and TEMPORARY SCORE lamps are lit.
 - REMOVE DARTS and GAME OVER lamps will flash twice and go off.
 - Each display flashes a single zero and then goes blank.
 - ROUND lamp goes off and DARTS and PLAYER CHANGE lamps are lit.
- If the machine is in operating mode, when turned on, the following sequence occurs:
 - Dart board will lite.
 - ROUND, REMOVE DARTS, TEMPORARY SCORE, and GAME OVER lamps are lit and all PLAYER SCORES display a single zero.
- Perform the 5000 Series Test Routine as detailed in figure 6.
- After running the 5000 Series Test Routine outlined in figure 6, the English Mark Darts game is ready to play.

If Power Up Sequence is incorrect, use of the reset switch will reset the game to the correct sequence. The reset switch is located inside the coin door next to the coin mechanism (figure 7).



Figure 2. Top light is attached to top of dart board.

SECTION IV—TECHNICAL DESCRIPTION

4.1 General

The rear views of the 5000 Series game (figure 8A) show exposed views of boards used in the game machine: (1) Main CPU Board; (2) Target Interface Board; (3) Lampboards; (4) Power Supply Board. These boards are described in paragraphs 4.2 through 4.5.

The hinged door (figure 8B) swings open to allow easy service access to the dart head and lamp boards. (See CAUTION on door).

4.2 Main CPU Board (figure 9)

The Main CPU Board (mother board) contains the main control circuitry. It is the heart of the machine, consisting of an 8749 microprocessor and peripheral integrated circuits (ICs) as described in Table I.

TABLE I

Description of components or equivalent cross reference on Main CPU Board.

Fig. 9 Ref. No.	Description
1	8749 Microprocessor (1A 6 megahertz crystal)
2-5	8243 Input/Output Expanders
6	316B103 10K Ohm Resistor Network
7-8	74LS244N 3-State Octal Buffer
9-13	74LS04N Hex Inverter
14-16	74LS138N 10F8 Decoder/Demultiplexer
17	74LS02 Quad 2 Input NOR Gate
18	74LS273 Octal D Flip Flop
19-20	7407 Hex Buffer/Driver
21	LM383T 8-Watt Audio Amplifier
22	LM7815 15-Volt Regulator
23	LM358 Dual Operational Amplifier



Figure 3. Attaching top assembly to base.

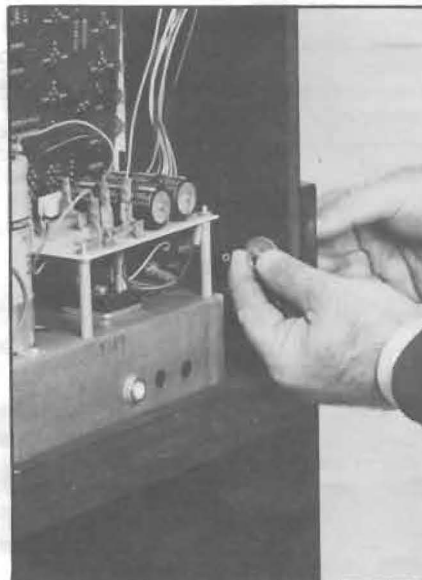


Figure 4. Bolting top to base, with bolts inserted from outside.

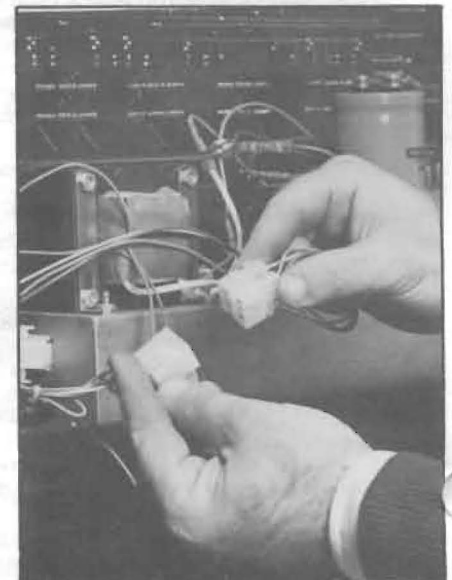


Figure 5. Connecting coin door plug to main harness.

5000 SERIES TEST ROUTINE

1. On the Main CPU Board (back side), push slide switch to up. The following lamps should be lit: DART, TEMPORARY SCORE, PLAYER CHANGE, panel numbers and top display.
2. Press PLAYER CHANGE once. Machine should go into self test mode.
3. All displays will begin counting "0" through "9" at the same time. Watch displays for missing segments and missing digits.
4. After displays have counted to "9", each lamp will be lit in a logical sequence one by one. Check for defective bulbs.
5. When the GAME OVER lamp lights, the dart board illumination lamp will flash once.
6. After the last win lamp is lit, all 20 number lamps will lite (one at a time). While this is happening, the machine will play all four sounds.

— NOTE —

- The self test can be stopped anywhere in the cycle by pressing PLAYER CHANGE. When you are ready to resume, the cycle can be restarted by pushing the PLAYER CHANGE button again.
7. After the last sound made by the machine during self test, the test for the dart head's scoring ability can be performed.
 8. All displays will be off and the TEMPORARY SCORE lamps will be lit.
 9. Tap each segment. You should be able to see the score in TEMPORARY SCORE. Make a note of any number that doesn't match the segment number you hit, or doesn't score.
 10. On the Main CPU Board, push slide switch to down position. This returns game to normal operation.
 11. Activating the machine with quarters, push each GAME SELECT pushbutton. The corresponding GAME lamp should lite and then go off when the next game is selected.
 12. The eighth game pushbutton pushed will be "split second." This game is played one round for each of the four players displayed.
 13. When the game begins, tap three segments for each of the four players.
 14. After the fourth player, push the PLAYER CHANGE button again. Machine will go back to player one. Watch the machine count from 1 to 20 by individually turning on and off, in sequence, the back lit numbers.
 15. After the machine has gone to 20, the PLAYER CHANGE lamp will lite and the number "1" lamp will be lit.
 16. Test the slam switch on coin door as follows:
 - (a) Close and lock coin door.
 - (b) Hit the coin door with your hand. If adjusted properly, the machine will reset.
 - (c) Reopen the coin door and push the Reset button on the inside (see figure 7). The machine should reset.
 17. Replace the back door, checking the fit and ease of locking.
 18. Make note of any problems in closing and locking of the coin door, back door, or anything else that may not be correct.

(Ref. Para. 3.1 (c))

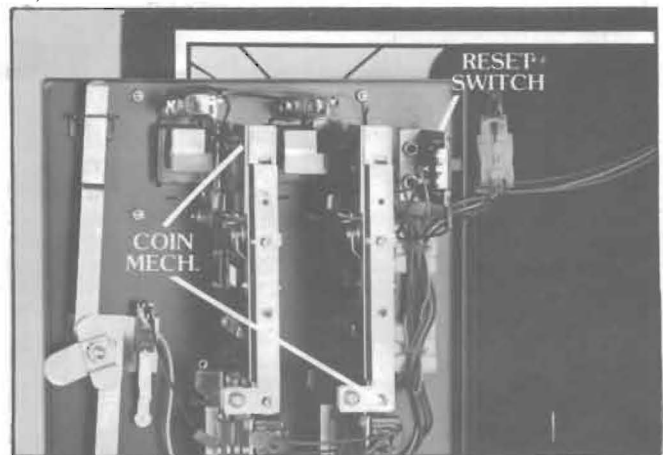


Figure 7. Coin door open, showing coin mechanism and reset switch.

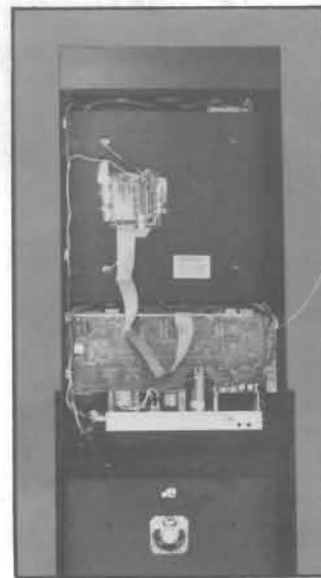


Figure 8A. Rear view of 5000 Series game machine.

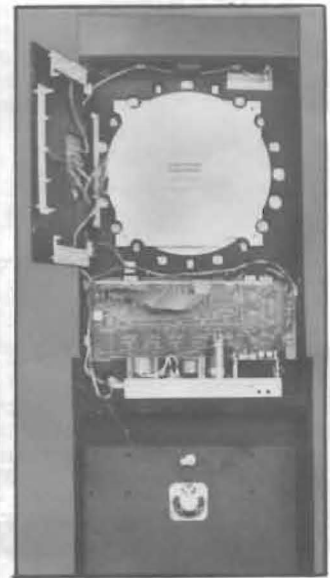


Figure 8B. Door opens for access to dart head.

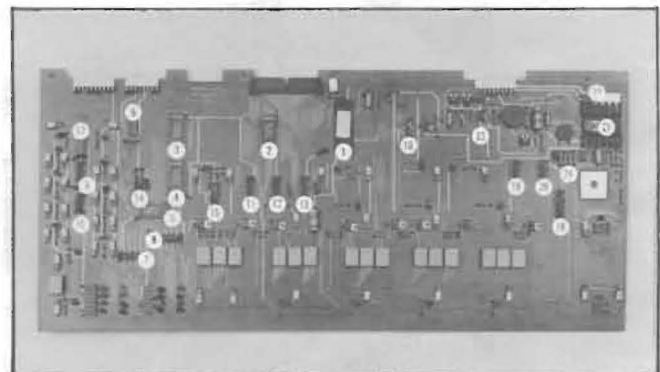


Figure 9. Front view of Main CPU Board.

Figure 6. Series 5000 Test Routine.

TABLE II

Lamp driving components on Main CPU Board

Light	Transistor	IC No. (74LS138)	Pin No.	IC NO. (8243)	Pin No.	Notes
GAME 1	Q34	U4	15	U5	—	
GAME 2	Q36	U4	13	U5	—	
GAME 3	Q38	U4	11	U5	—	
GAME 4	Q40	U4	9	U5	—	
GAME 5	Q35	U4	14	U5	—	
GAME 6	Q37	U4	12	U5	—	
GAME 7	Q39	U4	10	U5	—	
GAME 8	Q41	U4	7	U5	—	
SELECT GAME	Q42	—	—	U5	21,22	a. (1 of 2)
SELECT GAME REMOVE	Q43	—	—	U5	23	b. (2 of 2)
DARTS GAME	Q44	U6	15	U5	—	
OVER PLAYER	Q45	U6	14	U5	—	
CHANGE	Q46	U6	13	U5	—	
BUST	Q47	U6	12	U5	—	
THROW DARTS	Q48	U6	11	U5	—	
ROUND	Q49	—	—	U5	17	
DARTS	Q50	—	—	U5	17	
PLAY'R 1	Q2	—	—	U11	2	
PLAY'R 2	Q4	—	—	U11	4	
PLAY'R 3	Q6	—	—	U11	1	
PLAY'R 4	Q8	—	—	U11	22	
1 WIN	Q3	—	—	U11	3	
2 WIN	Q5	—	—	U11	5	
3 WIN	Q7	—	—	U11	23	
4 WIN	Q9	—	—	U11	21	

Other components include eight MPSU51 transistors in a line above seven segment displays.

The lamps on the mother board are driven by 2N4400 transistors. Table II lists the transistor and corresponding IC numbers to check for each lamp.

All driver transistors are next to the lamps they drive. The TEMPORARY SCORE lamps have no driver.

4.2.1 Seven Segment Displays

Located above the displays are eight MPSU51 transistors. These provide the main power to the displays in the following sequence:

MPSU No.	Number from left to right	Display No.
1	1 & 2	
2	3 & 4	
3	5 & 6	
4	7 & 8	
5	9 & 10	
6	11 & 12	
7	13 & 14	
8	15 & 16	

The ROUND counter is counted as number 1.

The segments in each display are driven by 2N4400 transistors in sequence with two 74LS244 buffers and an 8243 I/O expander. The I/O expander receives a signal from the 8049 microprocessor and outputs it to the 74LS224N buffers, which in turn, deliver the signal to the transistors driving the segments. The drive control sequence is shown in Table III.

TABLE III

Drive control sequence of Segment Displays

8243 (IC 13) Out Pin No.	74LS244 In Pin No.	74LS244 Out Pin No.	Transistor	Display	Segment	74LS244 IC No.
2	2	18	Q18	ODD	A	14
3	17	3	Q19	ODD	B	14
4	4	16	Q20	ODD	C	14
5	15	5	Q21	ODD	D	14
1	6	14	Q22	ODD	E	14
23	13	7	Q23	ODD	F	14
22	8	12	Q24	ODD	G	14
21	11	9	Q25	ODD	D.P	14
20	2	18	Q26	EVEN	A	15
19	17	3	Q27	EVEN	B	15
18	4	16	Q28	EVEN	C	15
17	15	5	Q29	EVEN	D	15
13	6	14	Q30	EVEN	E	15
14	13	7	Q31	EVEN	F	15
15	8	12	Q32	EVEN	G	15
16	11	9	Q33	EVEN	D.P	15

4.2.2 Player Change

The player change switch grounds pin 38 of U16 through a 560 ohm resistor.

4.2.3 Sound Circuitry

The sound section of the mother board revolves around three components: a LM7815CT 15V DC voltage regulator, a LM358 low power dual operational amplifier, and a LM383T 8-watt audio power amplifier. Also included are three 10K ohm potentiometers (volume controls) located in the upper right corner of the mother board: Pot 1 is a signal control; Pot 2 is an optional speech control; and Pot 3 is the master volume. Pots 1 and 2 are preset at 50% value.

4.3 Target Interface Board

This board interfaces the target to the Main CPU Board. It carries the scoring signals from the dart board to the main board. It also drives the number lamps located around the dart board and the machine's top light assembly.

There are three main types of components on the Target Interface Board (figure 10) as shown in Table IV.

There are 20 transistors on the target interface board. These control the number lamps around the dart board in the sequence shown in Table V, column 2.

Starting with Q1, transistors are numbered right to left and top to bottom (see figure 10). These transistors are controlled by four ICs (Type 74LS04) on the target interface board and two

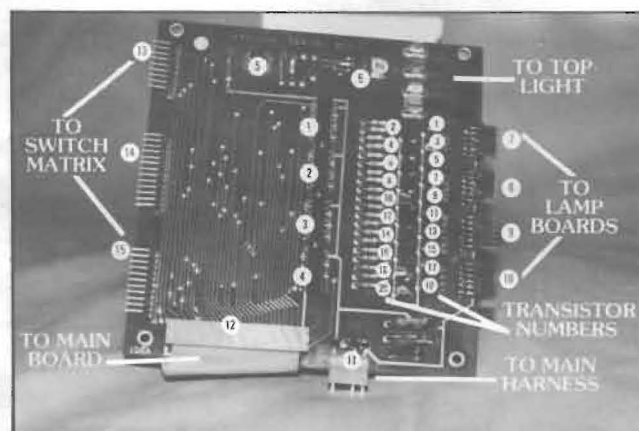


Figure 10. Target Interface Board.

TABLE IV

Description of components on Target Interface Board

Fig. 10 Ref. No.	Description
1-4	74LS04 IC Hex Inverter
5	MOC3030 Triac Driver
6	SC146D Triac
7-10	Lamp Board Connectors
11	Main Harness Power Connector
12	40-Pin Ribbon Cable Connector
13	Connectors to Switch Matrix

I/O expanders (Type 8243) on the mother board. The pins interconnecting these and the line number in the ribbon cable are shown in Table V, columns 3-8.

The ribbon cable numbers start from the colored edge. On the 74LS04 ICs, Pin 7 is ground; Pin 14 Vcc.

4.3.1 Top Light

The top light consists of two sources. The two lamps behind the English Mark Darts® display panel are tied directly into the line through a 3/4 amp fuse on the power chassis. These lamps are lit whenever the machine is plugged in. The light that illuminates the dart board is driven by IC MOC3030 and a SC146D triac on the target interface board. This light is lit only during the actual playing of a game. When the game ends, the light will flash and then go out.

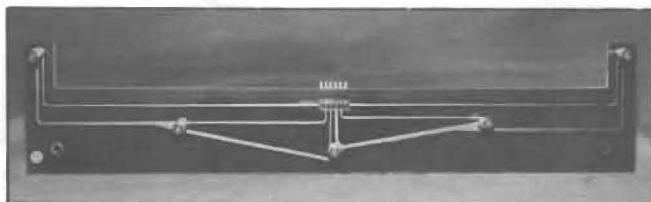


Figure 11. Lamp Board contains a six-pin connector and five lamps.

TABLE V

Target Interface transistors with corresponding lamp (score) numbers and interconnecting pin numbers

1	2	3	4	5	6	7	8
Transistor No.	Lamp No. (Score)	IC No. (7404)	Pin Out	Pin In	Ribbon Cable Pin No. (8243)	IC No.* (8243)	Pin Out
Q1	12	1	2	1	18	12	21
Q2	5	1	13	12	5	12	2
Q3	20	1	4	3	12	12	16
Q4	1	1	10	11	21	5	13
Q5	18	1	6	5	10	12	14
Q6	16	1	8	9	11	12	17
Q7	8	2	2	1	4	12	5
Q8	11	2	13	12	15	12	22
Q9	14	2	4	3	13	12	19
Q10	9	2	10	11	8	12	1
Q11	2	2	6	5	22	5	14
Q12	17	2	8	9	7	12	13
Q13	3	3	2	1	19	5	15
Q14	19	3	13	12	9	12	15
Q15	7	3	4	3	3	12	4
Q16	4	3	10	11	20	5	16
Q17	13	3	6	5	17	12	20
Q18	6	3	8	9	6	12	3
Q19	10	4	2	1	16	12	23
Q20	15	4	13	12	14	12	18

*Located on Main CPU Board.

4.4 Lamp Boards

The lampboards contain one six-pin connector, five 4999-004 lamp sockets, and five CM7373 type incandescent bulbs (see figure 11).

4.5 Power Supply

The 5000 Series Power Supply (figure 12) consists of the components described in Table VI. It uses two transformers. One is specially designed for Arachnid (the smaller of the two). The larger transformer is a standard 12-volt, 8-amp power transformer. Both transformers have a 120V AC primary. A 5V DC regulator (LM323, or equivalent) supplies the voltage to all integrated circuits in the game. The regulator receives its voltage from the standard transformer through an MT980-2 bridge rectifier, 1.5-ohm, 10-watt resistor; and a 7.5-amp fuse.

The audio supply comes from a special transformer through four MR501 diodes in a rectifier alignment and a 3/4-amp fuse. The output is on Pin 2 of the connector.

The main line voltage is on a 3-amp circuit breaker mounted on the front of the supply.

4.6 Dart Head (Scoring)

The dart head is set to exact specifications at the factory. The bolts that hold the board together are tightened to finger tight only. Do not tighten any further or this will crush the switch matrix and cause inaccurate scoring.

If the machine does begin to miss-score, reference the troubleshooting chart. The scoring lines on the target interface board are direct connections through the ribbon cable to the 8049 microprocessor on the mother board.

TABLE VI

Description of Power Supply Components

Fig. 12 Ref. No.	Description
1	12.6V 8-Amp Power Transformer
2	16V 2-amp Audio Transformer
3	18,000µfd Capacitor
4 & 5	4700µfd Capacitors
6	Motorola MD980-2 Bridge Rectifier
7	7.5-Amp Fuse
8	3/4-Amp Fuse
9	(4) MR501 Diodes
10	1.5-Ohm 10-Watt Resistor
11	3/4 Amp Fuse
12	Heatsink Mounted LM323 5V Regulator
13	Main Power Cord (under chassis)
14	V150 LA20A GE Varistor (under chassis)
15	3-Amp Circuit Breaker (under chassis)

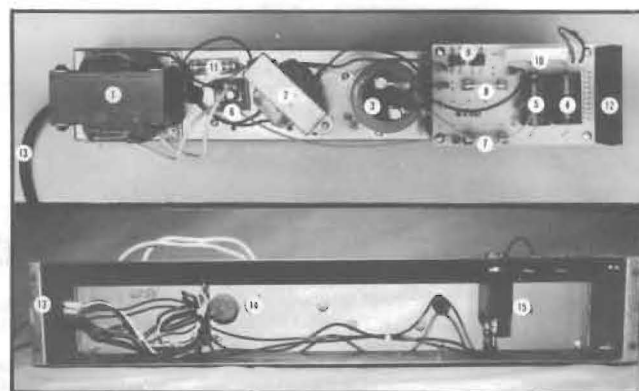


Figure 12. Top and bottom view of 5000 Series Power Supply.

— WARNING — Unplug power to game before working on machine.

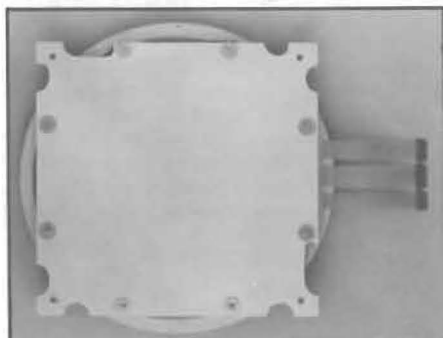
4.7 Dart Head Dissassembly/Reassembly

To replace the switch matrix in the dart head it is necessary to disassemble and reassemble as follows:

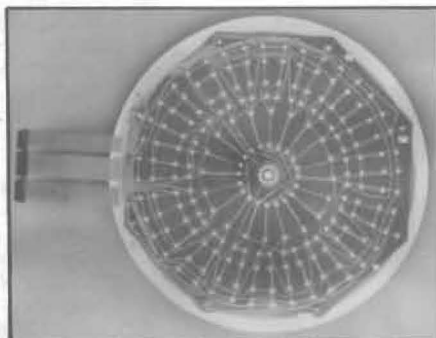
- Remove the bolts holding the particle board to the back of matrix.
- Remove switch matrix.

- Remove .020 gasket.
- Remove rubber damper
- Clean and replace rubber damper and gasket.
- Place new switch matrix on back of the gasket (figure 13A).
- Replace targetback and bolt, using fingers for tightening (figure 13C).

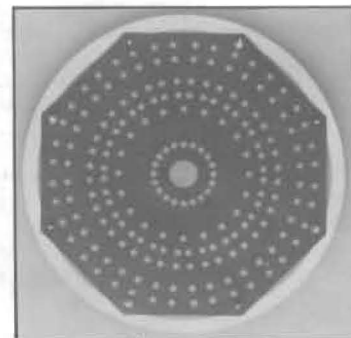
— CAUTION — Bolts must be finger tight only. Any tighter will crush contacts in the matrix and cause inaccurate scoring.



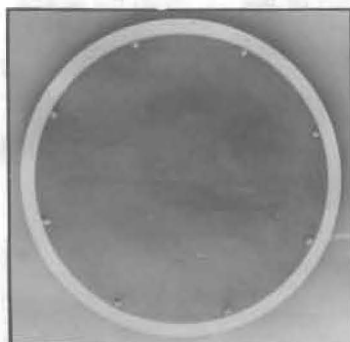
A. Complete assembly from back.



B. Matrix, on top of dart head assembly



C. .020 gasket



D. Silicone Rubber Damper



E. Spider Assembly

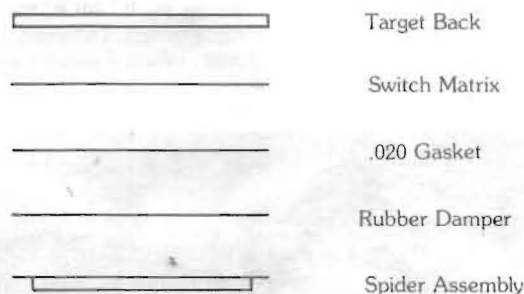


Figure 13.

SECTION V—TROUBLESHOOTING

— WARNING — Unplug power to game before working on machine.

5.1 Troubleshooting

NOTE: Before troubleshooting ascertain that the machine is properly grounded.

Problem	Probable Cause	Procedure	References
Segment display failure	(a) 39Ω resistor between grd. and drive resistor is faulty. (b) Single display (c) All displays - odds or evens	(a) Check resistor on applicable transistor. If bad, replace. (b) Change LED display (c) Transistors (2N4400) (Q18-Q33) 74LS244 (IC14 Odds) (IC15 Evens) 8243 (IC13)	Table III Para. 4.2.1 Sec. IV
Player change not working	Switch	Replace switch, and/or 560 ohm resistor, and/or micro (U16)	Sec. IV Para. 4.2.2
Sound problems	(a) Volume Control (3 pots) (b) Faulty 15V regulator (ML7815)	(a) The 2 pots next to the 10-pin connector are: 1st pot, a signal control factory-set at half value (may be adjusted for more volume); 2nd pot, for the optional voice circuitry, set at half value; and the 3rd pot, the master, which can be adjusted as required. (b) Using Pin 2 as ground, check for +24V DC on Pin 1 and +15V DC on Pin 3. If incorrect, replace regulator.	Para. 4.2.3 Sec. IV Table I

Problem	Probable Cause	Procedure	References
Sound problems (continued)		<p>—NOTE— If just the input is incorrect, check the power supply output voltage on Pin 2 or the P.S. connector.</p> <p>(c) Faulty IC (LM 358)</p> <p>(d) LM 383T (5-pin package next to regulator)</p> <p>(e) 8243 I/O expander</p>	
Ripple in audio output.	Faulty filter capacitor C1.	Replace C1, a 4700 ufd capacitor, on power supply.	Para. 4.2.3 Para. 4.5 Table VI Sec. IV
Dart Board illumination light does not lite.	<p>(a) Faulty bulb.</p> <p>(b) Faulty Triac (SC146D) or Driver MOC3030.</p>	<p>(a) Check bulb. Replace, if required.</p> <p>(b) Check Triac. If faulty, replace. If correct, check resistors and input to MOC3030 Triac.</p>	Para. 4.3 Fig. 10 Table IV
Machine is operational, but some lampboard lights do not lite.	If all components are good, see Table V for inter-connections.	Check solder connections for cold junctions, and run continuity check on wiring harness.	Fig. 11 Sec. IV Table V
Power-Up Sequence is incorrect and doesn't correct itself after hitting reset. (Should be hit more than once.)	LM 323 5V regulator (mtd. on P.S. heat sink.)	<p>Check regulator. If faulty, replace.</p> <p>Check soldered points to PC board on P.S.</p> <p>Check reset switch. If faulty, see below.</p> <p>If, in addition, no lights on except temporary score 5volt supply is faulty. Change LM 323.</p> <p>Replace Micro (U16)</p> <p>Replace 74LS138 (U17)</p> <p>Replace 8243 (U5, U11-13)</p>	Para. 3.1 Fig. 7 Fig. 12 Sec. IV Sec. III Para. 4.2 Table I
Reset switch does not work.	<p>(a) Open in wiring between coin door and mother board.</p> <p>(b) If (a) is correct, the switch is faulty.</p> <p>(c) Microprocessor</p>	<p>(a) Run continuity check and inspect plugs for poor connections.</p> <p>(b) Replace switch.</p> <p>(c) If reset still does not work, after checking plugs and replacing switch, contact factory for details.</p>	Para. 3.1 Fig. 7 Fig. 12 Sec. IV Sec. III Para. 4.2 Table I
Top display light does not lite.	<p>(a) Faulty bulb.</p> <p>(b) 120V AC source</p> <p>(c) Common to target interface</p>	<p>(a) Check bulb, replace if required.</p> <p>(b) Check 3/4-amp fuse (located on chassis next to transformer). If blown, replace.</p> <p>(c) Check connections: black and white wires to target interface.</p>	Para. 4.3.1 Fig. 12 Sec. IV

Problem	Probable Cause	Procedure	References
Game selects not operating correctly.	(a) Switches and/or wiring harness. (b) If (a) is correct, 8243 output expander may be faulty. (c) Coin switch jammed. (d) Selects game only once.	(a) Check switches and run continuity test on harness. (b) Check 8243 (U11) Pins 13-20. (c) Check to see if wire has returned to original position. (d) Check Player Change switch for short or 560 ohm series resistor. Also R96 and .1 ufd capacitor on Pin 38 of U16.	
No score.	Dart tip stuck in cup. Main Board	Remove broken tip. (To check electronics, disconnect three leads to matrix. Short any pin from middle conn. (J6) to any pin from top conn. (J4) on target interface to score.) Change 74LS273 (U25). Change Micro (U16)	Sec. IV Para. 4.6 Fig. 13
"Remove" and "Throw Darts" lights are on at the same time.	40-pin ribbon cable connector backwards.		
Game stays on "Remove Darts"	Change 74LS138 (U17) on Main CPU Board		

Warning: This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instructions 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 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 is likely to cause interference in which case the user at his own expense will be required to take whatever measure may be required to correct the interference. Note: Proper grounding through power cord is necessary for compliance.

**ENGLISH
MARK DARTS™**

by **Arachnid**™

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