

# SERVICE TIPS

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TELEX: 253290



- MANDATORY
- ON FAILURE ONLY
- FOR YOUR INFORMATION

82-14

ATTN: SERVICE MANAGERS

GAME: WILD WESTERN

SUBJECT: MISPRINT IN OPERATOR'S MANUAL ON PAGES 7 (CONTROL PANEL)  
AND PAGE 8 (DOOR ASSEMBLY).

SOLUTION: CONTROL PANEL PICTURE ON PAGE 7 IS PRINTED BACKWARD IN  
A MIRROR IMAGE. SEE PAGE 2 OF THIS SERVICE TIP FOR THE  
CORRECT VIEW.

DOOR ASSEMBLY PARTS LIST (FIGURE 10, PAGE 8) HAS THE  
FOLLOWING PARTS NUMBERS INCORRECT. THE CORRECT NUMBERS  
ARE AS FOLLOWS:

ITEM	WRONG NUMBERS	CORRECT NUMBERS
2	08-00028-002	08-00036-002
3	08-00028-003	08-00036-003
4	08-00028-004	08-00036-004
5	08-00028-005	08-00036-005

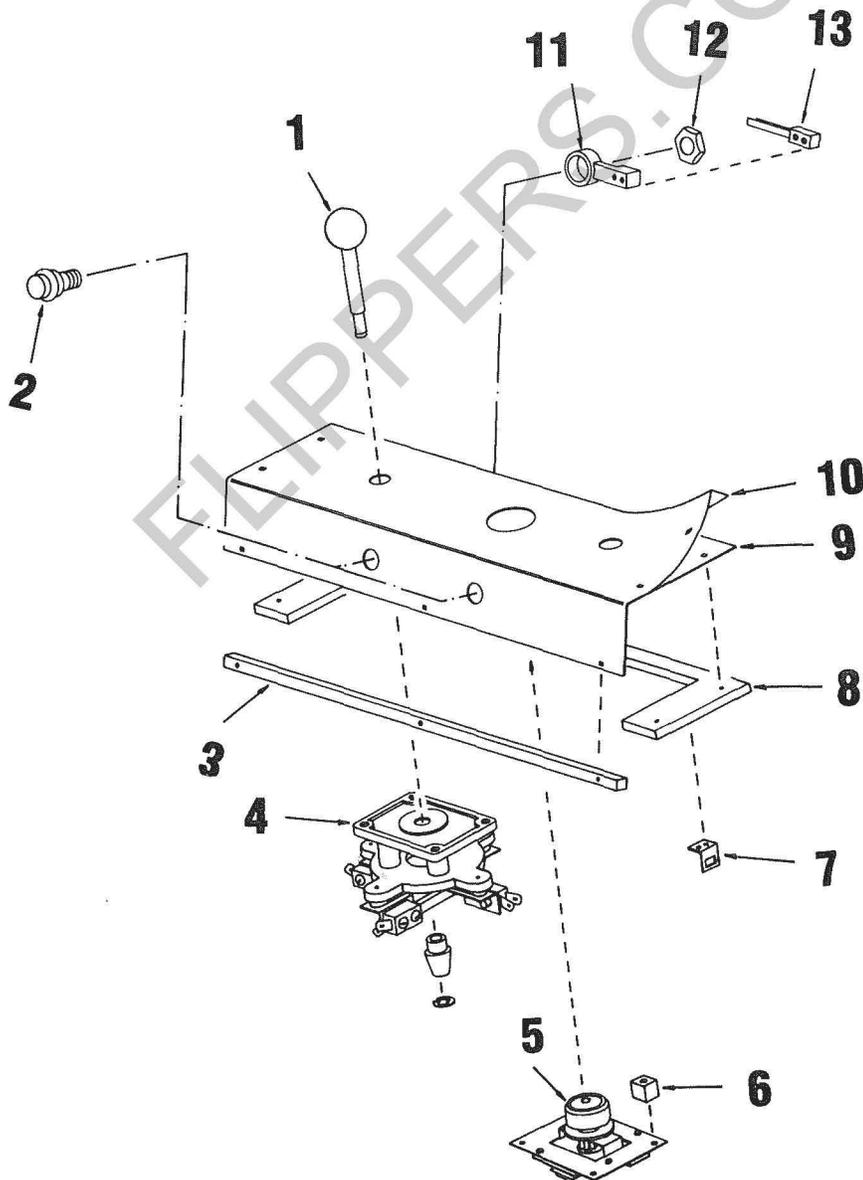
PARTS NEEDED: NONE

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# CONTROL PANEL

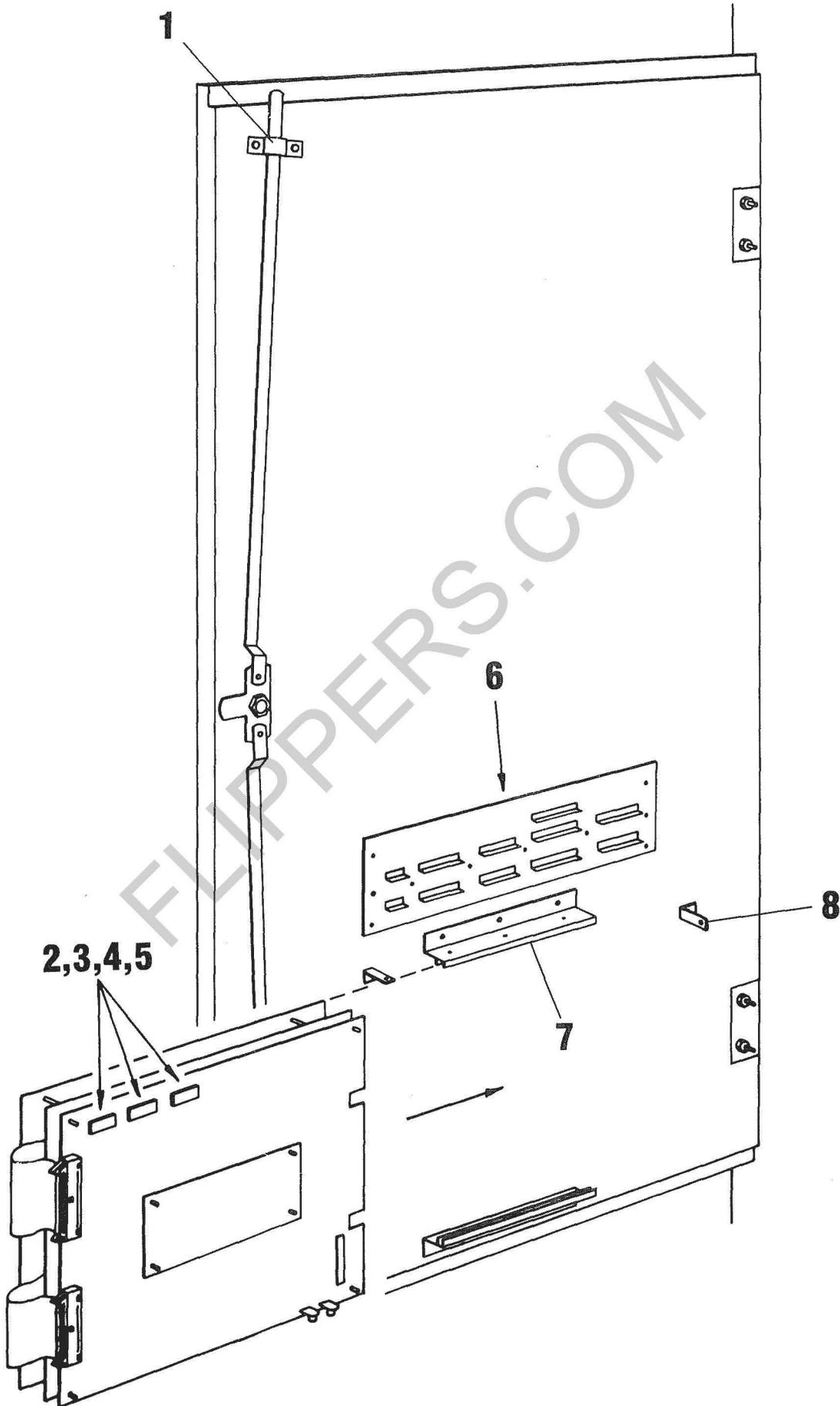
FIGURE 9

ITEM	TAITO PART NO.	DESCRIPTION
1	63B00031-001	Ball & Shaft
2	63B00024-001	Push Button White
3	42B00108-001	Cleat Wood
4	63D00032-006	8-Way Control
5	07-00136-001	Control Assy., Revolving
6	42B00132-001	Standoff Control Assembly
7	61A00015-001	Strike Hook
8	42D00017-001	Control Panel Wood
9	07M00135-001	Control Panel, Metal
10	63D00086-001	Lexan Decal
11	63-00025-001	Switch Support
12	54A07001-008	Nut, Stamped 5/8-11
13	29B00020-001	Switch, Push Button



# DOOR ASSEMBLY

FIGURE 10



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ATTN: SERVICE MANAGERS

GAME: WILD WESTERN

SUBJECT: SWITCH SETTINGS FOR COINAGE

SOLUTION: THE FOLLOWING TABLE IS THE CORRECTED TABLE FOR THE COIN SLOT PROGRAMING ON DIP SWITCH B. THIS REPLACES THE TABLE IN THE WILD WESTERN MANUAL ON PAGE 2.

	ONE WAY				TWO WAY			
	1	2	3	4	5	6	7	8
1 COIN - 1 PLAY	ON	ON	ON	ON	ON	ON	ON	ON
1 COIN - 2 PLAYS	OFF	ON	ON	ON	OFF	ON	ON	ON
1 COIN - 3 PLAYS	ON	OFF	ON	ON	ON	OFF	ON	ON
2 COINS - 1 PLAY	ON	ON	ON	OFF	ON	ON	ON	OFF
3 COINS - 1 PLAY	OFF	ON	ON	OFF	OFF	ON	ON	OFF

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ATTN: SERVICE MANAGERS:

GAME: POWER SUPPLY #08-00007-001 USED ON "QIX", ALPINE SKI, WILD WESTERN,  
KRAM, ELECTRIC YO YO.

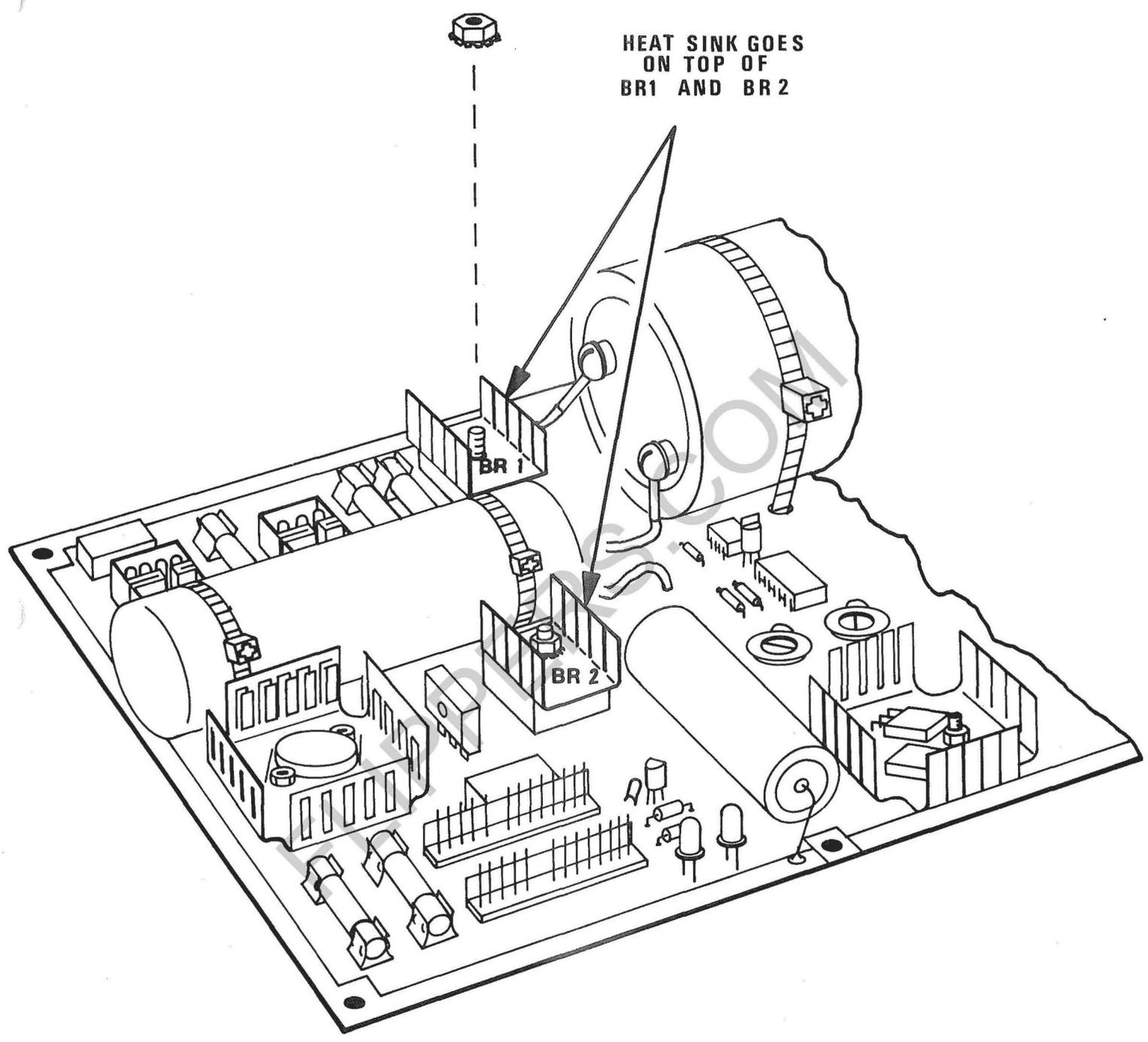
SUBJECT: BR1 AND BR2 HEATING UP TO THE EXTENT OF BREAKING DOWN INTERNALLY.

SOLUTION: ADDING HEAT SINKS ONTO BR1 AND BR2.

PARTS:	TWO	HEAT SINKS	30-00001-001
	TWO	SCREWS 6-32X1	51-02002-001
	TWO	KEPS NUTS 6-32	54-02002-001
		HEAT SINK COMPOUND	

PROCEDURE: POWER DOWN GAME, REMOVE POWER SUPPLY P.C.B. 08-00007-001  
APPLY HEAT SINK COMPOUND TO THE TOP OF BR1 AND BR2 (REFER  
TO FIGURE 1). PLACE A HEAT SINK ON TOP OF BR1 ALIGNING HOLES  
AND MAKING SURE THAT HEAT SINK DOESN'T TOUCH ANY OTHER  
COMPONENTS. FEED THE SCREW THROUGH THE ETCH SIDE OF THE  
POWER SUPPLY. TIGHTEN THE NUT SNUGGLY. REPEAT PROCEDURE  
FOR BR2.

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HEAT SINK GOES  
ON TOP OF  
BR1 AND BR 2

FIGURE 1

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82-23

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ATTN: SERVICE MANAGERS:

GAME: POWER SUPPLY #08-00007-001 USED ON ALPINE SKI, WILD WESTERN AND JUNGLE HUNT.

SUBJECT: BR1 AND BR2 HEATING UP TO THE EXTENT OF BREAKING DOWN INTERNALLY.

SOLUTION: ADDING HEAT SINKS ONTO BR1 AND BR2.

PARTS:	TWO	HEAT SINKS	30-00005-001
	TWO	SCREWS 6-32X1	51-02002-001
	TWO	KEPS NUTS 6-32	54-02002-001
		HEAT SINK COMPOUND	

PROCEDURE: POWER DOWN GAME, REMOVE POWER SUPPLY P.C.B.  
08-00007-001 APPLY HEAT SINK COMPOUND TO THE TOP OF BR1 and BR2 (REFER TO FIGURE 1). PLACE A HEAT SINK ON TOP OF BR1 ALIGNING HOLES AND MAKING SURE THAT HEAT SINK DOESN'T TOUCH ANY OTHER COMPONENTS. FEED THE SCREW THROUGH THE ETCH SIDE OF THE POWER SUPPLY. TIGHTEN THE NUT SNUGGLY. REPEAT PROCEDURE FOR BR2.

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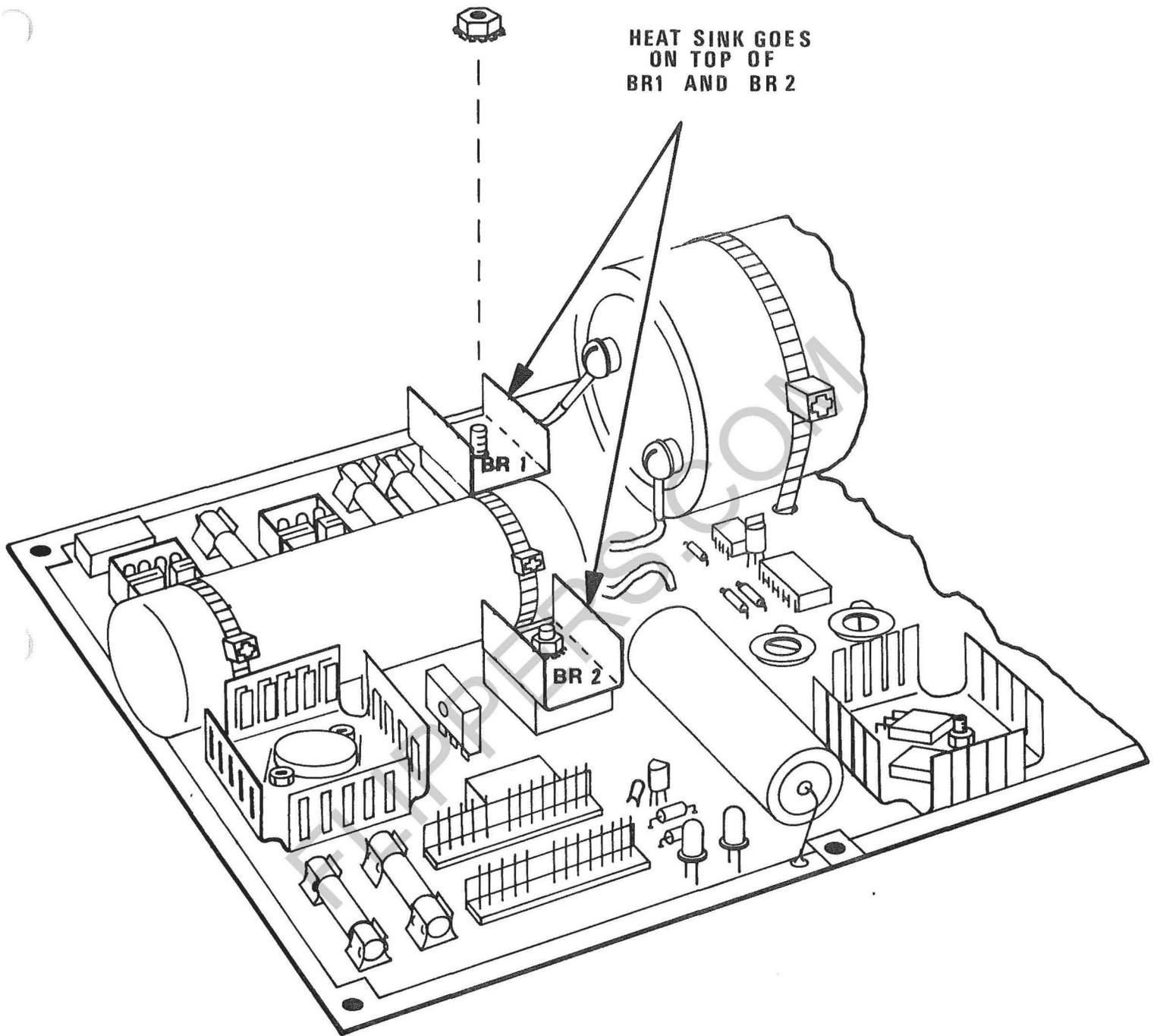


FIGURE 1

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83-2

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ATTN: SERVICE MANAGERS

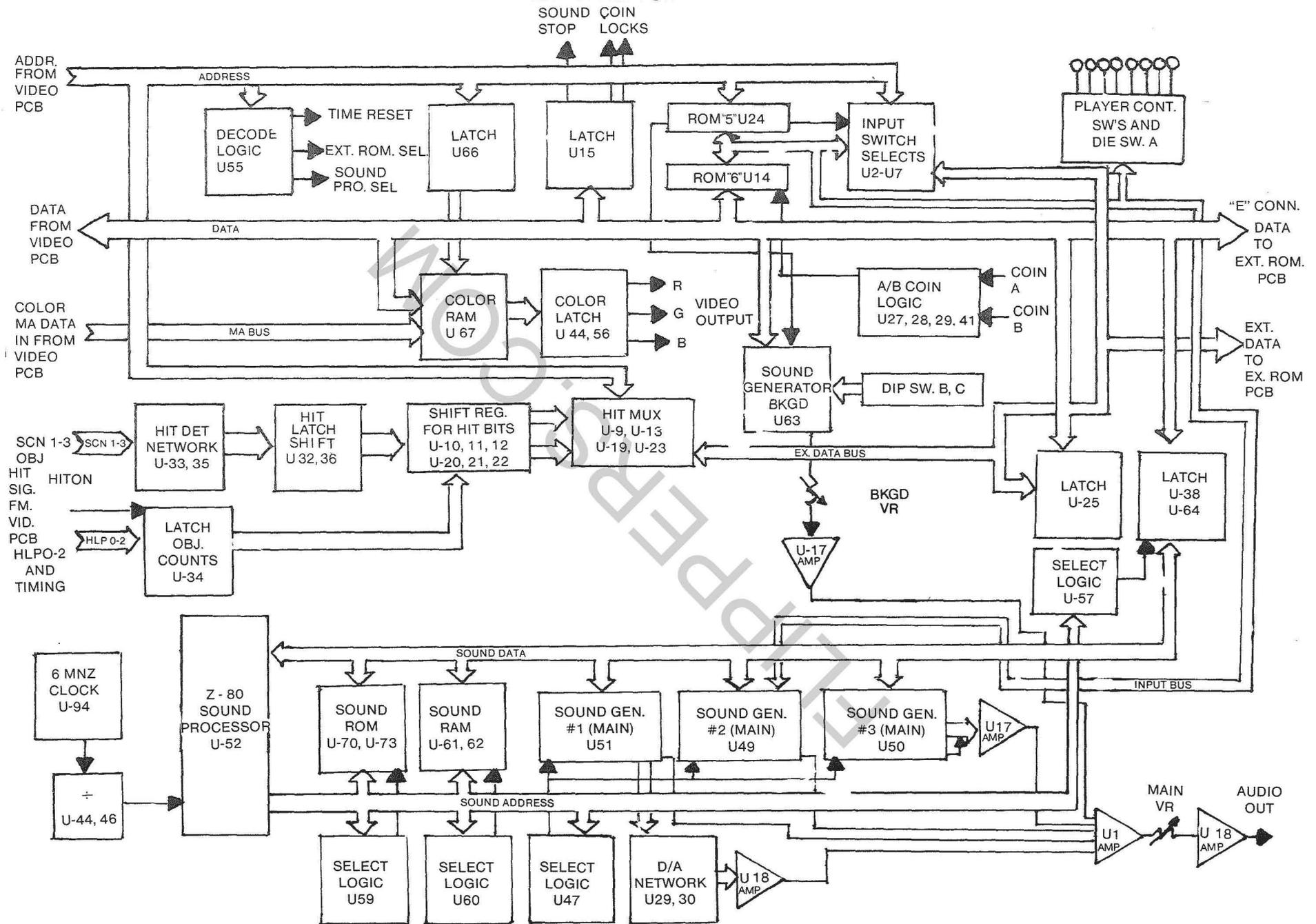
GAMES: ALPINE SKI, WILD WESTERN, JUNGLE HUNT

SUBJECT: TROUBLESHOOTING "S.J." SYSTEMS.

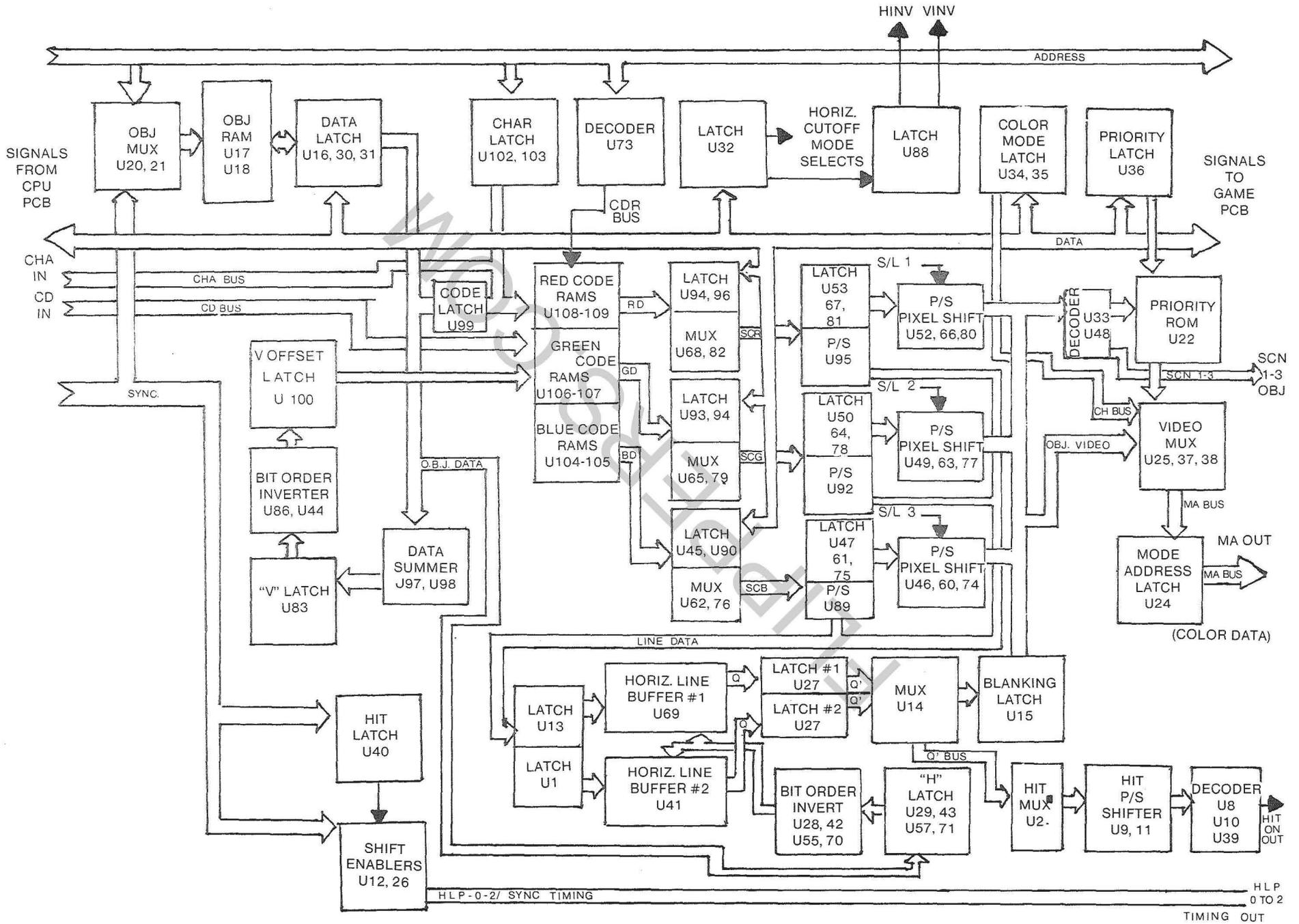
SOLUTION: PLEASE FIND ATTACHED "S.J." SYSTEM BLOCK DIAGRAM.  
WE HOPE THIS WILL BE USEFUL IN DIAGNOSIS AND  
TRACING FAILURES WITH THE LOGIC OF ALPINE SKI,  
WILD WESTERN, AND JUNGLE HUNT.

PARTS NEEDED: NONE

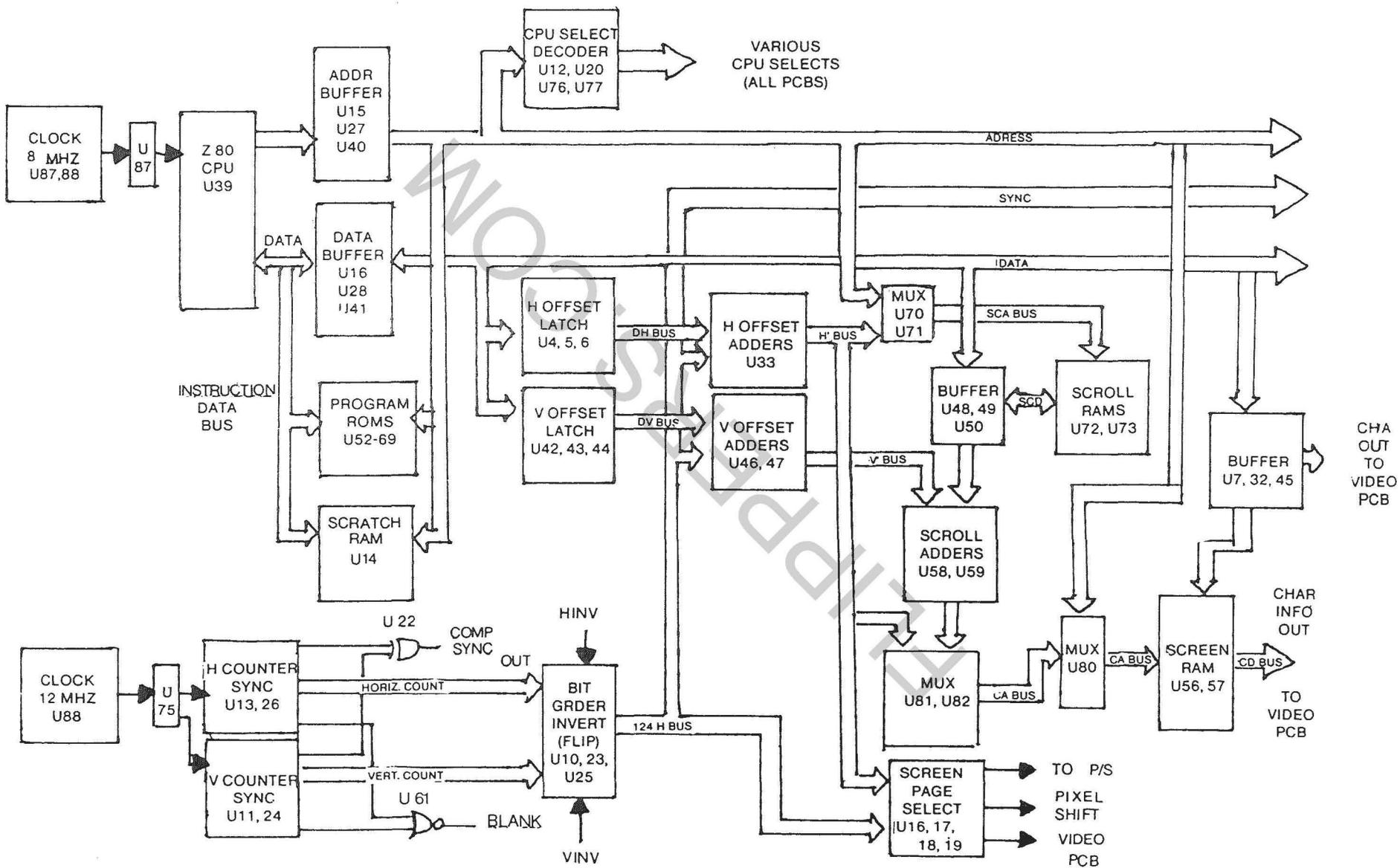
# S J SYSTEM GAME PCB



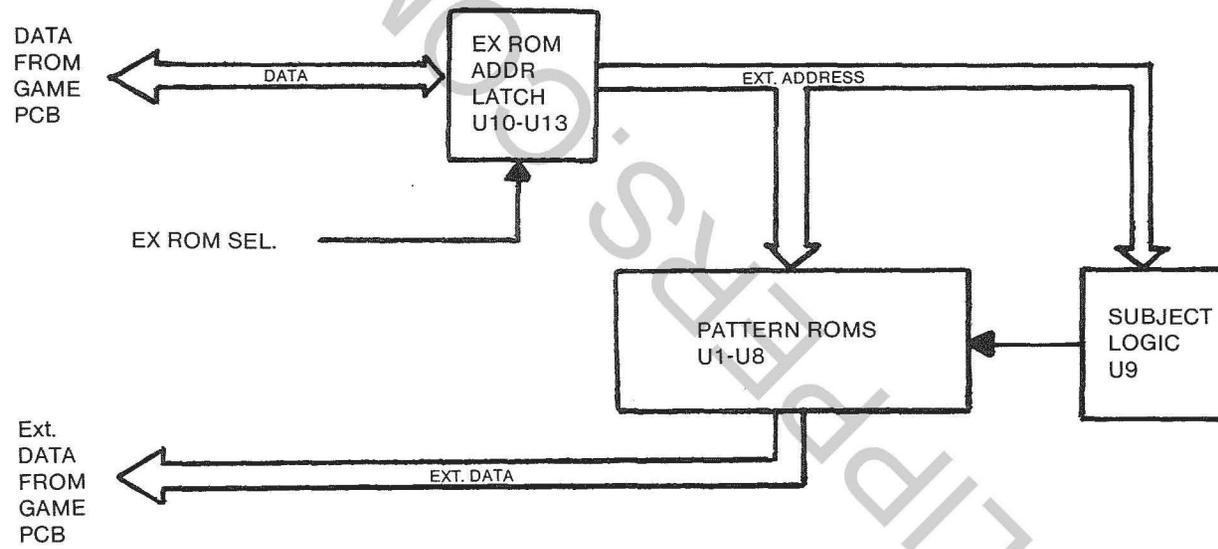
# SJ SYSTEM VIDEO PCB



SJ SYSTEM CPU PCB



S J SYSTEM EXTERNAL ROM PCB



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83-4

ATTN: SERVICE MANAGERS

GAME: ALPINE SKI, WILD WESTERN, JUNGLE HUNT, FRONT LINE.

SUBJECT: CONVERTING GAME FROM TWO COIN METERS TO ONE COIN METER.

SOLUTION: BY FOLLOWING THIS PROCEDURE, BOTH COIN SWITCHES  
WILL RECORD ON ONE COIN COUNTER.

PARTS NEEDED: NONE

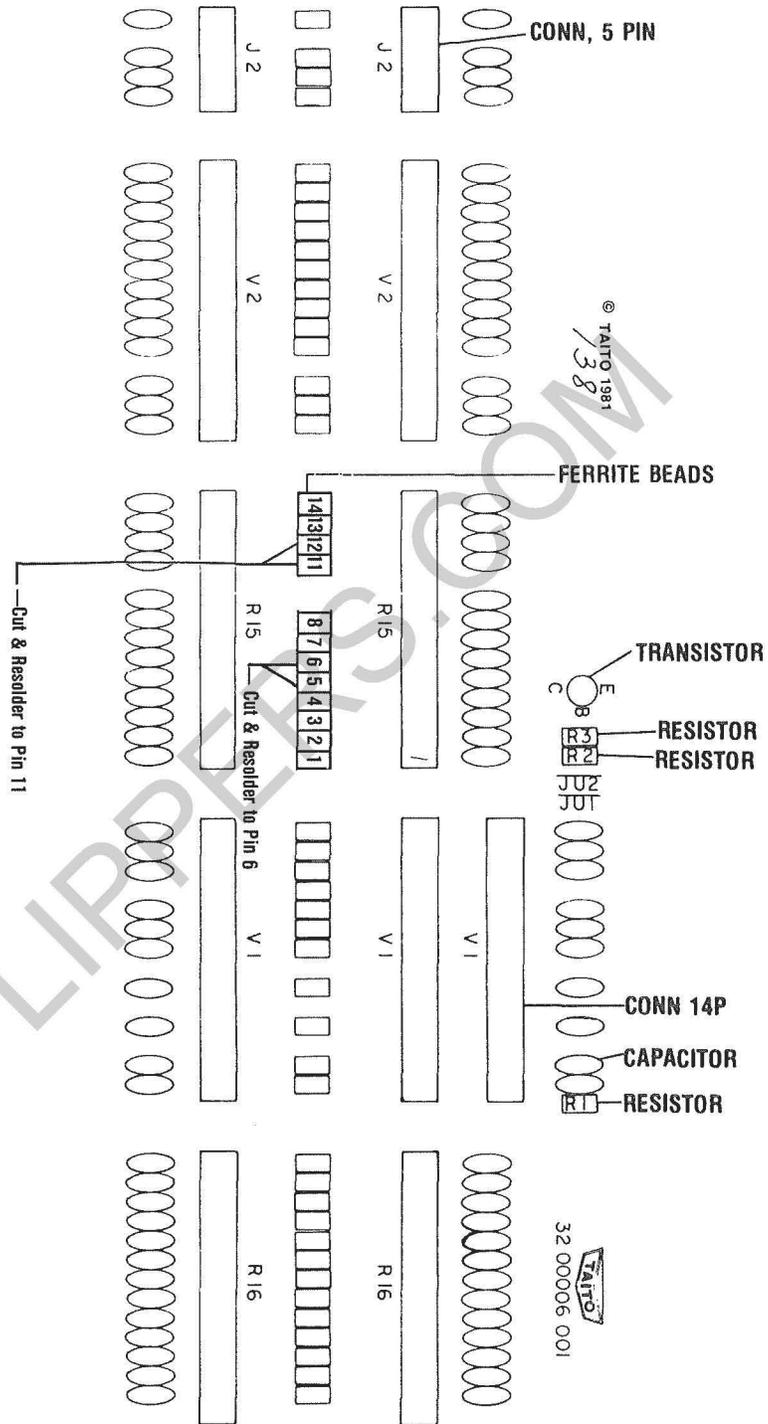
LOCATE R15 CONNECTOR ON THE FILTER BOARD. YOU WILL NOTICE THAT THERE ARE FERRITE BEADS BETWEEN THE TWO R15 JACKS ON THE BOARD. THERE IS A FERRITE BEAD (OR PLACE FOR A FERRITE BEAD) FOR EACH PIN ON THE CONNECTOR. (REFER TO FIGURE 1) PIN 1 IS ON THE RIGHT SIDE OF THE CONNECTOR.

UNSOLDER THE BOTTOM LEAD OF THE FERRITE BEAD ASSY TO PIN 5 AND THE BOTTOM LEAD OF THE FERRITE BEAD ASSY TO PIN 12 (AS SHOWN IN FIGURE 1). SOLDER THE LEAD YOU JUST UNSOLDERED ON PIN 5 TO THE BOTTOM LEAD ON THE FERRITE BEAD PIN 6. SOLDER THE LEAD FROM THE FERRITE BEAD FOR PIN 12 TO THE BOTTOM OF THE FERRITE BEAD PIN 11.

TURN DIP SWITCH C, SWITCH #8 ON.

# FILTER BOARD

FIGURE 1



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ATTN: SERVICE MANAGERS

GAMES: ALPINE SKI, WILD WESTERN, JUNGLE HUNT, FRONTLINE, QIX, KRAM,  
SPACE DOUNGEON, ELECTRIC YO-YO (GAMES WITH AMERICAN POWER  
SUPPLY)

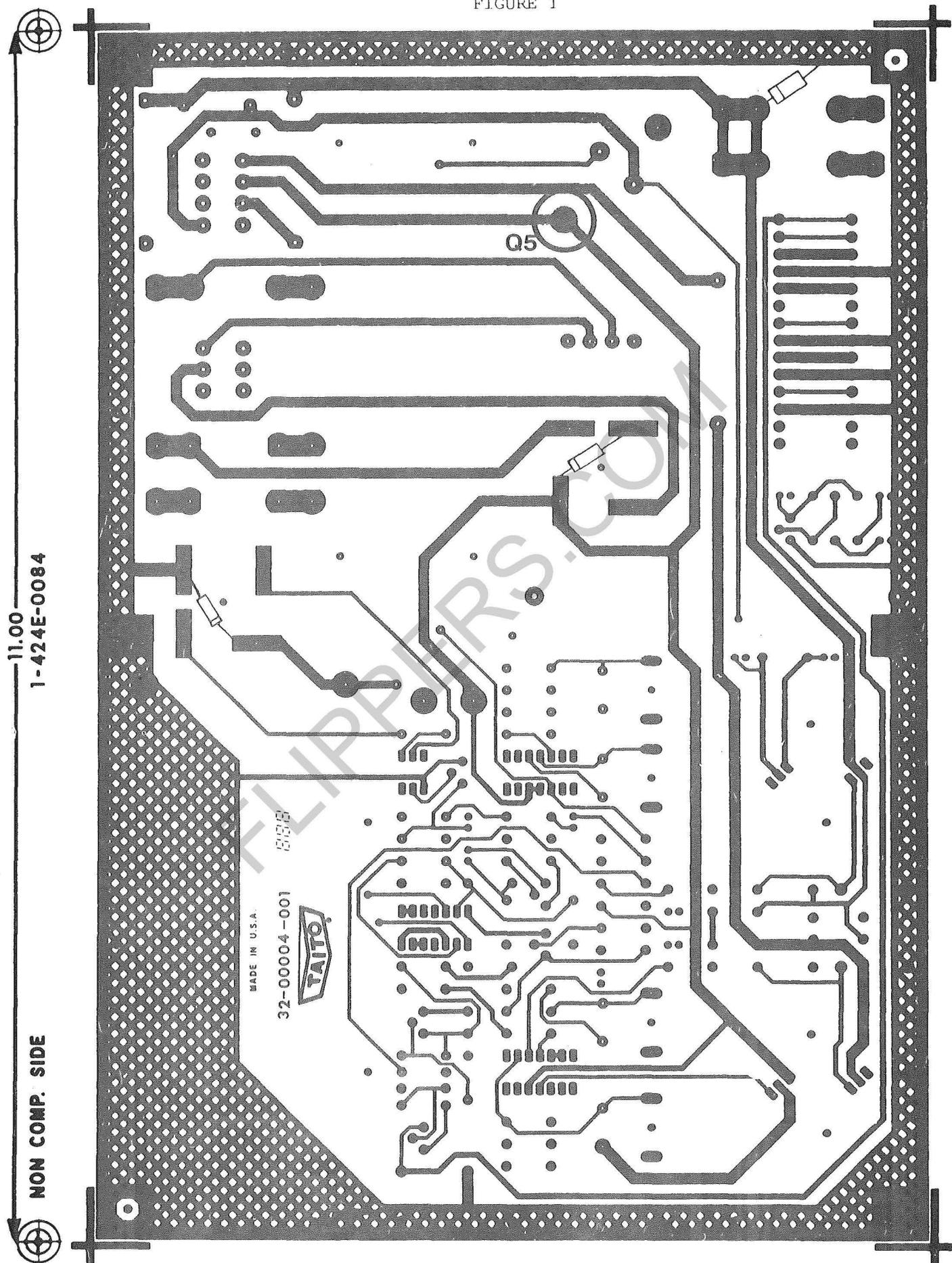
SUBJECT: POWER SUPPLY +5 VOLT PROBLEMS

SOLUTION: IMPROVE Q5'S CONNECTION ON POWER SUPPLY

PARTS NEEDED: NONE

PROCEDURE: REMOVE THE TWO NUTS AND BOLTS HOLDING DOWN Q5. ON THE ETCH  
SIDE OF THE BOARD (REFER TO FIGURE 1), SCRAPE THE GREEN SOLDER  
RESIST OVER THE FOIL AROUND THE SCREW PAD FOR Q5. WET THE  
PAD WITH SOLDER TO MAKE SURE THAT ALL SOLDER RESIST MATERIAL  
IS REMOVED. REPLACE NUTS AND BOLTS FOR Q5.

FIGURE 1



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83-6

ATTN: SERVICE MANAGERS

GAMES: ALPINE SKI, WILD WESTERN, JUNGLE HUNT, FRONTLINE, QIX, KRAM,  
SPACE DUNGEON, AND THE ELECTRIC YO-YO

SUBJECT: COIN DOOR CABLE CAN GET PINCHED IN COIN DOOR FRAME.

SOLUTION: RE-ROUTING OF COIN DOOR CABLING AND ITS HARNESS AS FOLLOWS:

PARTS NEEDED: 1. PLASTIC CABLE CLAMP, TAITO PART # 59-00004-004  
2. PLASTIC CABLE TIE, TAITO PART # 59-00003-001

DISPOSITION OF OLD PARTS: SCRAP

PROCEDURE: 1. RE-ROUTE COIN DOOR HARNESS AS FOLLOWS:

- A. UNLOCK AND OPEN COIN DOOR.
- B. UNLATCH AND REMOVE GAME CONTROL PANEL.
- C. REMOVE SECOND CABLE CLAMP ON THE LEFT OF THE HARNESS THAT RUNS ABOVE THE COIN DOOR.
- D. IF THERE ARE ANY EXTRA LOOSE WIRES ON THE HARNESS NOW FREE, USE 4" TIE-WRAP (59-00003-001) TO BIND THEM TO THE HARNESS.
- E. UNPLUG MOLDED CONNECTOR TO COIN DOOR.
- F. REMOVE CABLE CLAMP HOLDING POWER INTERLOCK WIRING, AND REINSTALL AROUND THE HARNESS THAT IS NOW FREE.

2. RE-ROUTE CABLE ON COIN DOOR AS FOLLOWS: (SEE FIG. 1 )

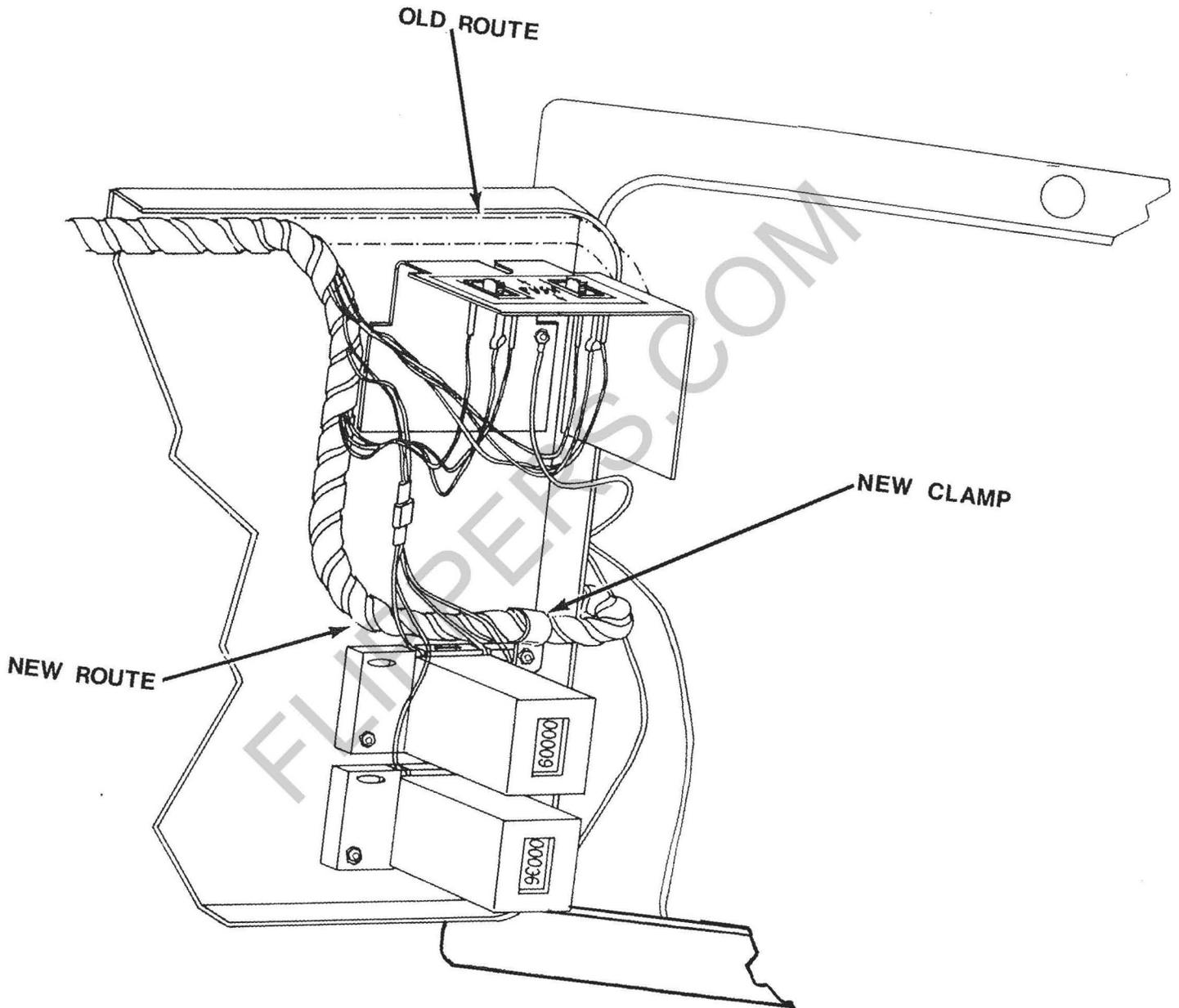
- A. SNIP WIRE TIE THAT HOLDS FLEXIBLE CABLE TO COIN DOOR (ABOVE SERVICE SWITCH BRACKET).

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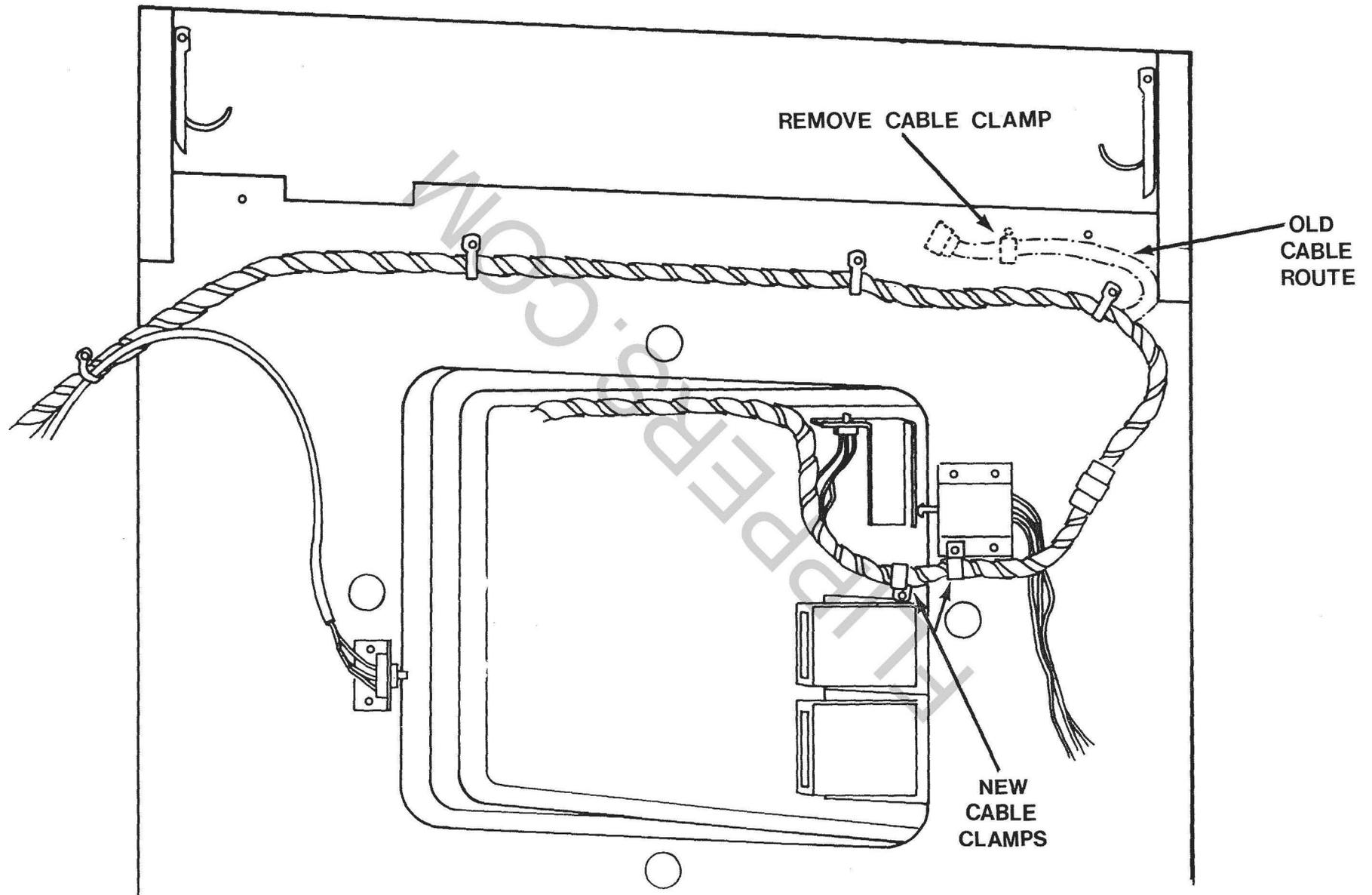
- B. RE-ROUTE CABLE TO THE LEFT OF AND UNDER THE SERVICE SWITCH BRACKET.
  - C. REMOVE UPPER RIGHT NUT FROM THE TOP COIN COUNTER.
  - D. REINSTALL NUT TRAPPING SMALL CABLE CLAMP (59-00004-004) AROUND COIN DOOR CABLE ON COIN COUNTER SO THE CABLE IS NOW POSITIONED HALF-WAY DOWN THE COIN DOOR HINGE.
3. REINSTALL CABLES AS FOLLOWS: (SEE FIG. 2 )
- A. REMOVE LOWER RIGHT SCREW ON INTERLOCK ASSEMBLY COVER.
  - B. REINSTALL SCREW, ANCHORING PREVIOUSLY REMOVED CABLE CLAMP AROUND COIN DOOR CABLE.
  - C. RECONNECT MOLDED CONNENCTORS FOR COIN DOOR CABLE.
  - D. VERIFY THAT CABLE FREELY MOVES THROUGH CABLE CLAMP UNDER INTERLOCK ASSEMBLY COVER, TO PREVENT PINCHING THE CABLE.

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FIGURE 1



**FIGURE 2**



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ATTN: SERVICE MANAGERS

GAMES: ALPINE SKI, WILD WESTERN, JUNGLE HUNT, FRONTLINE, QIX, KRAM,  
SPACE DOUNGEON, ELECTRIC YO-YO (GAMES WITH AMERICAN POWER  
SUPPLY)

SUBJECT: POWER SUPPLY'S +5 VOLT FAILURE TROUBLE SHOOTING HINTS

SOLUTION: WE HOPE THE FOLLOWING PROCEDURES WILL BE HELPFUL IN ISOLATING  
FAILURES IN THE +5 VOLTS CIRCUIT. THE TYPICAL SYMPTOMS INCLUDE:

- 1) BR1 GETS EXCESSIVELY HOT AFTER HEAT SINK (#30-00005-001) IS  
INSTALLED.
- 2) F1 BLOWS REPEATEDLY AFTER SEVERAL HOURS OF NORMAL OPERATION.
- 3) +5 VOLT SEEMS TO FLUCTUATE (L.E.D. 1 SEEMS TO FLICKER).
- 4) ROLLING DARK BARS ACROSS THE SCREEN VERTICALLY.

PARTS NEEDED: ON FAILURE, AS ENCOUNTERED.

PROCEDURE: SYMPTOMS 1 & 2 :

ANY TIME THAT "BR1" (BRIDGE RECTIFIER 1) IS REPLACED, THE FUSE  
HOLDER FOR F1 SHOULD BE RESOLDERED. WHEN INSTALLING A NEW BR1,  
ENSURE THERE IS AT LEAST 1/8 INCH CLEARANCE BETWEEN THE BOARD  
AND THE RECTIFIER. FAILURE TO DO SO MAY RESULT IN FURTHER F1  
AND/OR BR1 FAILURE.

NOTE: F1 AND F2 ARE 10 AMP FUSES NO MATTER WHAT IS ETCHED ON  
THE POWER SUPPLY BOARD.

THERE ARE COMPONENTS UNDER THE POWER SUPPLY THAT LOOK LIKE DIODES (REFER TO FIGURE 1 AND 2)(ON ISS. "C" OF THE POWER SUPPLY THEY ARE CALLED D13, D14, D17 AND ARE ON THE COMPONENT SIDE). THESE COMPONENTS ARE CALLED TRANSORBS. THEY ARE USED TO COMPENSATE FOR FLUCTUATING A.C. LINE VOLTAGES. MEASURING THEM OUT OF CIRCUIT, OTHER THAN CHECKING FOR SHORTS, IS USELESS. THE ONLY WAY TO TEST THEM IS TO TAKE THEM OUT OF CIRCUIT, AND THEN POWER UP THE POWER SUPPLY WITH A LOAD. IF THE VOLTAGE, AFTER ADJUSTMENT, IS CORRECT, THEN THE TRANSORB NEEDS TO BE REPLACED.

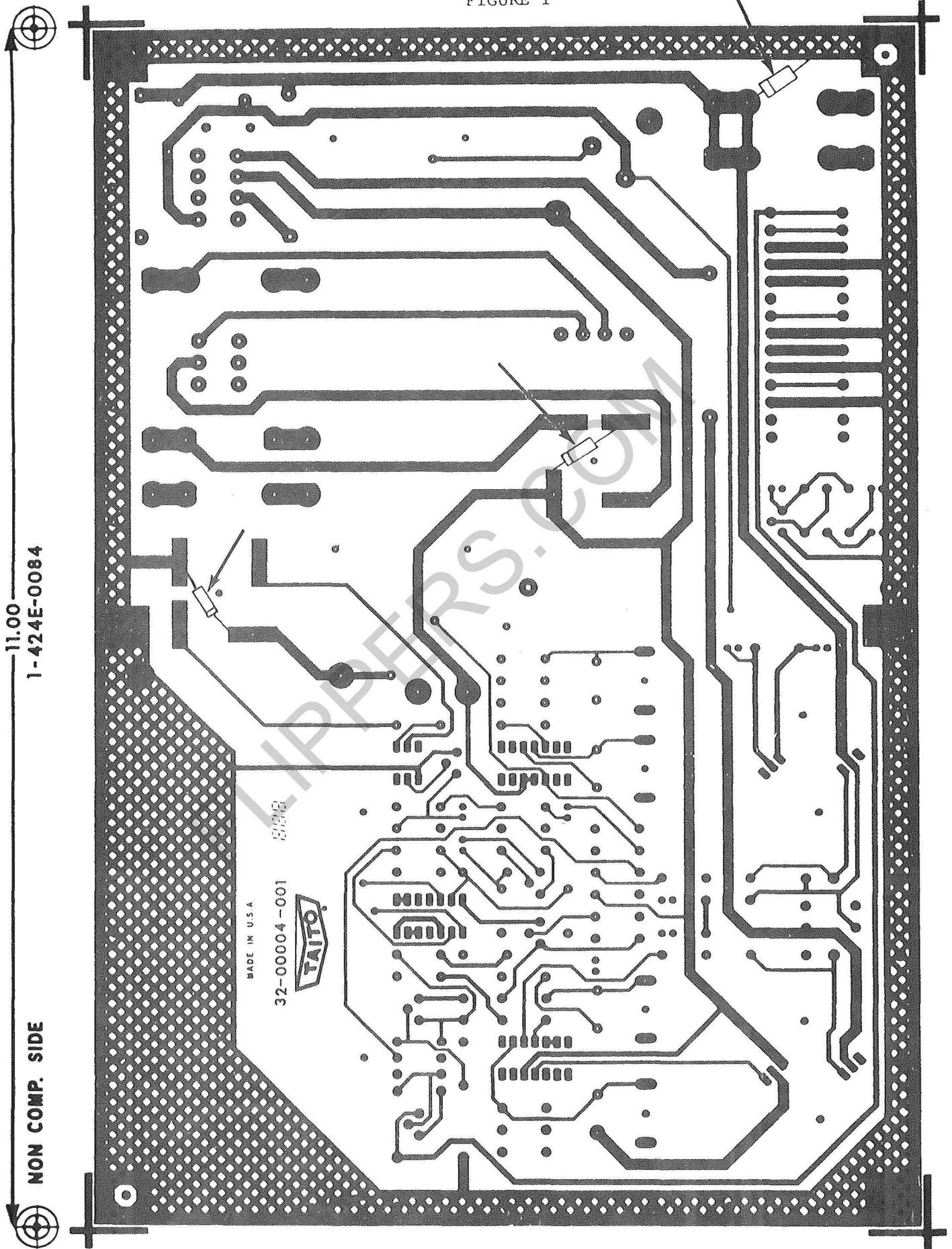
SYMPTOMS 3 & 4 :

ENSURE THAT THE SCREWS ON C7 AND C9 (REFER TO FIGURE 2) ARE TIGHT. AFTER THE SCREWS ARE TIGHT, MEASURE, WITH THE METER IN AC VOLTAGE MODE, THE OUTPUT OF +5V. THE RIPPLE SHOULD BE LESS THAN A QUARTER OF A VOLT (0.25 V). IF NOT, C7 COULD BE THE PROBLEM.

IF THE +5 VOLTS OUTPUT IS LESS THAN 0.7 VOLTS, MEASURE THE PLUS SIDE OF C7. THERE SHOULD BE AT LEAST +10 VOLTS D.C. IF IT IS LESS THAN 10 VOLTS, THEN ONE OF SIX THINGS COULD BE WRONG:

- 1) F1 IS BLOWN.
- 2) A.C. INPUT BETWEEN J1 PIN 1 & 2 IS LESS THAN 10 VOLTS AC.
- 3) BR1 IS WEAK.
- 4) THE TRANSORB FOR BR1 IS WEAK.
- 5) C8 IS SHORTED.
- 6) C7 IS SHORTED.

FIGURE 1



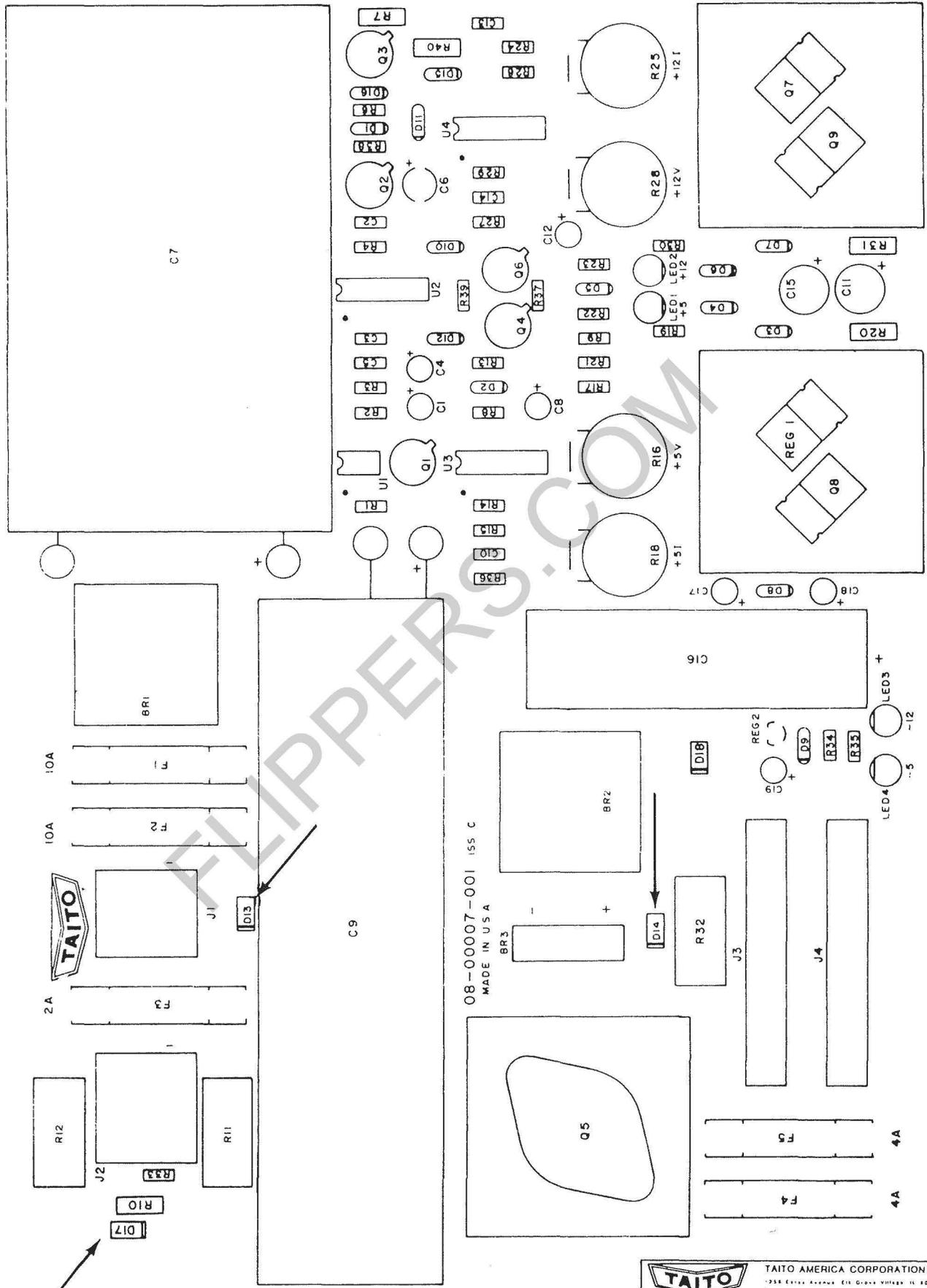
11.00  
1-424E-0084

NON COMP. SIDE

MADE IN U.S.A.  
32-00004-001  
TAITO

# TRANSORB POWER SUPPLY ISS.C

## FIGURE 2



08-00007-001 ISS C  
MADE IN U.S.A.

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DATE	REV	BY	CHKD

FRONT LINE™  
Power Supply Board Layout

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ATTN: SERVICE MANAGERS

GAMES: ALPINE SKI, WILD WESTERN, JUNGLE HUNT, FRONTLINE

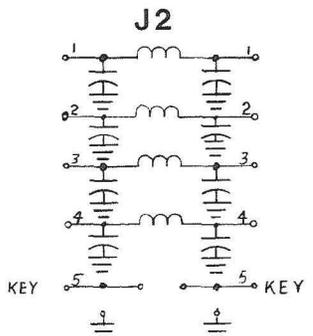
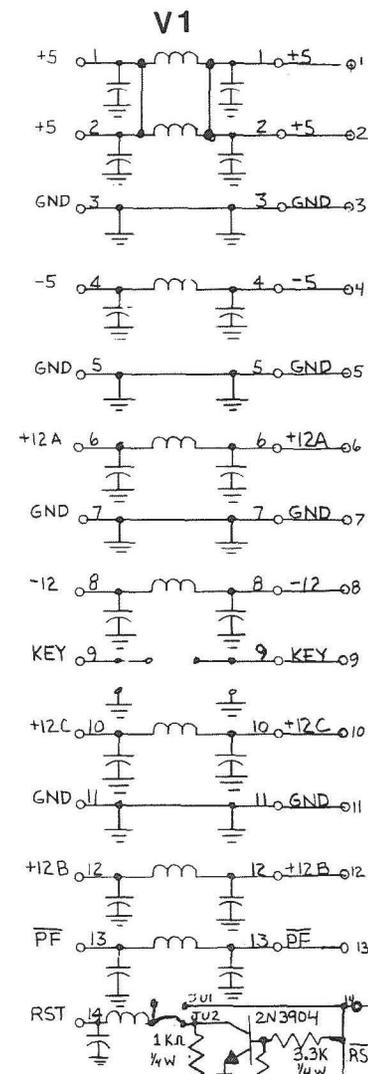
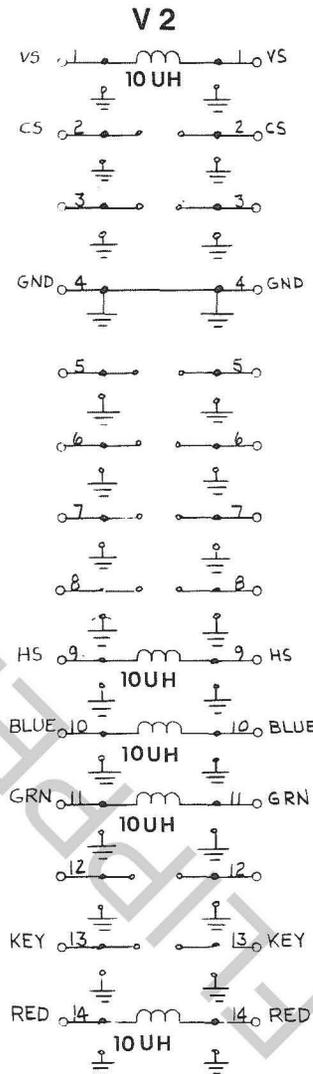
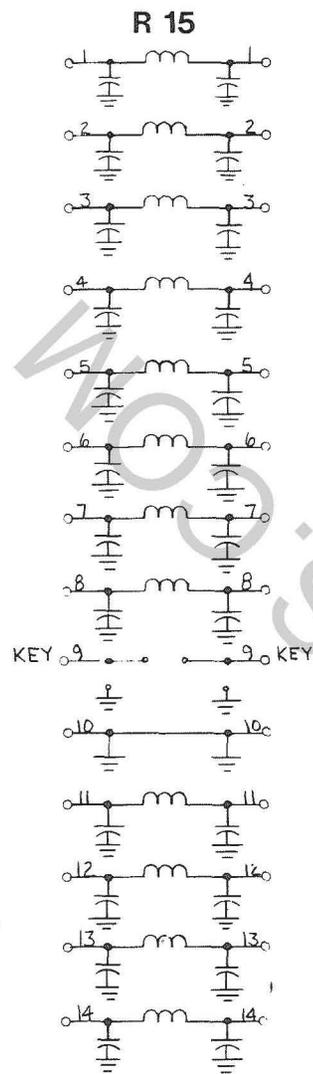
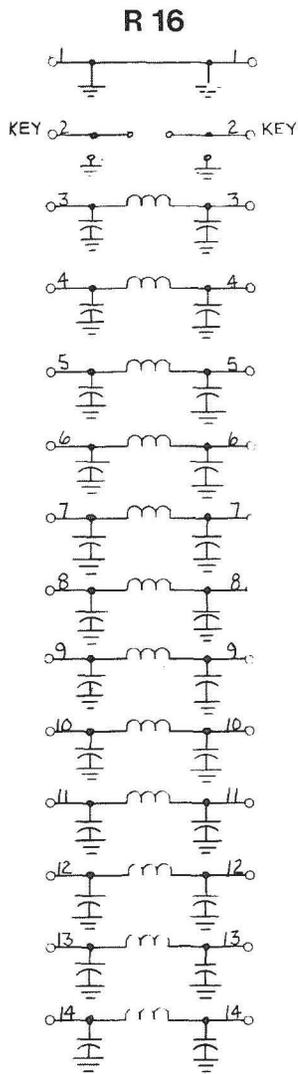
SUBJECT: FILTER BOARD SCHEMATIC

SOLUTION: NONE

PARTS NEEDED: NONE

PROCEDURE: ON THE ABOVE GAMES, THE MASTER RESET SIGNAL IS INVERTED BY Q1 ON THE FILTER BOARD. IF THE GAME IS INTERMITTENTLY RESETTING ITSELF, THE MOST LIKELY PROBLEM WOULD BE THIS TRANSISTOR. THE PROCEDURE TO DIAGNOSE THE PROBLEM FOLLOWS:

USE A LOGIC PROBE OR A METER TO LOOK AT YOUR RESET SIGNAL. THERE ARE THREE (3) V1 CONNECTORS ON THE FILTER BOARD. PIN 14 ON THE V1 CONNECTOR (A WHITE WIRE) IS FOR THE RESET SIGNAL. ON THE TOP V1 CONNECTOR, THE RESET SIGNAL SHOULD BE LOW (0V) FOR TWO (2) SECONDS AFTER POWER-UP, THEN GO HIGH (+5V) AND STAY HIGH. THIS SIGNAL COMES FROM THE POWER SUPPLY. ON THE BOTTOM V1 CONNECTOR, THE RESET SIGNAL SHOULD BE HIGH (+5V) FOR TWO SECONDS AFTER POWER-UP, THEN GO LOW (0V) AND STAY LOW. THIS SIGNAL COMES FROM Q1 ON THE FILTER BOARD.



NOTES:  
 ALL CAPACITORS 470pF  
 ALL INDUCTORS FERRITE BEADS  
 UNLESS SPECIFIED.

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 REVISIONS

ERO #91-00132
7-29-81 J.W.A.
AI (7/29/81)
ADDED SOUND CONNECTOR
ECO 92-00414
12-18-81 DON L
B
ADDED RESET CIRCUIT AND EXTRA POWER SUPPLY CONNECTOR
1-23-82 MARK L
ECO 92-00440
REVISED SOUND CONNECTOR
ECO 92-00444
1-29-82 DON L
D 1-29-82 RH

THIS DRAWING ORC00017-001

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 1258 Estes Avenue, Elk Grove Village, IL 60007  
 Telephone (312) 981-1000 Telex 25-3290

UNLESS OTHERWISE SPECIFIED	INCHES	DRAWN BY	JWA	DATE	7-29-81	SCALE	N/A	
DIM. TOL.	INCHES	APPROVED BY	CVS	DATE	7/29/81			
	MM							
X		DESCRIPTION	FILTER BOARD					
XX								
XXX								
Notes		DO NOT SCALE	USED ON	DRAWING NUMBER	ORC00017	SHEET	1 of 1	
Modification								

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83-13

ATTN: SERVICE MANAGERS

GAME: ALPINE SKI, WILD WESTERN, JUNGLE HUNT, FRONT LINE

SUBJECT: THEORY OF OPERATION OF THE "S.J." SYSTEM

SOLUTION: WE HOPE THIS INFORMATION WILL BE HELPFUL TO YOUR UNDERSTANDING OF THE "S.J." SYSTEM

## COMPUTERS

The two microprocessors that run the S.J. video system are both Z-80 C.P.U.'s, the main (video) processor being clocked at 4 megahertz, and the sound processor being clocked at 3 megahertz. The sound processor's address and data lines are unbuffered due to a low component count in the sound circuitry. Each processor is allocated a scratchpad RAM memory, the sound C.P.U. having 2 kilobytes (2114 rams) and the main C.P.U. also having 2 kilobytes (2016 ram). Both processors access independent program ROM banks, jumperable to most common types of EPROMS. Inter-processor communication is achieved through byte-I/O transfers on a latch.

Of the two most popular methods to perform data I/O operations (memory-map or porting), memory-mapping is used extensively for all data operations. The porting conventions on the Z-80 processor are only used to clear any asserted interrupts at the beginning of each machine cycle ("M1" state).

## TIMING

All video timing is derived from a 12 megahertz master clock, which controls all timing within the system with the exception of the microprocessors. The C.P.U.'s each have an independent clock circuit, each with its' own crystal oscillator.

Timing signals are applied to the video sections (in addition to synchronizing them) and are summed with data from the C.P.U. to provide "offsets" to the horizontal and/or vertical timing to produce motions in the video displays.

Timing can also be summed with horizontal or vertical offset data and be applied to the scrolling circuits. The scrolling circuits control 3 completely independent "background" video pages, each uniquely moveable in any direction (These circuits may be used to generate other than background video if it is desired or necessary).

The timing signals are also used to inform the circuitry that moves the small "objects" on screen when to produce them and where to put them. These "objects" are usually the player's character etc., and the timing will help the C.P.U. to determine when there has been a collision between any of the "objects" or if one has collided with the "background" video.

## VIDEO

As mentioned, there are two types of video information present; "background" and "object" video. There are completely different circuits for organizing and moving the data that comprises either type of video, but the source of picture information is the same for both circuits. The picture information is referred to as "postage stamps" of video data, and a postage stamp occupies 8 by 8 dots on the screen. The bank of ROM where the postage stamp's data is held is called the "pattern ROM" bank. Postage stamps infer a very software intensive type of video game, and video difficulties are perhaps more confusing to diagnose due to many circuits having multiple functions.

The "objects" on the screen are actually assemblages of 4 postage stamps to obtain a 16 x 16 dot "character" which can be moved about or swapped with similar patterns to "animate" the character. There are 2114 rams called "object rams" which carry data on which objects are currently being displayed, what colors are to be applied to them, and their coordinates on the screen. Various circuits digest this data and in turn control other circuits which act on it. The object producing circuitry is capable of maintaining and manipulating 22 objects on the screen at any one time. Each object that is being displayed has a distinct priority established by hardware. This prioritization is used to mask lower priority objects when higher priority objects pass through them to give the impression of "depth" when a character passes "under" another.

"Background" video is actually 3 independent screenfuls of video data, each moveable regardless of other screens or any objects on screen. The background video is also comprised of many "postage stamps". The visual impression of motion is produced by "scrolling" or shifting the characters that comprise the background. As mentioned, the data for producing the background video is of the same source as that for objects. The RAMS that then hold the pattern data ("code rams", 6 2016 RAMS) maintain the characters somewhat differently than the object RAMS, in that the postage stamp patterns codes are maintained in the code rams alone. The data for coordinating the placement of the patterns is held in the "screen rams" (2 2016 RAMS), and this information is directed by the sum of the data held in the "scroll rams" (2 2114 RAMS) and the timing signals mentioned previously.

The background video data and the object video data need to be output from code rams under the direction of the screen rams to the shift registers. The three background screens are simultaneously shifted into serial form and passed to the prioritization circuitry. The object video data is also in the code rams at this time, and the object data is also shifted into serial form, but instead of being sent to the priority circuit it is read into the "line buffers" these are extremely fast (230 ns bi-polar RAMS, type 93422). The line buffers alternately hold and display 1 horizontal line at a time, and while 1 is reading its object data to the screen, the other is being written for the next line.

The priority circuit is actually a 1-of-4 selector, choosing between 3 background screens and object data. A priority is assigned from a lookup table called the "priority ROM" (sometimes mistakenly referred to as a "color ROM") and the video signal present at that time with the highest priority will be the one honored. This prioritization is the key to detecting whether an object collides with another or a background "character" by observing whether or not there was a priority conflict.

The controlling microprocessor oversees all these operations, and can directly access any of the memories mentioned thus far with the exception of the line buffer "fast RAMS". The video chain now is passing 1 dot of video information per cycle to the final stages. The video information is 6 parallel bits of color coding and each cycle of 6 bits applies a distinct level of R-G-B voltage to the monitor's guns. Six bits provides a one of 64 color select, but the color lookup table is a RAM with 9 bits of data giving 512 possible colors, any 64 of which may be used instantly. This lookup is a hardware digital-to-analog converter, with the increments installed by the C.P.U. in the RAM.

#### SOUND

Sound is produced under the control of both microprocessors. The main (video) C.P.U. is used to read player inputs and produce background sound effects. Some games use this background sound for music. The sound is produced by an 8910 programmable sound generator (P.S.G.) chip. This P.S.G. also has 2 parallel ports available on it, so they are used to read 2 D.I.P. switch banks for game options. This sound is shaped by a 3900 operational amplifier (op-amp) and has a separate mixing level (bgnd volume control).

All other game sound effects are produced under the control of the sound C.P.U. Most of the sounds are also produced by 3 8910 P.S.G. chips, however one of the P.S.G.'s parallel ports are used to form a hardware digital-to-analog converter. This D/A converter is principally used to produce sine-wave type noise since the P.S.G.'s only produce filtered square waves. Extremely complex waveforms such as voice also may be produced by this D/A network.

The outputs of the D/A network and the main sound P.S.G.'s are shaped and filtered somewhat differently, but all use 3900 op-amp circuitry. The signals are finally summed (mixed) by another 3900 op-amp, and sent (via volume control) to the sound output amplifier.

The Main C.P.U. passes sound requests to the sound C.P.U., and requires little or no handshaking after that. The Main C.P.U. may also gate off the sound (as when in the attract mode) by one of its peripheral outputs.

The player switch inputs are debounced and fed onto the "external data bus" along with the other D.I.P. switch bank and Pattern ROM data. This is then passed to the main C.P.U. data bus when the C.P.U. is ready for the data.

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