

SERVICE TIPS

FAST AID HOT LINE: 800-323-0666
EXCEPT ILLINOIS: 312-981-1000 Ext. 215
TELEX: 253290



MANDATORY

82-5

ON FAILURE ONLY

FOR YOUR INFORMATION

ATTN: SERVICE MANAGERS

GAME: ALPINE SKI, SERIAL NUMBERS UP TO 132199

PROBLEM: JOYSTICK MAKES CLICKING SOUND AND MOVEMENT OF JOYSTICK IS LIMITED, CAUSED BY THE SPRING BEING IN THE WRONG POSITION.

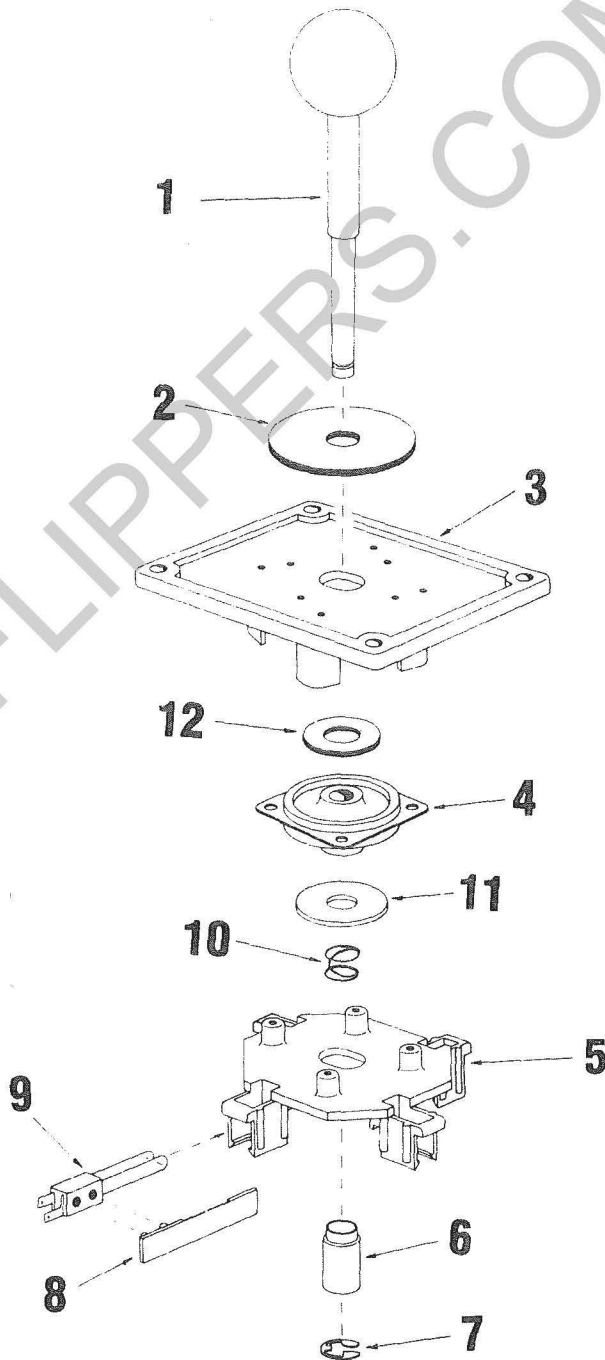
SOLUTION: MOVE TOP SPRING (SEE FIGURE 1) BETWEEN THE SPACER AND THE ACTUATOR.

PROCEDURE: REMOVE "E" RING (FIGURE 1) AND ACTUATOR. CAREFULLY REMOVE THE BALL, SHAFT, AND THE SPRING THAT IS ON THE SHAFT. REPLACE THE SHAFT INTO THE MOUNTING PLATE AND PLACE THE SPRING ON THE SHAFT SO THAT THE SPRING IS BETWEEN THE ACTUATOR AND THE MOUNTING PLATE.

4-WAY JOYSTICK

FIGURE 1

ITEM	TAITO PART NO.	DESCRIPTION
1	63B00071-001	Ball & Shaft
2	63A00074-001	Mask
3	63C00069-001	Mounting Plate
4	62C00004-001	Shock Mount Pad
5	63C00070-001	Switch Plate
6	63A00075-001	Actuator
7	59B00020-017	"E" Ring
8	63A00072-001	Switch Spacer
9	29B00033-001	Leaf Switch
10	58A00006-001	Spring
11	61A00227-001	Spacer
12	63A00073-001	Spacer, Plastic



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ATTN: SERVICE MANAGERS

GAME: ALPINE SKI

SUBJECT: "T" CONNECTOR (POWER CONNECTOR) BECOMES DISCONNECTED WHEN THE GAME IS USED.

SOLUTION: INSERT SPRING PIN INTO "T" CONNECTOR

PARTS NEEDED: FOUR SPRING PINS P/N 25-00034-001

PROCEDURE: INSERT FOUR SPRING PINS INTO THE "T" CONNECTOR AROUND THE KEY IN THE CONNECTOR.

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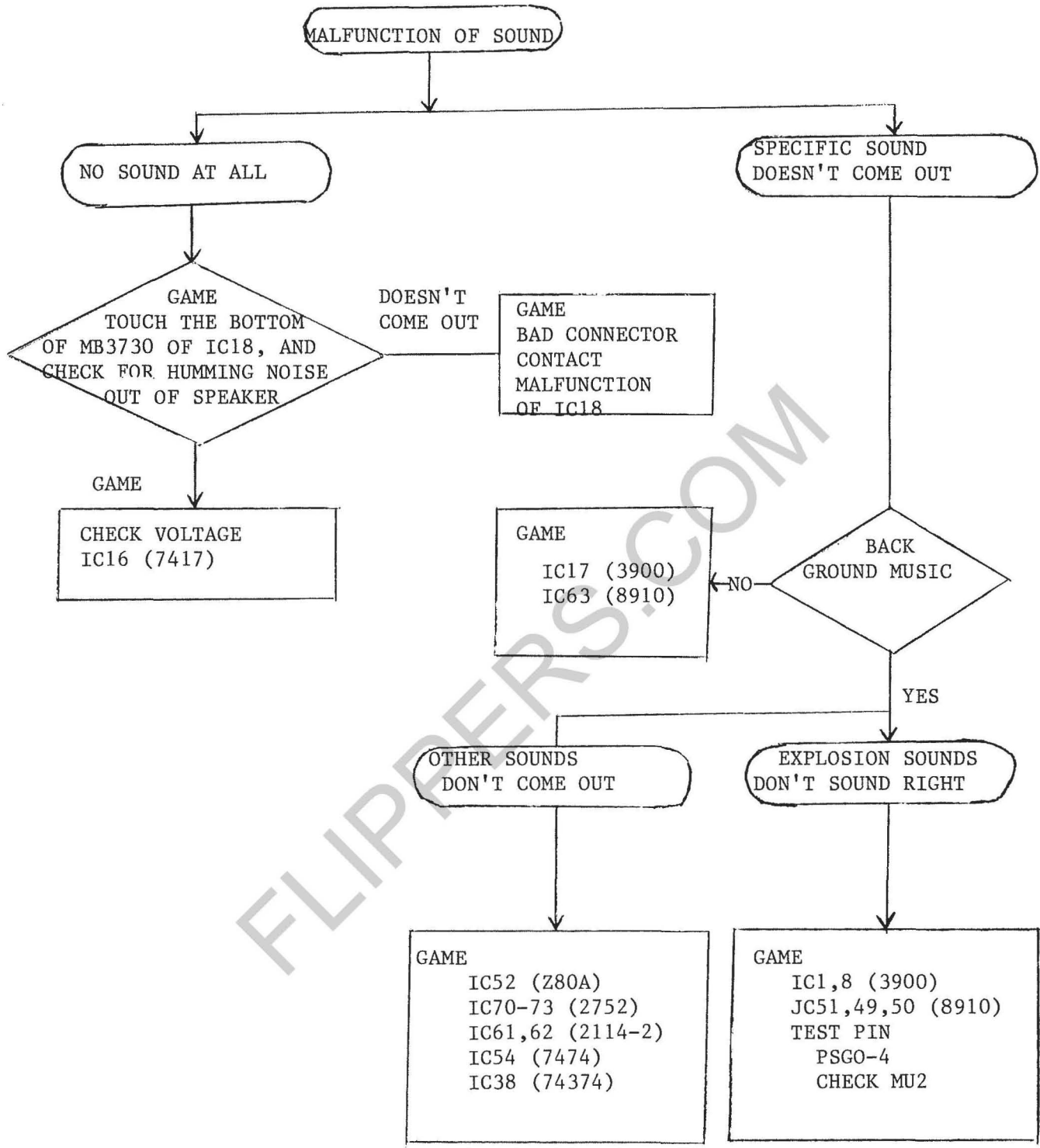
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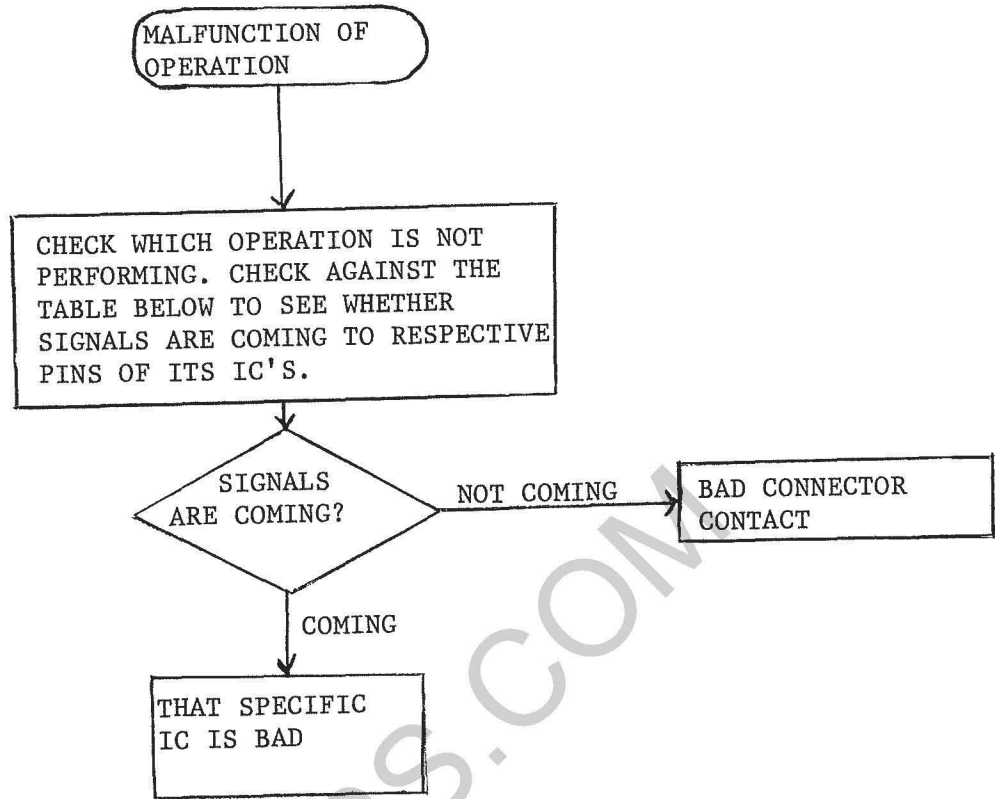
82-7

ATTN: SERVICE MANAGERS

GAME: ALPINE SKI
SUBJECT: TROUBLESHOOTING CHART

SOLUTION: THE ATTACHED IS A COMBINATION PROCEDURE FLOW-CHART TYPE
OF TROUBLESHOOTING GUIDE. HOPING THAT INFORMATION LIKE
THIS WILL AID YOU IN TROUBLESHOOTING TAITO AMERICA
CORPORATION PRODUCTS.





OPERATION SWITCH	IC AND ITS PIN NO.
COIN SWITCH (LEFT)	IC27-3
COIN SWITCH (RIGHT)	IC27-9
SERVICE SWITCH	IC27-1
TILT	IC7-5
SELECT (1 PLAYER)	IC6-3
SELECT (2 PLAYER)	IC6-13
RIGHT	IC3-11
LEFT	IC3-5
FORWARD	IC5-5

KEY TO TROUBLESHOOTING AND REPAIR OF PCB'S.

1. Define the Problem

The key to troubleshooting and repair of not only PCB's, but of any electronic game is the accurate analysis and definition of the problem. For instance, does the screen show anything, or do you have any sound, or can you operate the game? In other words, try to narrow down your problem to one or two well defined areas.

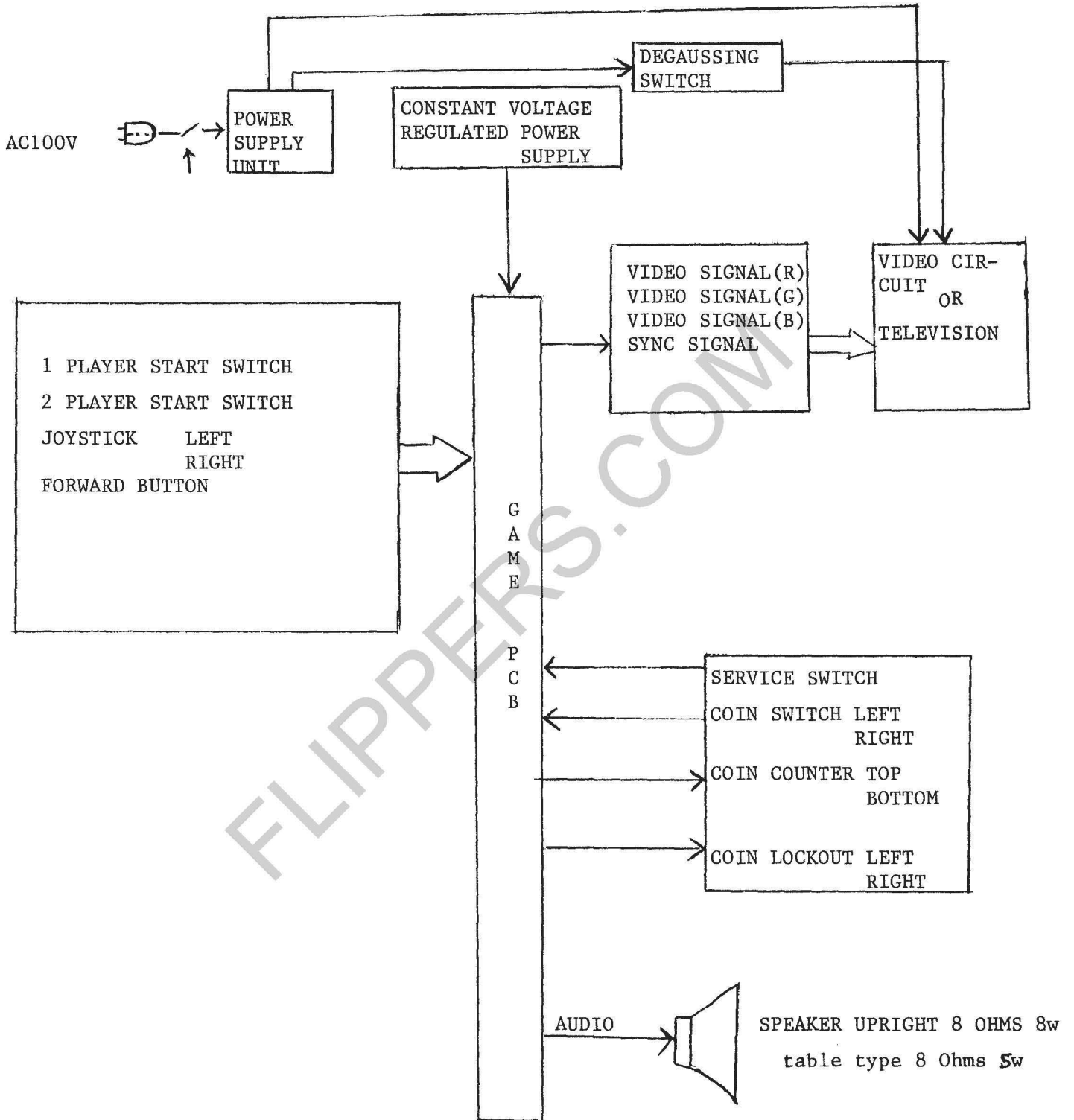
2. Localize and Isolate the Problem

Once you have narrowed down your problem to a well defined area the next step is to localize and isolate the cause of the problem. This is the most difficult task and takes a lot of patience. The method of troubleshooting the problem, is done basically by narrowing down the area one by one, and finally down to a specific device or component.

When there are more than two sets of PCB's change the respective combination of CPU, Video Game, and Sub-PCB, and by comparing the changes of conditions and by defining the problem area is an effective way of troubleshooting PCB's.

Please make use of the following check flow charts for checking malfunctions of screen, sound, and operation of the game. Also, for precision checking of PCB's a Triggered-Scope of more than 20MHz would be required.

TROUBLESHOOTING ALPINE SKI



SOUND OUTPUT TEST POINTS

PSG0 -- This is the output signal of 8910 of IC63.

IC63 is controlled by the game CPU, and outputs the background music.

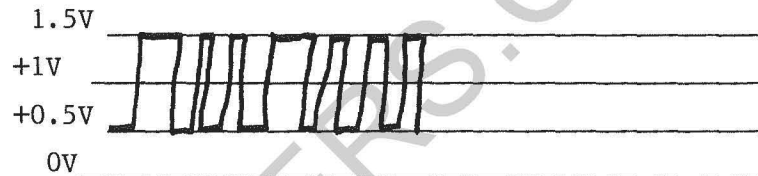


* Output only during output of background music.

* At 0V level during normal time.

This is located between the GRD Pin and the "R" Connector, source is Pin 3,4, and 38.

PSG1 -- This is the output signal of 8910 of IC51.



* Output only during output of sound.

* At 0.5V level during normal time.

This is the sound of the turning of the Ski's.

PSG3 -- This is the output signal of 8910 IC49.

IC49 is controlled by the sound CPU, and the output waves are the same as PSG1.

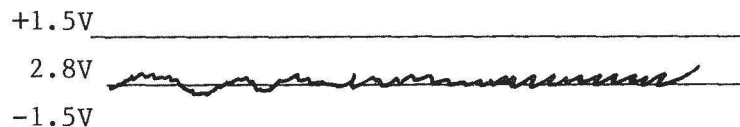
* Output only during output of sound.

* At 0.5V level during normal time.

This is the Snow Plow sound.

PSG4 -- This is the output which filtered the output of 8910 of IC50 by the 3900 of IC17.

* IC50 is controlled by the sound CPU.



This is the crowd cheering sound.

DAOUT -- This uses the output of 8910 of IC51, and configures the D/A Converter with ladder resistors and the output of this is the DAOUT.

* Since this is the integrated output of D/A Converter output, the output waves are small.

* Sound CPU controls this.

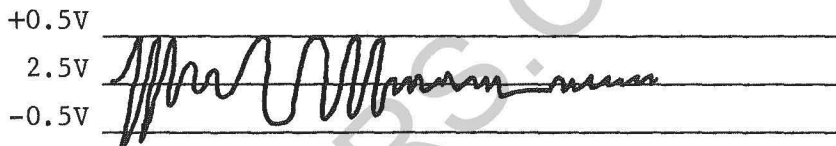


* Output only during output of sound.

* At 0.5V level during normal time.

This is the Hit and Crash Sound.

PSG2 -- The output of DAOUT is filtered by 3900 of IC8, and is the output which was further amplified.

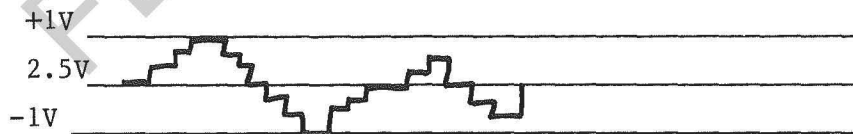


* At 2.1V level during normal time.

MU1 -- This is the amplified output of PSG0 output.

* Will output during the background music at the output of 3900 of IC17.

* Output waves shall change slightly depending upon the sound volume.

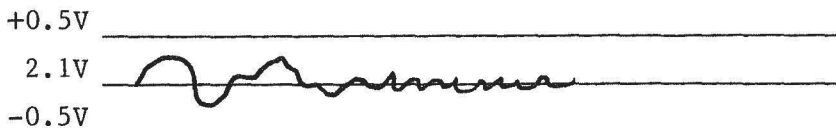


* At 2.5V level during normal time.

MU2 -- This is the output of mixing the outputs of PSG1, PSG2, PSG3, and PSG4 with 3900 of IC1.

* Output only during output of sound.

* When there is no output from MU2, it may be the sound CPU control is malfunctioning.



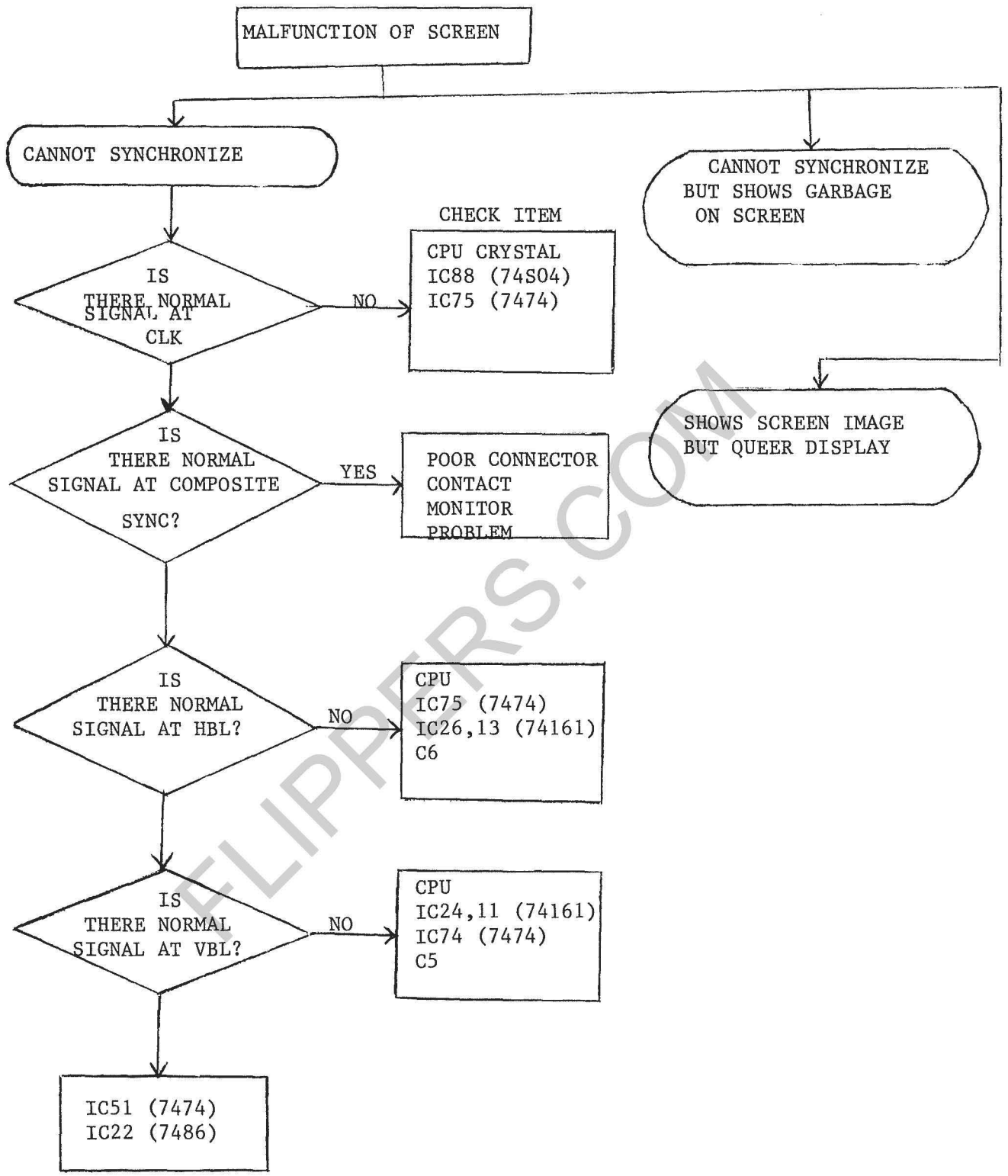
* The waves are different depending on the output of MU2.

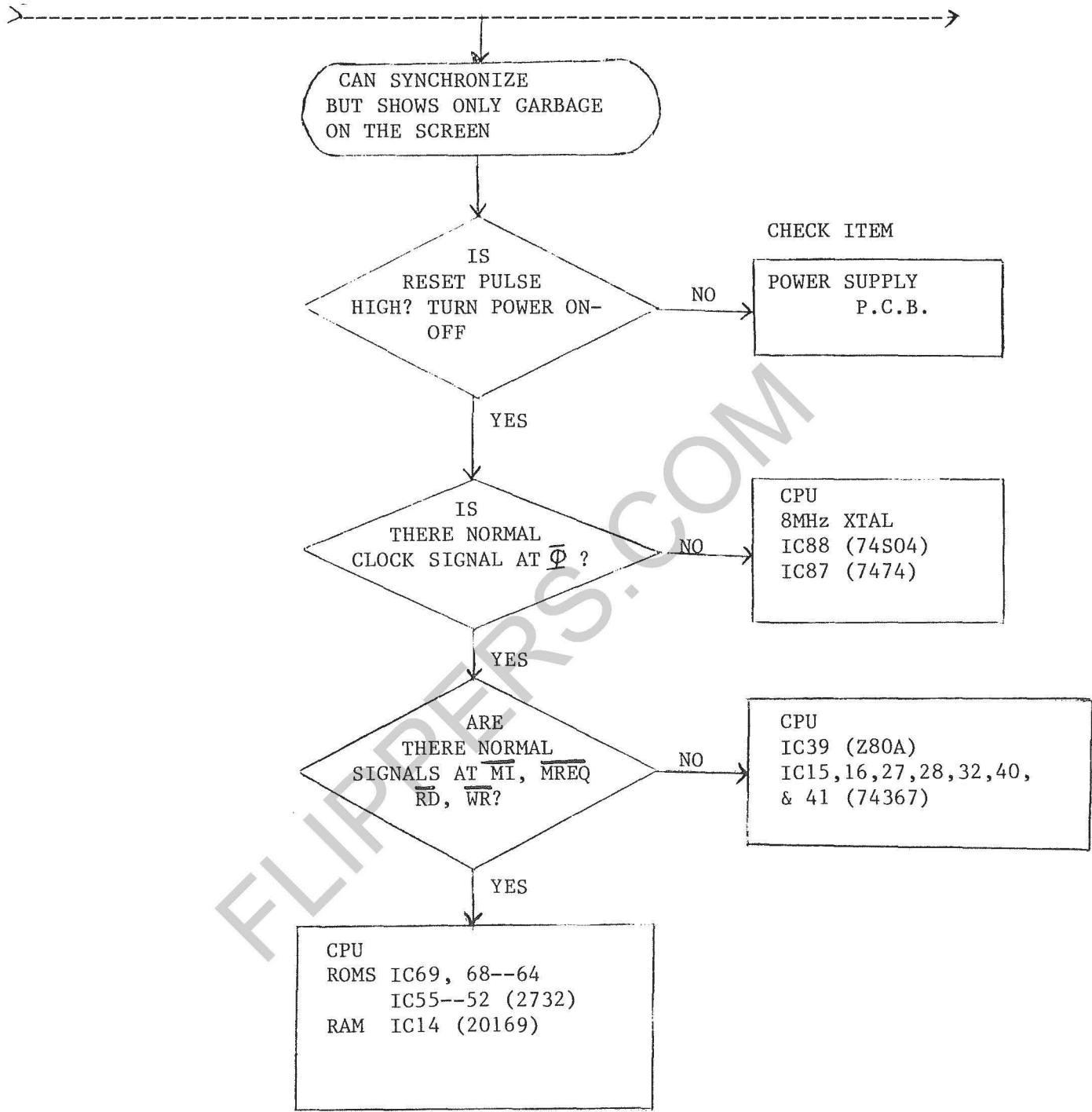
* At 2.5V level during normal time.

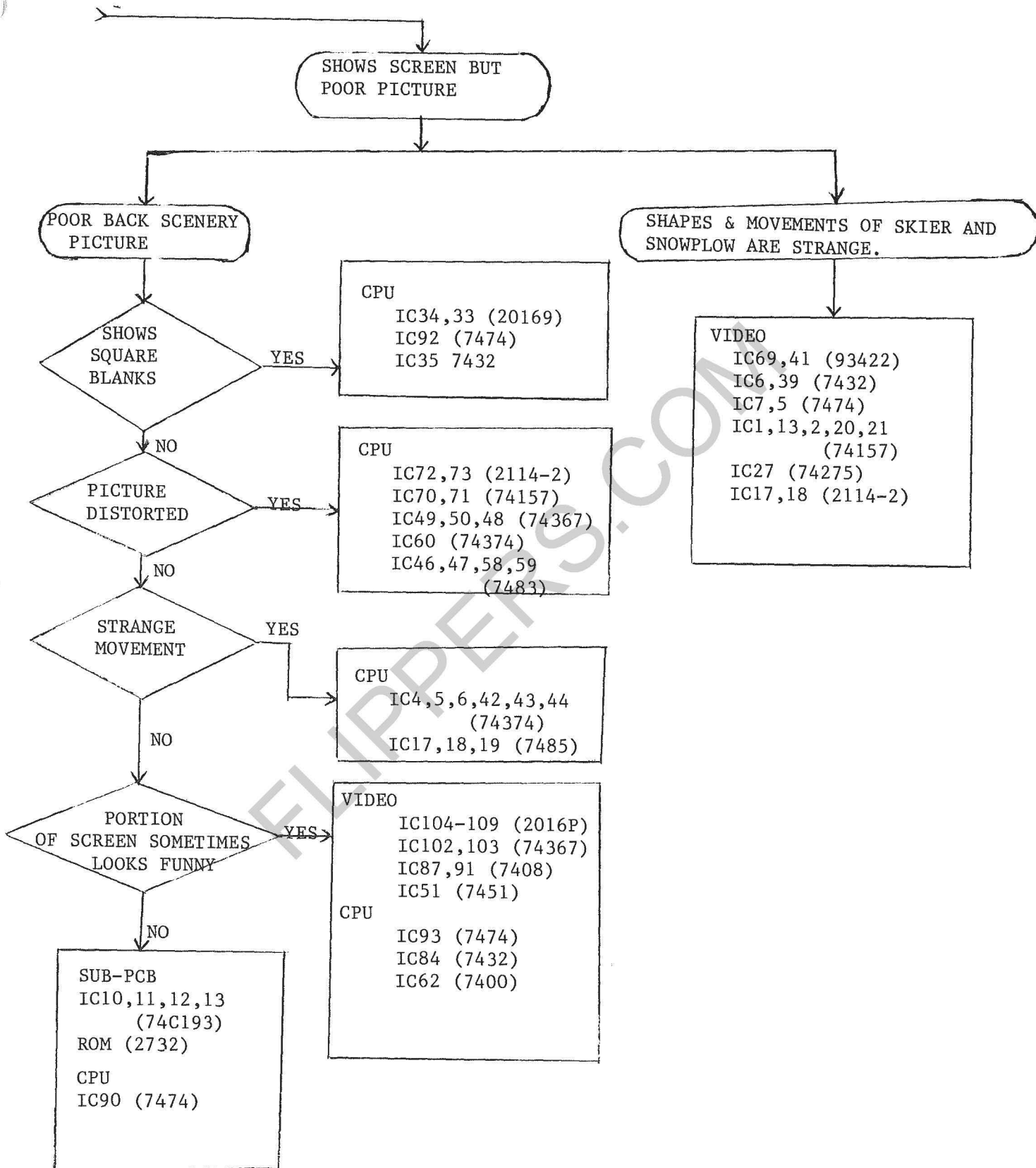
NOTE 1. IC52 is the sound CPU.

NOTE 2. When there is no sound coming out even though MU1 and MU2 is outputting, it may be either the sound stop circuit, and 7417 of IC16 are failing, or the MB3730 of the output AMPLifier is damaged.

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82-16

ATTN: SERVICE MANAGERS:

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

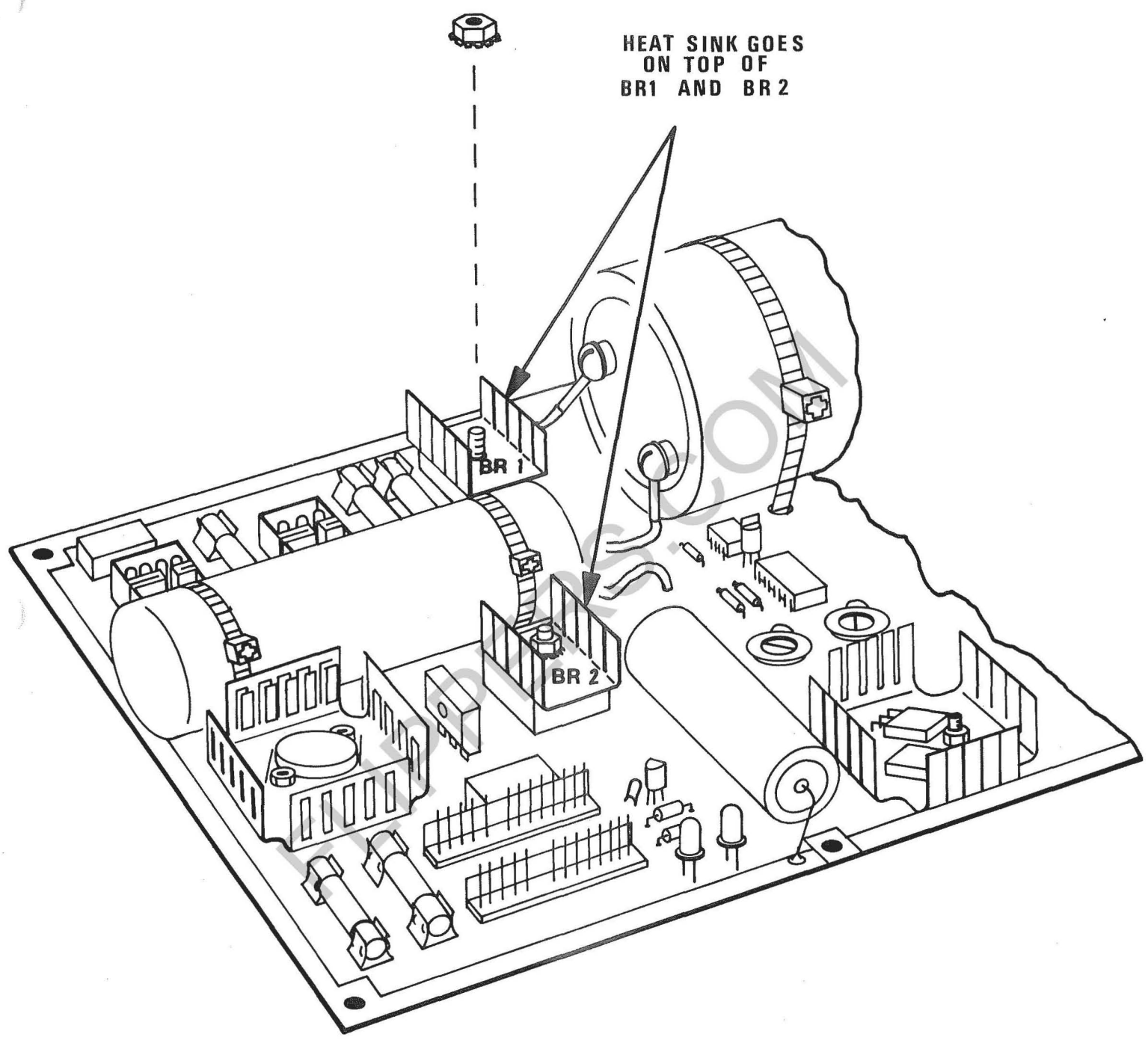
SUBJECT: BR1 AND BR2 HEATING UP TO THE EXTENT OF BREAKING DOWN INTERNALLY.

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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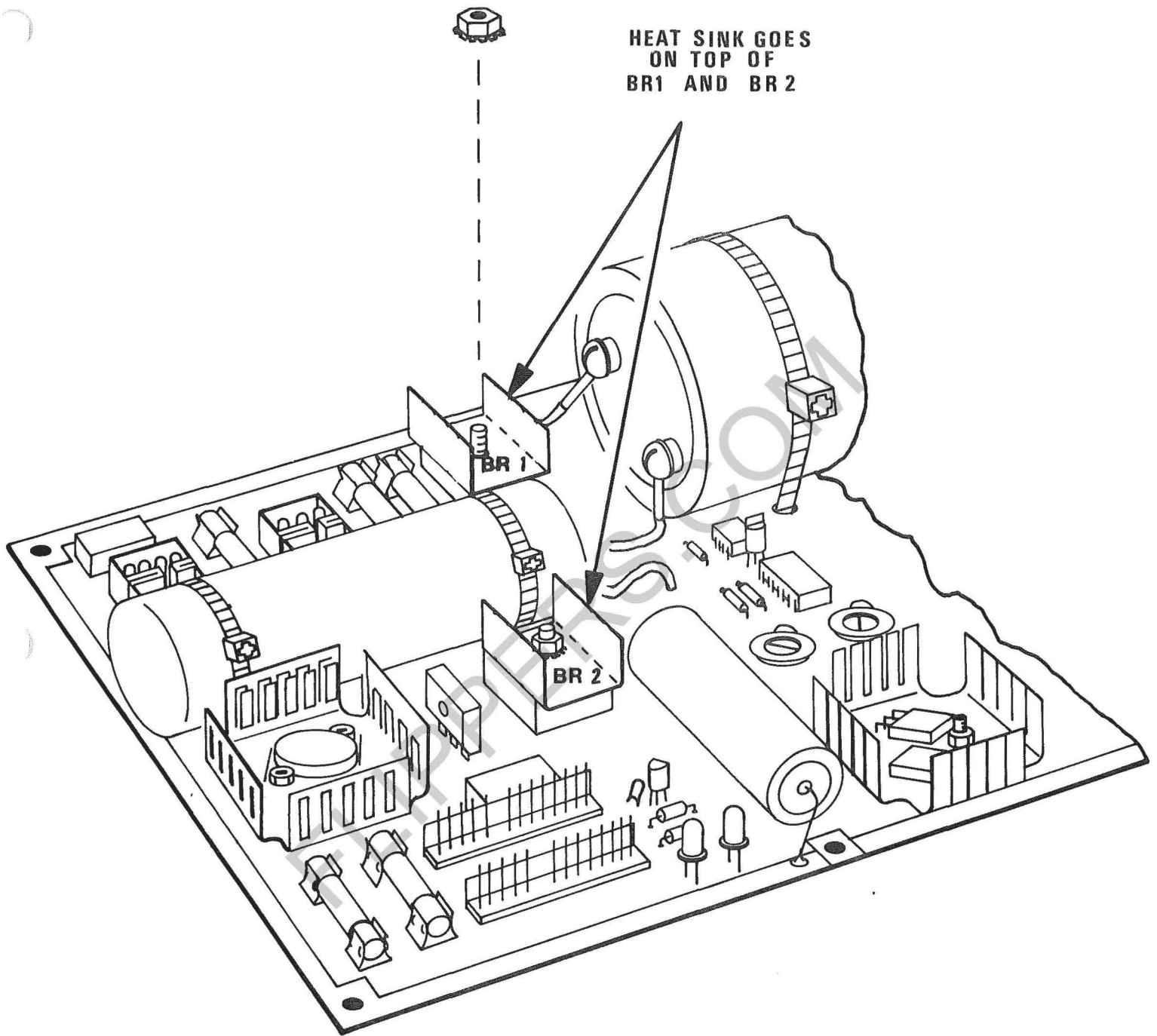


FIGURE 1

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83-2

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ATTN: SERVICE MANAGERS

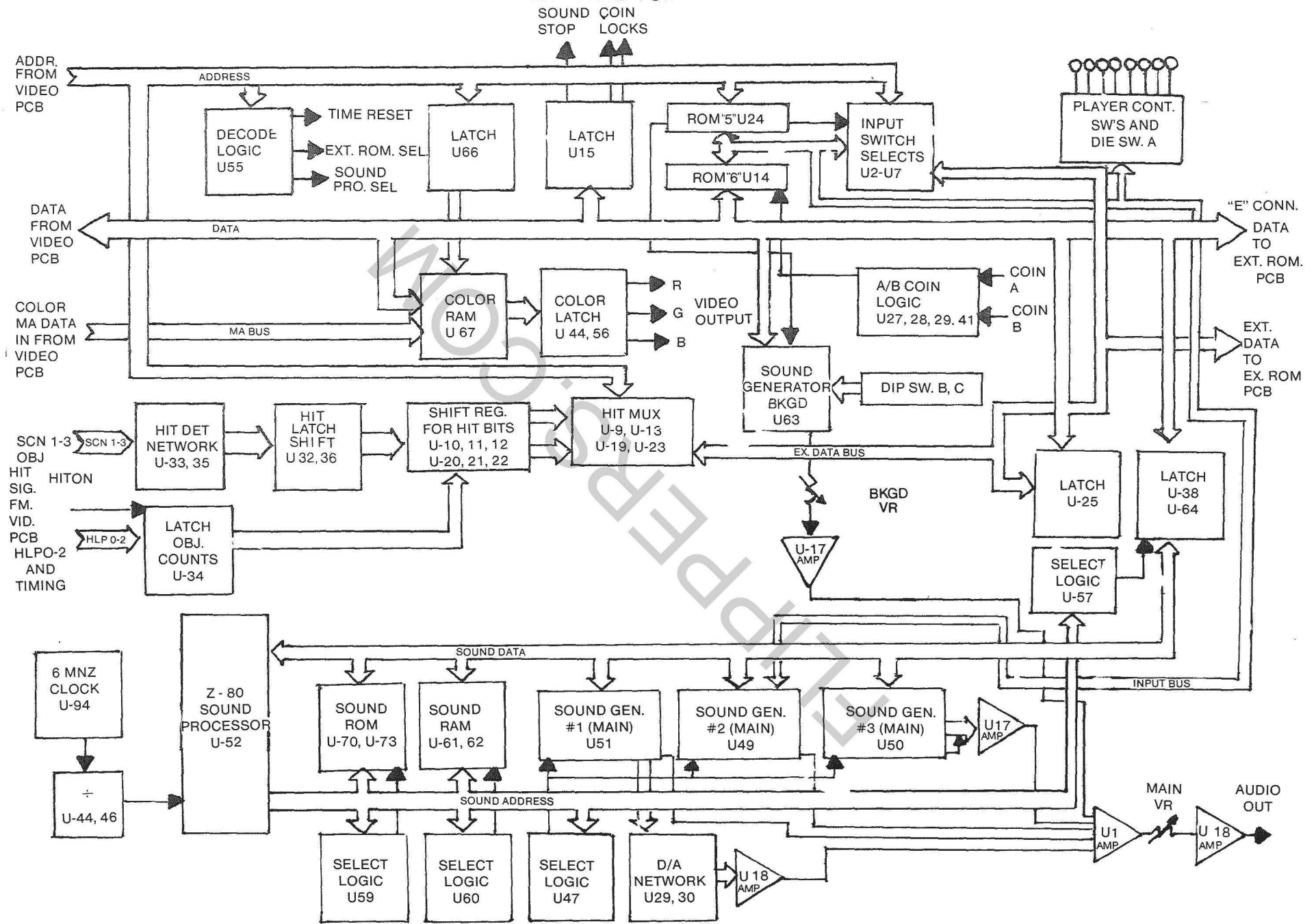
GAMES: ALPINE SKI, WILD WESTERN, JUNGLE HUNT

SUBJECT: TROUBLESHOOTING "S.J." SYSTEMS.

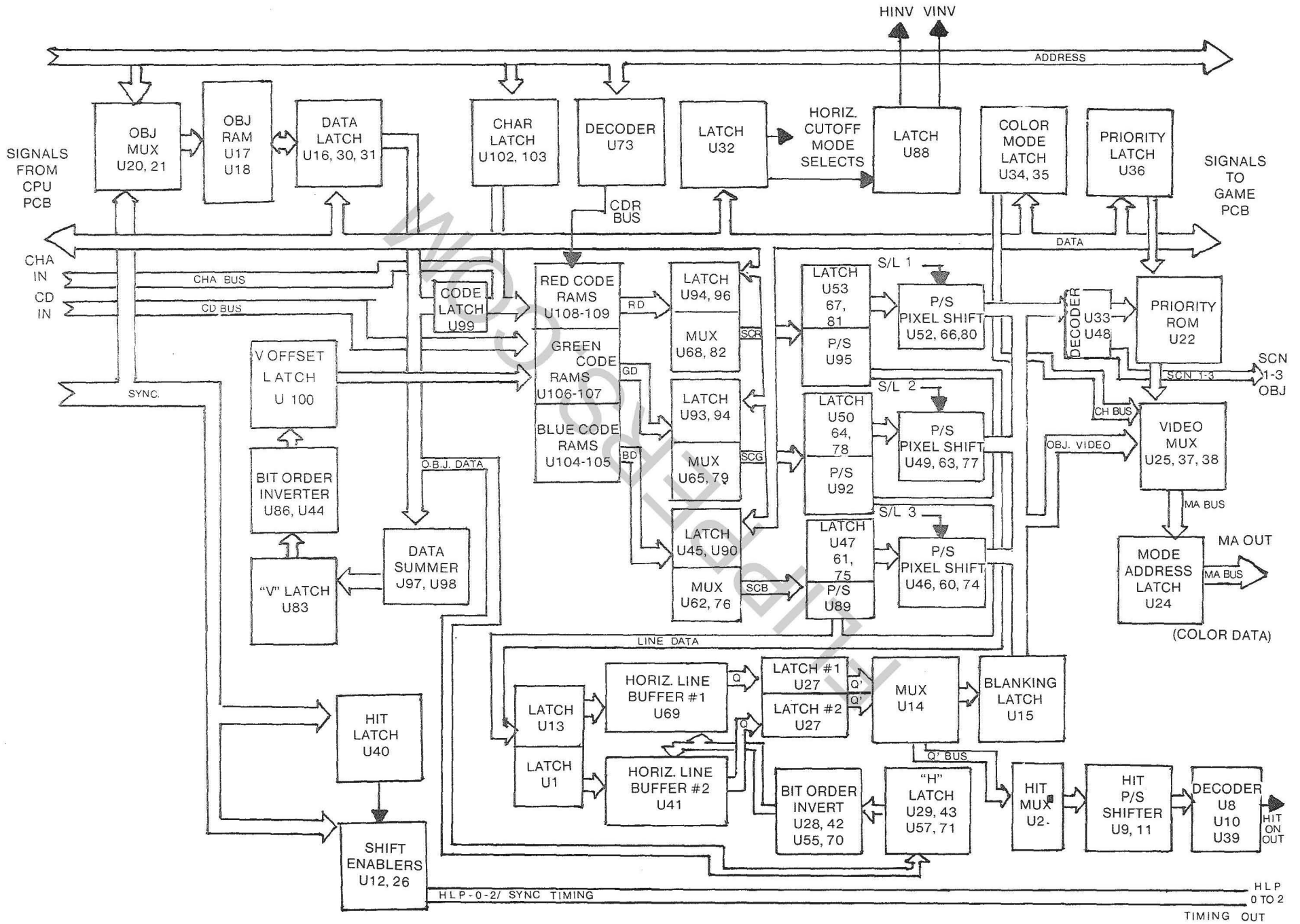
SOLUTION: PLEASE FIND ATTACHED "S.J." SYSTEM BLOCK DIAGRAM.
WE HOPE THIS WILL BE USEFUL IN DIAGNOSIS AND
TRACING FAILURES WITH THE LOGIC OF ALPINE SKI,
WILD WESTERN, AND JUNGLE HUNT.

PARTS NEEDED: NONE

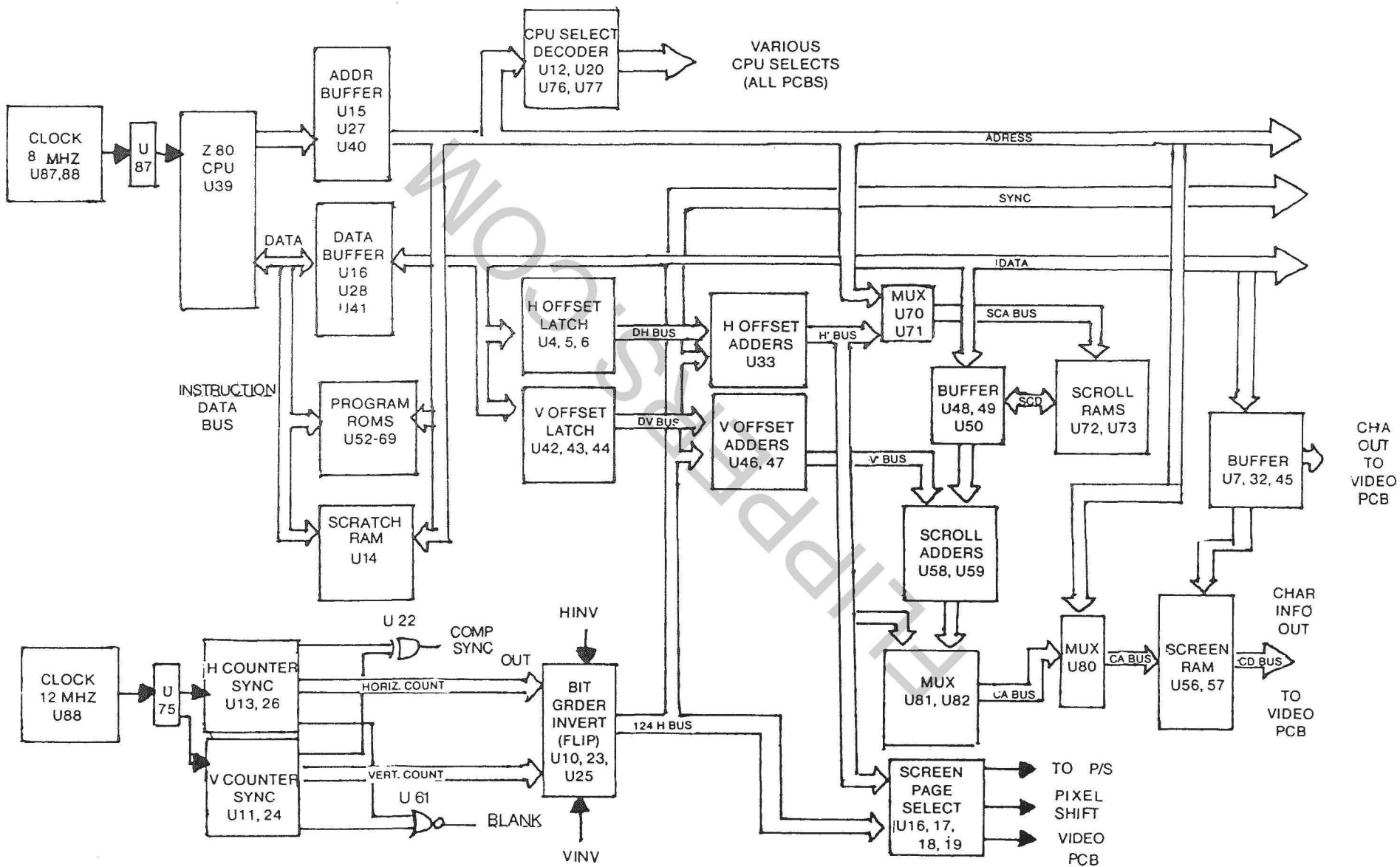
S J SYSTEM GAME PCB



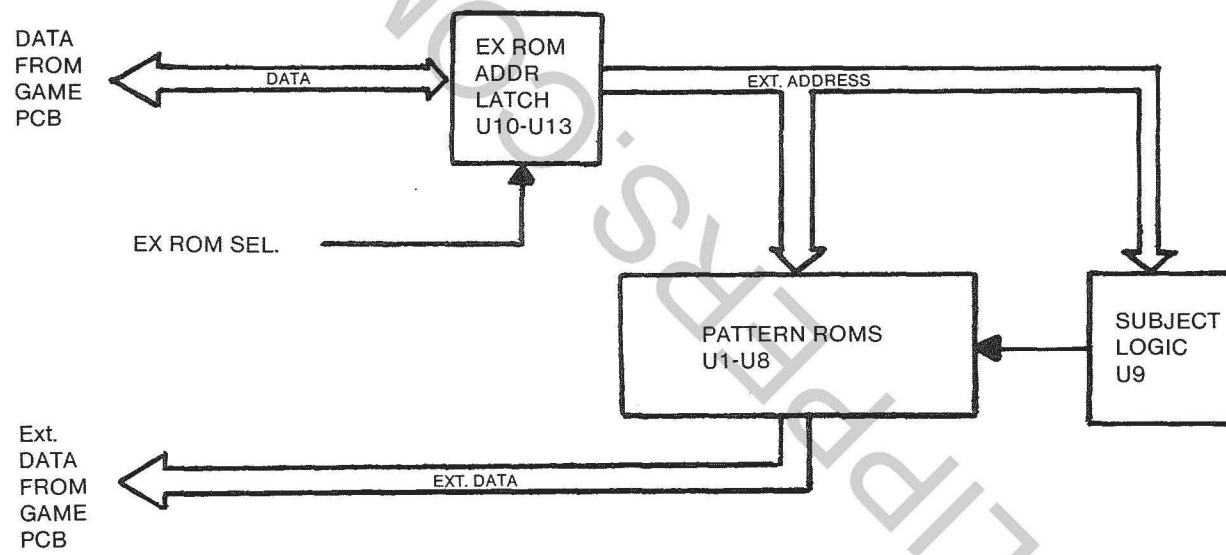
SJ SYSTEM VIDEO PCB



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

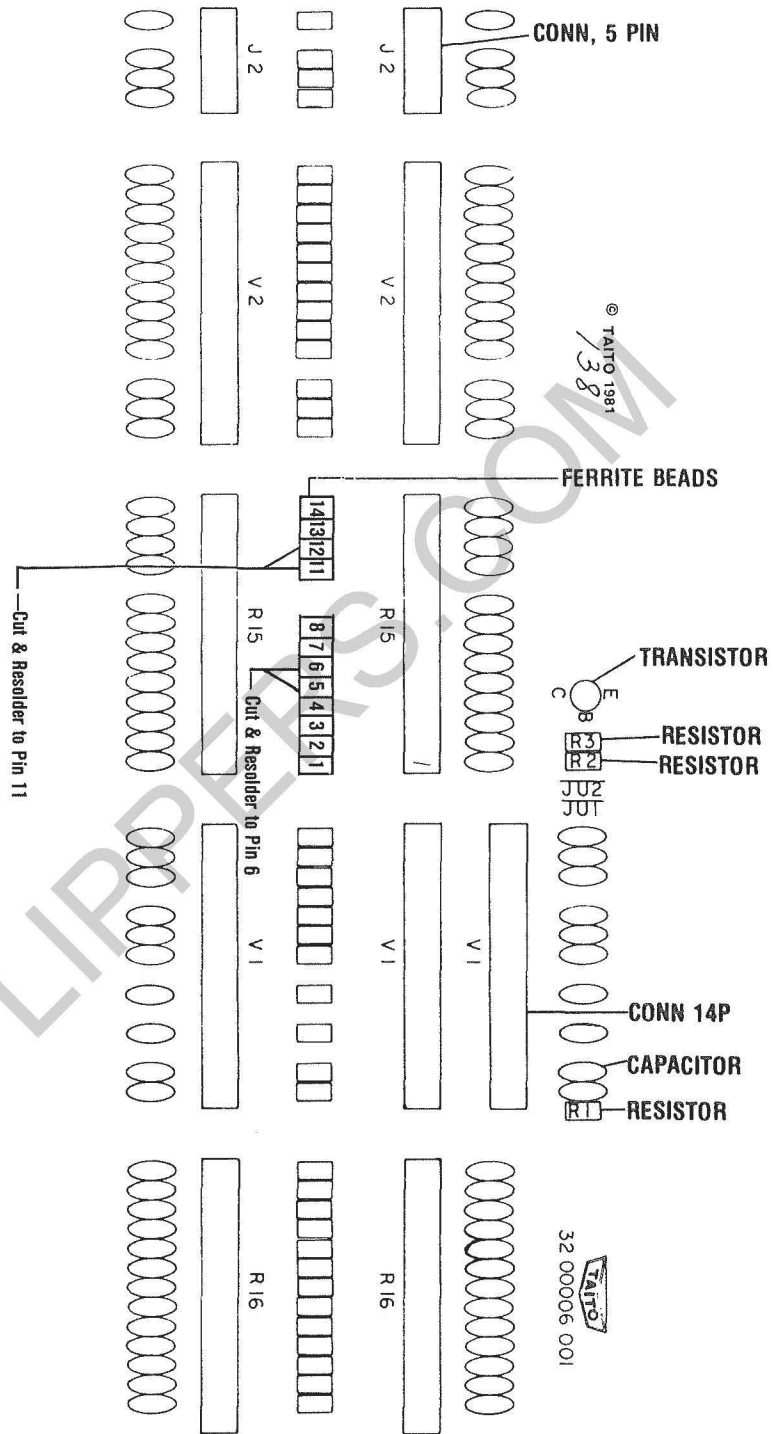
LOCATE R15 CONNECTOR ON THE FILTER BOARD. YOU WILL NOTICE THAT THERE ARE FERRITE BEADS BETWEEN THE TWO R15 JACKS ON THE BOARD. THERE IS A FERRITE BEAD (OR PLACE FOR A FERRITE BEAD) FOR EACH PIN ON THE CONNECTOR. (REFER TO FIGURE 1) PIN 1 IS ON THE RIGHT SIDE OF THE CONNECTOR.

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)

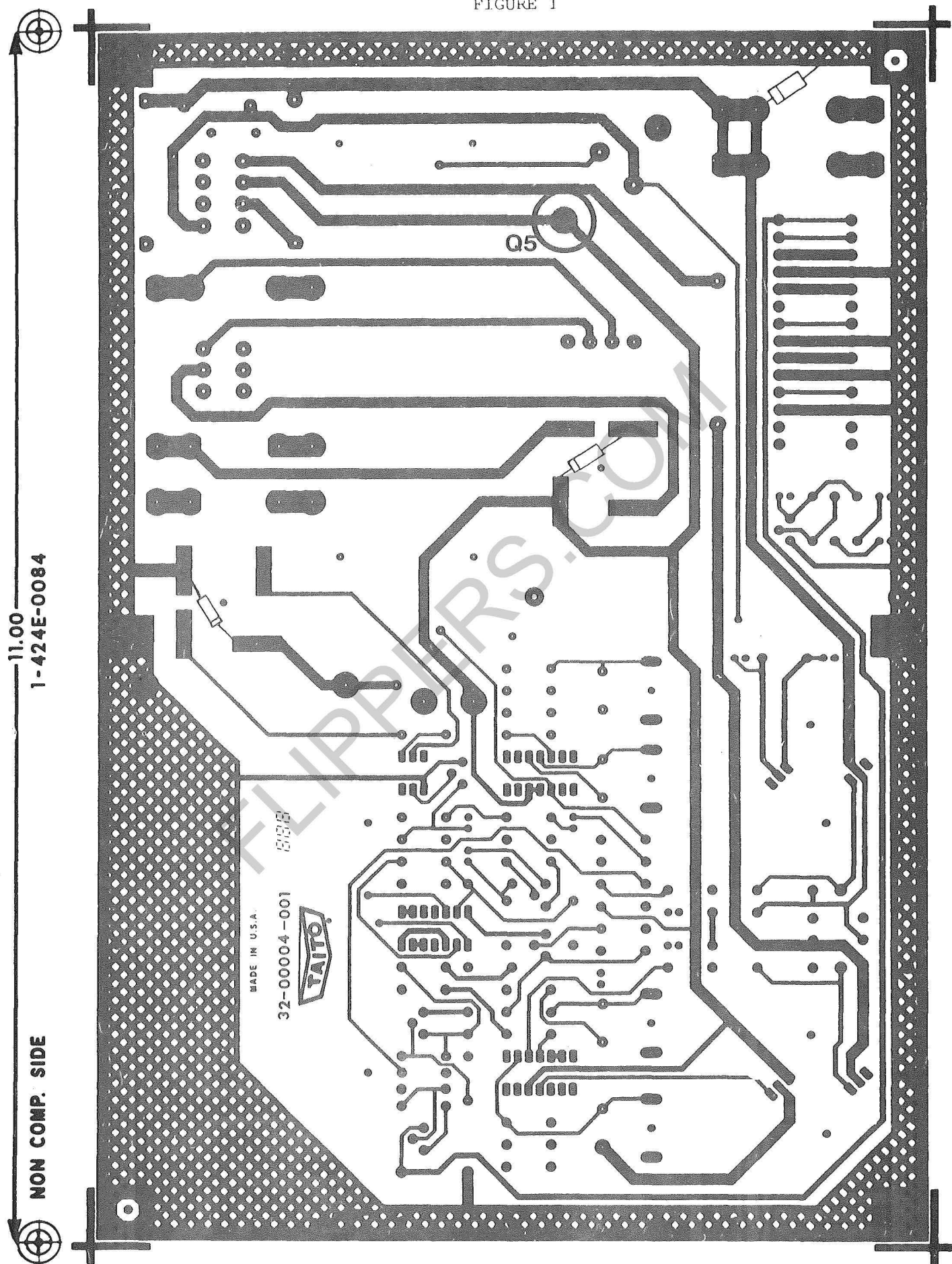
SUBJECT: POWER SUPPLY +5 VOLT PROBLEMS

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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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

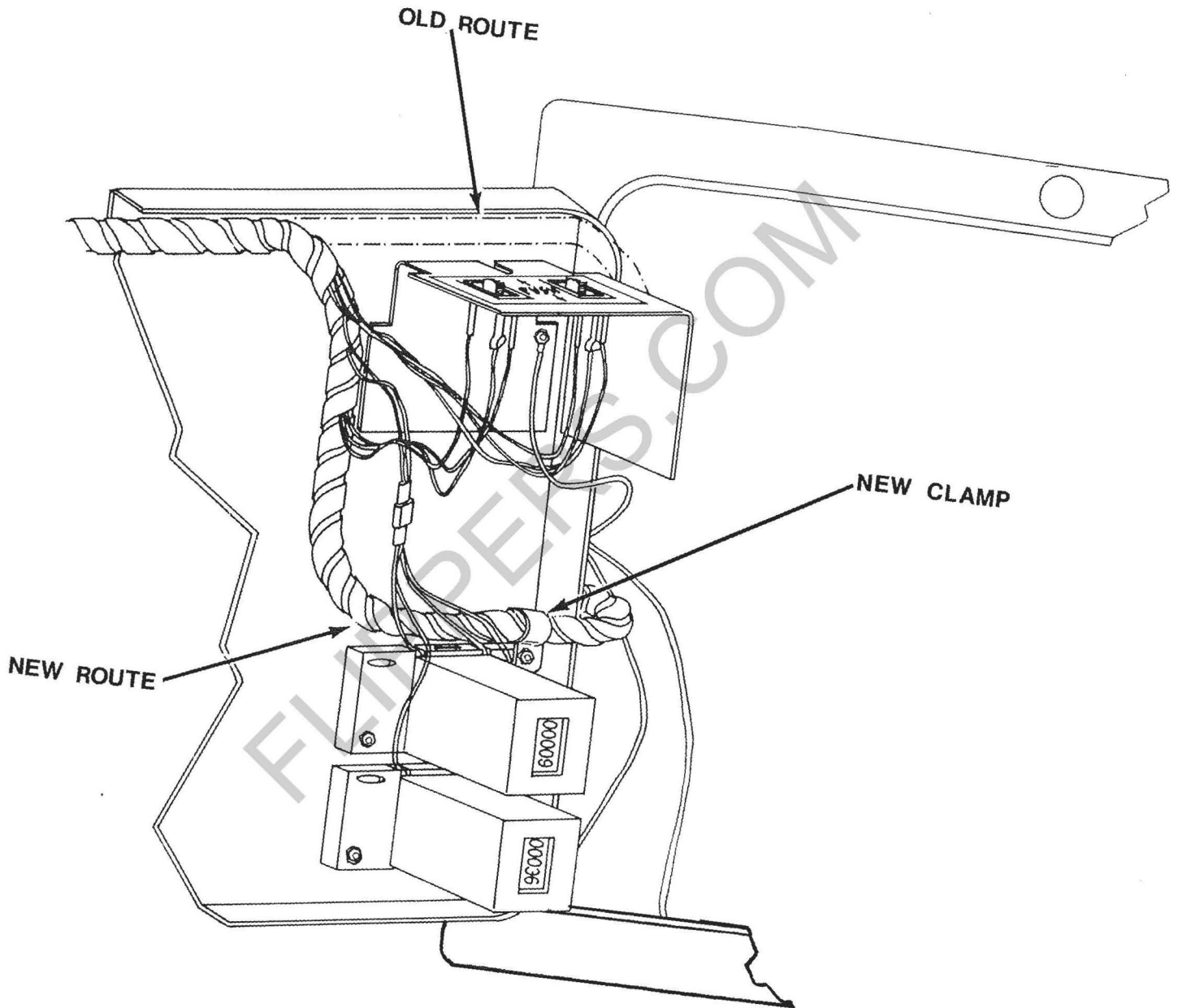
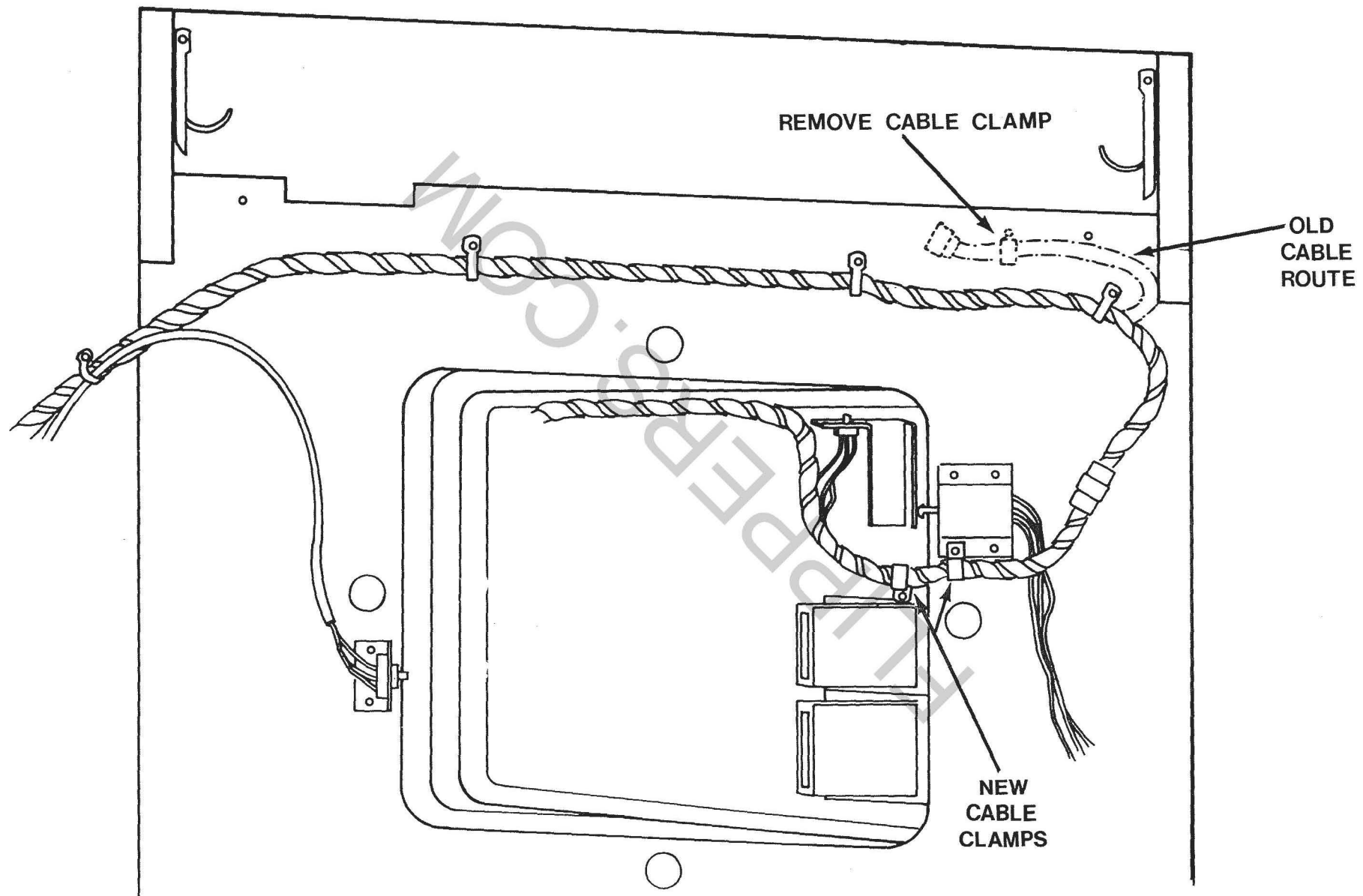


FIGURE 2



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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.

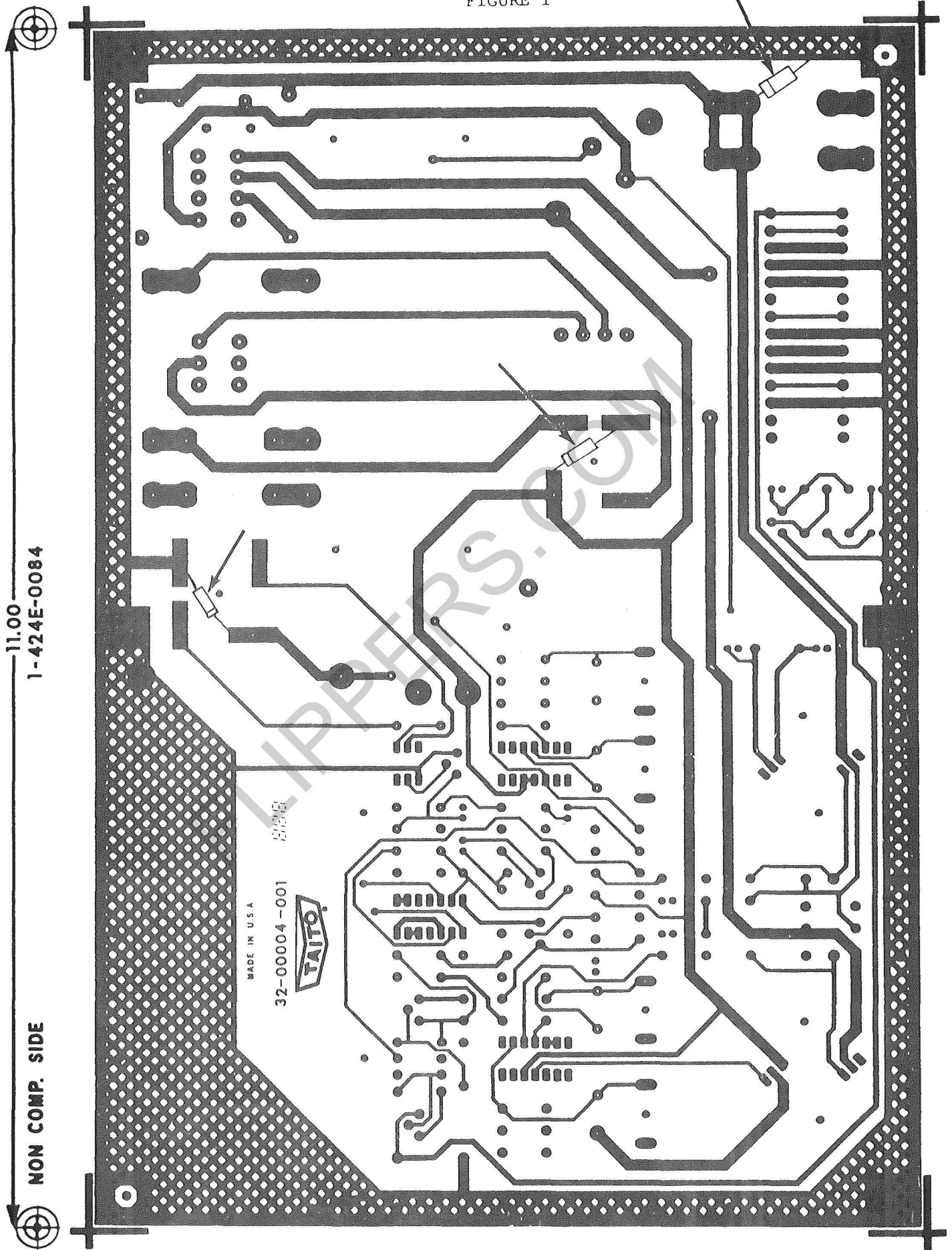
SYMPTOMS 3 & 4 :

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:

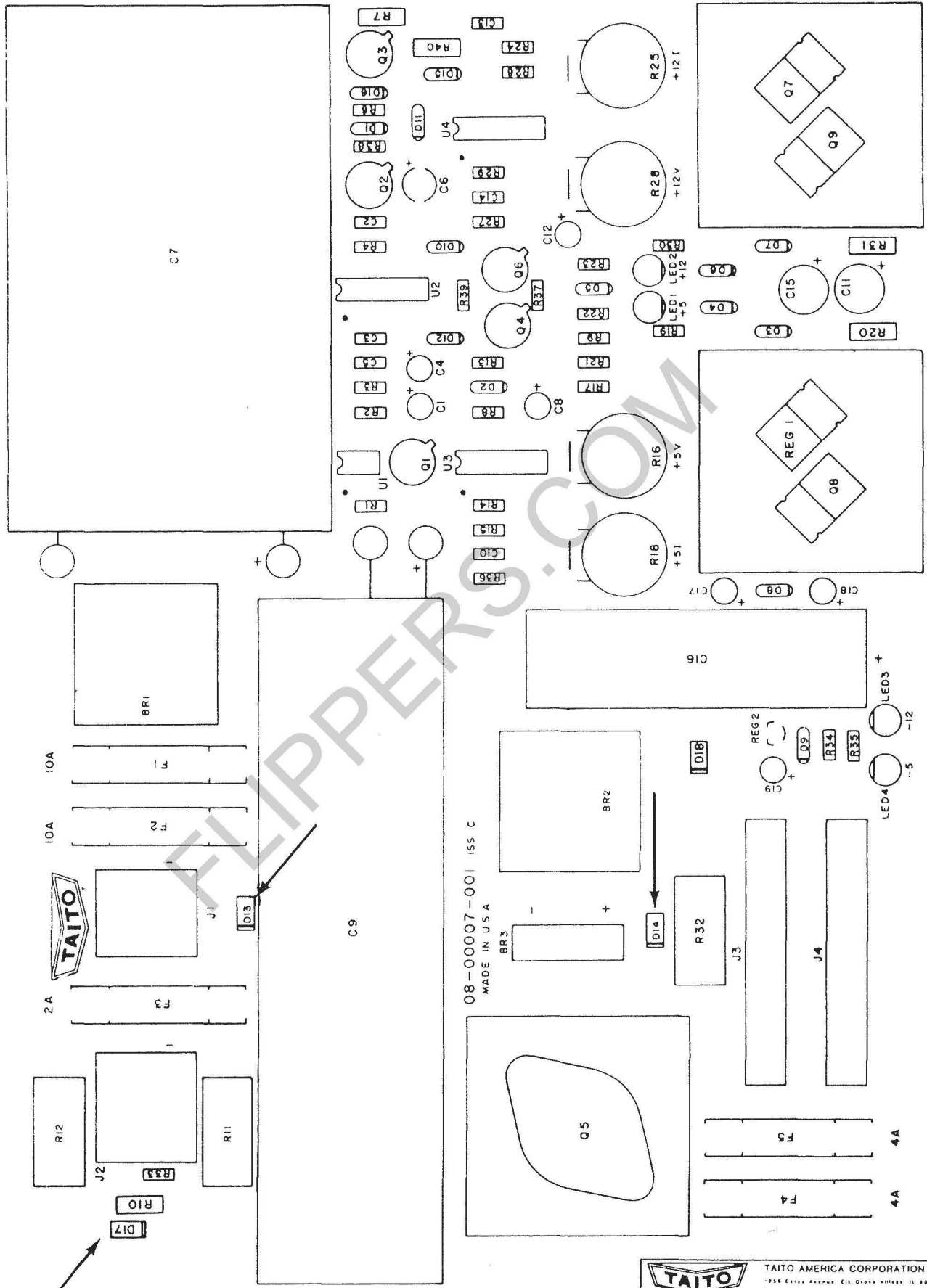
- 1) F1 IS BLOWN.
- 2) A.C. INPUT BETWEEN J1 PIN 1 & 2 IS LESS THAN 10 VOLTS AC.
- 3) BR1 IS WEAK.
- 4) THE TRANSORB FOR BR1 IS WEAK.
- 5) C8 IS SHORTED.
- 6) C7 IS SHORTED.

FIGURE 1



TRANSORB POWER SUPPLY ISS.C

FIGURE 2



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

		TAITO AMERICA CORPORATION 2556 E. 15th Avenue, Englewood, CO 80110 Telephone: (303) 687-1000 Telex: 24-3280	
ORDER INFORMATION Part No. _____ Qty. _____ Date _____	ORDER INFORMATION Order No. _____ Ship To _____ Ship Date _____	ORDER INFORMATION Sales Rep. _____ Approved By _____ Date _____	ORDER INFORMATION Order No. _____ Ship To _____ Ship Date _____
FRONT LINE™ Power Supply Board Layout			

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ATTN: SERVICE MANAGERS

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

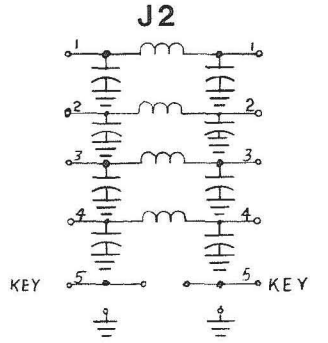
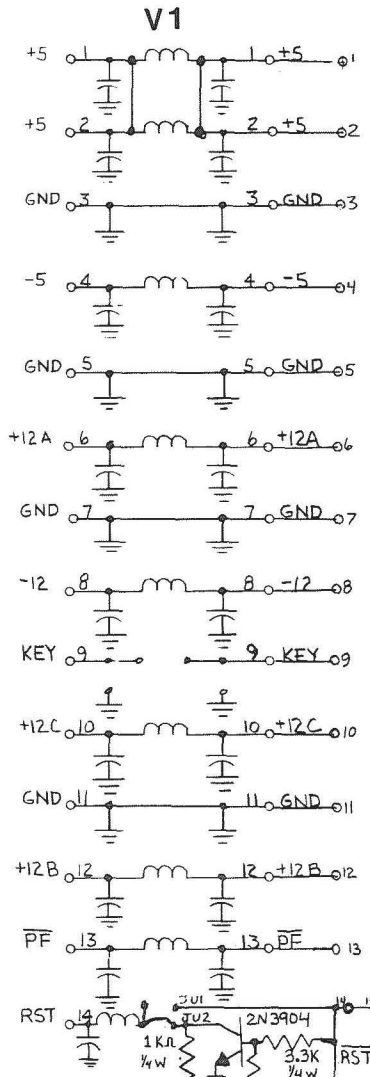
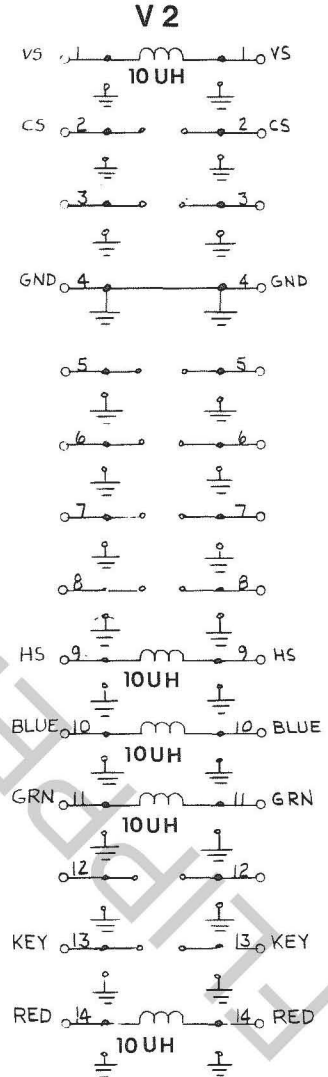
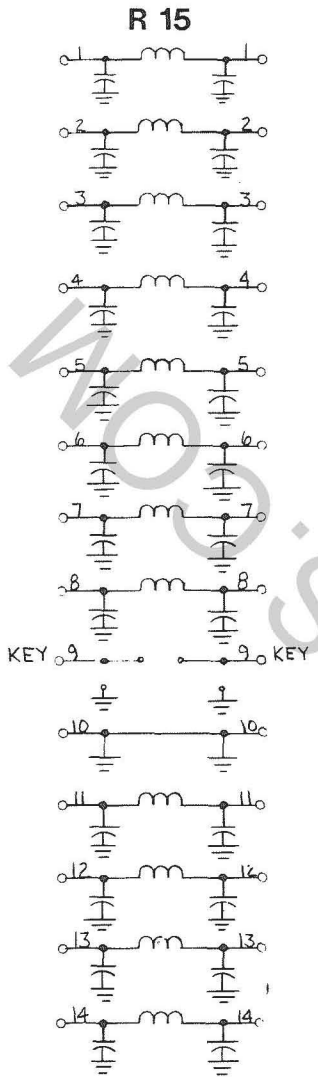
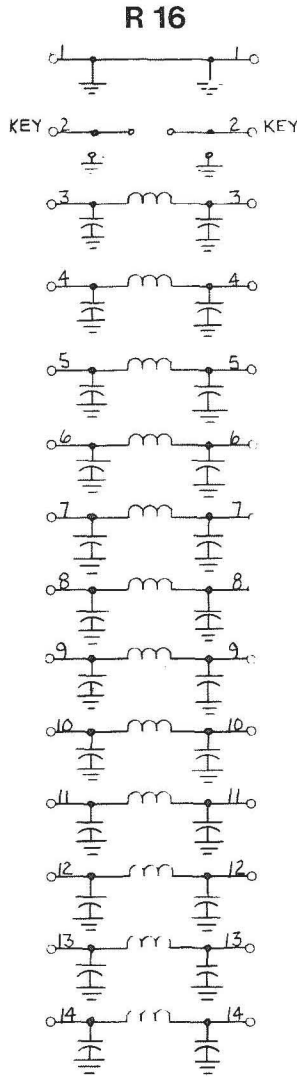
SUBJECT: FILTER BOARD SCHEMATIC

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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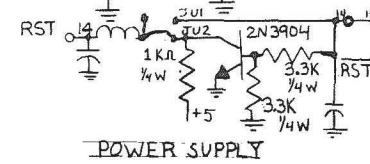
REVISIONS

ERO #91-00132
 7-29-81 J.W.A.

A) (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

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

UNLESS OTHERWISE SPECIFIED	INCHES	DRAWN BY	DATE	SCALE
DIM. TOL.	INCHES mm	JWA	7-29-81	N/A
		APPROVED BY	DATE	
		CVS	7/29/81	
DESCRIPTION				
FILTER BOARD				
DRAWING NUMBER				SHEET
ORC00017				1 of 1

SERVICE TIPS

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- MANDATORY
- ON FAILURE ONLY
- FOR YOUR INFORMATION

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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