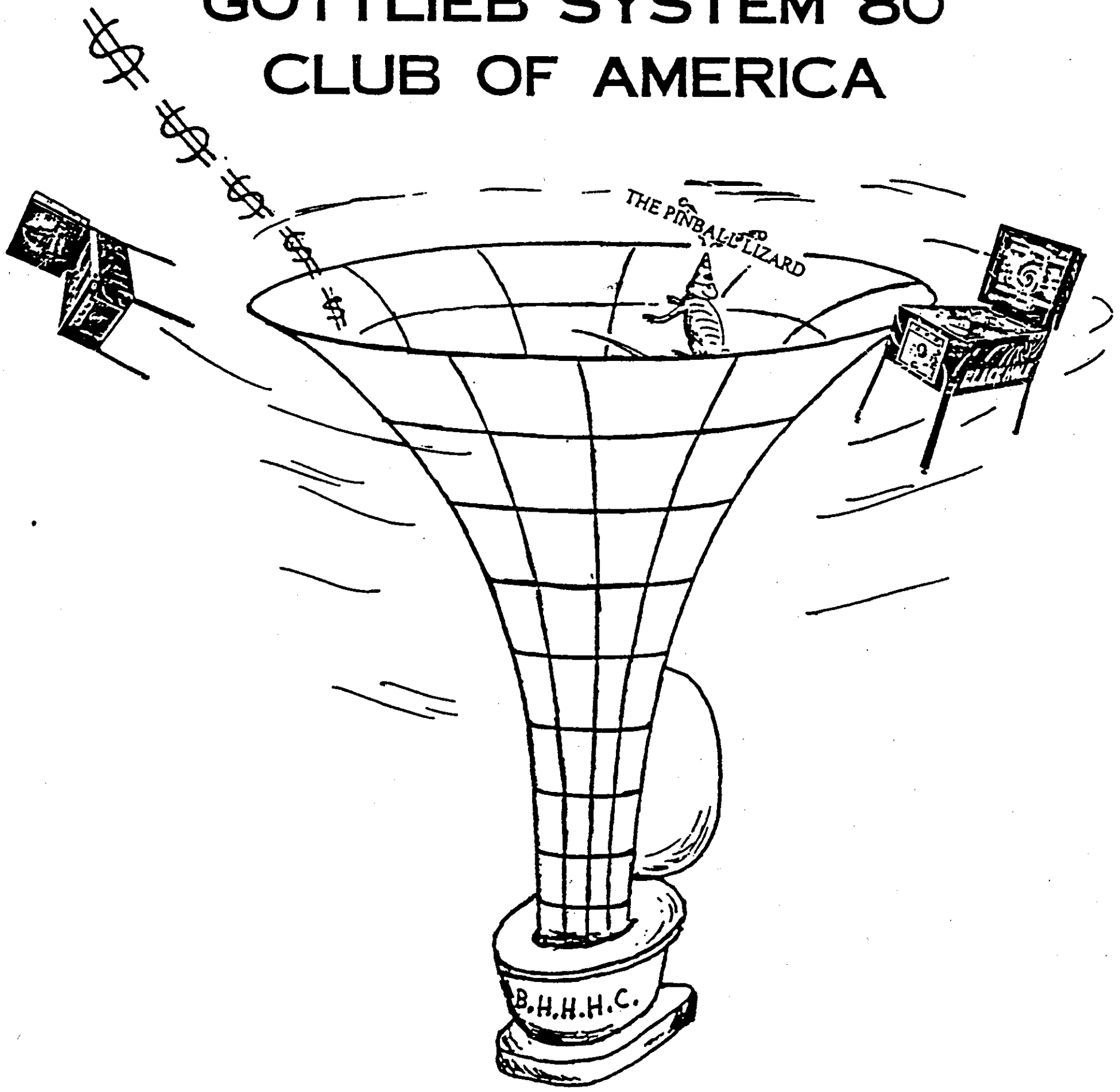
THE

B.H.H.H.C.

BLACK HOLE/HAUNTED HOUSE

* GOTTLIEB SYSTEM 80 *

CLUB OF AMERICA



THE PINBALL LIZARD

JOEL COOK & VICKIE HUISENGA

GOTTLIEB
STAR SERIES
* 80 *

653 - SPIDER-MAN

654 - CIRCUS

652 - PANTHERA

656 - COUNTER FORCE

657 - STAR RACE

658 - JAMES BOND

659 - TIME LINE

661 - FORCE II

664 - PINK PANTHER

666 - MARS, GOD OF WAR

667 - VOLCANO

668 - BLACK HOLE

669 - HAUNTED HOUSE

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WHAT WE SEE AS THE MAJOR PROBLEM AREAS WITH SYSTEM 80 GAMES

- These are very complex games (especially Black Hole and Haunted House) and were somewhat ahead of their time by a few years. There are a lot of pieces and parts in these games! Overall the design is OK, it is the execution of the design that we need to clean up and help with some improvements.

- There is no short cut to understanding these games. They have the same basics as all electronic pinball machines. You must already have some of this knowledge, and/or be willing to acquire it - we can help a little, but this information will tend to cover System 80 specific problems.

- Like most other types of electronic pinball machines, all System 80 games contain: A general power supply board for raw voltages, and solenoid and switched lamp voltages located in the bottom of the game. Lots of fuses. A regulated power supply for logic and display voltages. Circuit boards for CPU, lamp and solenoid driver, sound or sound/speech and several other support functions.

- Pop Bumper Driver Boards are unique to Gottlieb. Their first ones had a design error and must be reworked. See that particular section for details. Everybody knows this!?! But there are still a lot of un-re-worked PBD boards out there!

- CPU boards can "lock-up" just from the game sitting idling for long periods due to (perhaps) a clock phasing problem or a "glitch" (hardware OR software!). The bad result of this are burned coils, burned drive transistors, and burned driver boards from being stuck "ON" or burned out displays from not being strobed. Solutions are to install a RESET board, also called a "watch dog timer". If you are there when this happens, you can simply turn "OFF" the game, wait 5 seconds and turn it back "ON". If you AREN'T there, well.....you need a RESET board.

- Gottlieb circuit boards in these games suffered from 2 major problems: 1) some were poorly designed and need some rework to ensure reliability, and 2) ALL had manufacturing problems in the early days (generally production years 1980 through 1982, which covers all of the games in this club!). These are two separate problems with the same result - they cause the circuit board to not work correctly and thus some part or all of the game to not work.

- IDC (Insulation Displacement Connector) style connectors are used by all pinball manufacturers even to this day. You must use caution when unplugging this type of connector so that wires are not pulled from the

housing. This is the number one cause of intermittent operation in ALL brands of pinballs.

- System 80 power supplies have a design error and also suffered the manufacturing defect problem. During manufacture, the excess length of component leads were cut too deeply into the solder meniscus and the board must be disassembled and reworked. The design error can be corrected at the same time - see the power supply section for details.

- MANY articles have been written about grounding problems and burning out coils and driver transistors (and driver boards) due to ground differences, many of those in the Star Tech Journal. Which fix do you do to your board? The last published? All 3 or 10 or whatever? The answer is none! They were good about identifying a problem, but not so good about the solution. See the driver board section for details. The problem was caused by BOTH poor design AND poor execution (manufacturing) of that design.

- Like all CPU boards with batteries, Gottlieb CPUs get ruined by leaky batteries. Games with rechargeable batteries are worse because the charging current helps spread the destructive electrolyte to a much greater area on the circuit board. Absolutely, positively, no exceptions, EVERYTHING on the CPU board must be squeaky clean and shiny for the board to work correctly! Soldering heat applied directly to a battery can cause the seal to rupture or be weakened right on day one of installation of a new battery. Consider using a remote battery holder. A still better alternative is to use 3 "AA" alkaline batteries in a remote holder instead of the rechargeable Nicad.

- The same leaky batteries ruin the mating connectors directly below the battery, along the bottom edge of the CPU board. (We have seen a sound/speech board from a Haunted House that was also rotted from the material dripping all the way down to it!) The doubled sided housing to the driver board requires special crimp terminals and can usually be reworked. It must also be washed and dried to remove resident battery electrolyte. The other connectors were all custom made for Gottlieb/Premier and were very expensive. They can be replaced with standard edge card connectors with solder loop terminals, some heat shrink tubing and a lot of time and patience. (Think real hard again about the earlier battery comments!)

- Always consider the possibility that someone might have had a CPU board ruined by a battery, obtained another CPU board and simply plugged it in and tried to run the game. The connectors might be severely damaged, but from all appearances, the CPU looks fine, so you don't suspect connectors at first. Inspect your connectors for damage and fix or replace as necessary!

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- A large value capacitor (and it is also physically large) on the bottom power supply can go bad. This is another problem common to all pinball machines. Capacitors dry out from heat and hours of usage. Read the section about measuring power supply ripple and replace "leaky" (electrically leaky) capacitors.

- Another common weakness of all pinball machines is the strain on power supplies for lighting circuits, both general illumination and switched/feature lamps. Besides just the large number of lamps used, aging lamps also will increase the current required on an already well-loaded system. Aged lamps are apparent by the darkened ends or silver color on their tips. (You can also find them the hard way by touching one that has been on for several minutes! They get really HOT!) Save 40% of the lighting power consumed in your game by replacing #44 lamps with #47 lamps. Power supplies will run noticeably cooler and you will reduce the chances of overheated or burned connectors.

  Caution! The lamps that light the lower playfield on Black Hole are special 24 volt lamps! #47s (or #44s) will wink out really fast if you put them in by mistake! Some of these same lamps are also used in Haunted House - originally #313, but others types will work and may have been installed. Always replace lamps with the same voltage AND current rating, or as in the #44/#47 swap, lamps with lower current consumption.

- Double sided circuit boards are difficult to repair. These are boards with circuit traces on both sides and are typically much more complex (the reason traces are needed on both sides!) than single sided ones. Better tools, a higher level of skill, and great care are some of the techniques required to do repairs on double sided boards. If not careful, plated through holes will be damaged, leading to connection problems.

When replacing parts on double sided circuit boards, the following rules should always be followed:

Cut out the old part. ANY circuit board is far more valuable than ANY part installed on it! Don't try to save the old part to "recycle" (reuse) it!

Always use a socket to install the new part. Never solder the new part directly into the board. The circuit board is lucky to survive one rework, but will likely be further damaged if you have to desolder a device a second time. Excessive soldering heat breaks the epoxy bond between the copper trace material and the fiberglass circuit board.

Now that we will ALWAYS use a socket, DO NOT use standard sockets on double sided circuit boards! Rework involves special problems, and boards

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will usually have suffered some damage to plated through holes. Also, the general aging of the board will make soldering more difficult. If you are working on a corroded CPU board all of these problems are made even worse.

To ensure solder has flowed out UNDER the socket on the component side of the board where you cannot see, we ALWAYS use open rows of strip sockets. These are machined-pin type sockets that come in 64-pin lengths that you break to the required length. They allow touch up of the connections on all traces on the top side of the board. If the connections are not solid under a standard socket you just installed, you may find it gets even worse when the next thing you do is push the device into the socket! The insertion force will crack whatever small connection you MAY have had! Strip sockets are the only way to do repairs on double sided circuit boards!

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GOTTLIEB ELECTRONIC GAMES - CHRONOLOGICAL LIST

BHHC COVERAGE LIST

CONFIGURATION DATA

#	GAME #	SYSTEM	NAME	DATE	WB	TM	MB	D	#FLIP	#PBB	SOUND	COMMENTS
1	653	GTB-80	SPIDER-MAN	01/80	MW			6	4L	2	SND80	COMIC BOOK CHARACTER
2	654	GTB-80	CIRCUS	05/80	WB			6	3L,2S	2	SND80	CIRCUS THEME & SOUNDS
3	652	GTB-80	PANTHERA	05/80	MW			6	2L	2	SND80	
4	656	GTB-80	COUNTER FORCE	08/80	MW			6	4L	2	SND80	
5	657	GTB-80	STAR RACE	09/80	WB			6	4L	2	SND80	
6	658	GTB-80	JAMES BOND	10/80	MW			6	4L	3	SND80	ROGER MOORE & JAWS FROM "MOONRAKER"
7	659	GTB-80	TIME LINE	11/80	MW			6	4L	3	SND80	MINI PF IN LEFT CORNER W DRP TGTS
8	661	GTB-80	FORCE II	01/81	MW		2	6	4L	3	SND80	
9	664	GTB-80	PINK PANTHER	03/81	MW			6	3L	4	SND80	BASED ON MOVIES; PINK FEMALE ON BG
10	666	GTB-80	MARS, GOD OF WAR	03/81	MW		3	6	4L	4	S&S	LITE TUBE ALA XENON
11	667	GTB-80	VOLCANO	07/81	MW	TM		6	3L	4	S&S	JUMP RAMP, 2-PIECE BACKGLASS
12	668	GTB-80	BLACK HOLE	10/81	MW	TM	3	6	4L + 2L	4 + 2	S&S	2 PF'S, 1 BELOW MAIN PF, VIEW THRU WINDOW
13	669	GTB-80	HAUNTED HOUSE	01/82	MW			6	4 + 2 + 2	2 + 1 + 1	S&S	3 PF'S, DBL LEVEL ON MAIN, 1 BELOW

CODES

ORDER IS FROM 1982 GOTTLIEB CATALOG (CLEOPATRA THRU ROCKY)

MW = MEDIUM WIDE BODY

WB = WIDE BODY

TM = TALKING MACHINE

MB = MULTIBALL, # OF BALLS

D = 6 OR 7 DIGIT DISPLAYS

SOUND

SND80 = SYSTEM 80 SOUND BOARD

S&S = SOUND & SPEECH BOARD

#FLIP

L, LARGE 3" FLIPPER

S, SMALL 2" FLIPPER

#PBB = # OF POP BUMPERS

PLEASE HELP US CONFIRM OR ADD DATA TO THIS SHEET.

WE ARE LOOKING FOR INFO FOR THE MULTIBALL COLUMN.

SECTION III
PLAYBOARD PARTS

Gottlieb
AMUSEMENT GAMES

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SECTION III
PLAYBOARD PARTS

Premier Technology

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Some general suggestions for transistor substitutions are given below. A copy of Gottlieb's substitution chart is included on a separate page, but this list supersedes that list.

We have over-simplified the transistor parameters here, but these are the most important specifications. The transistors listed are proven subsitutions we have been making in our own games and repair work for our service business.

GOTTLIEB TRANSISTOR SUBSTITUTION CHART AS PER PBL

DEVICE #	TYPE	DARL ?	Ic MAX (A)	Vce MAX (V)	POWER (W)	CASE	PINOUT	APPLICATION
MPS-U45	NPN		2A	40V	10W	TO-202	EBC	LAMP DRIVER - NO SUBSTITUTE!
TIP102	NPN	DARL	8A	100V		TO-220	BCE	USE FOR GENERAL DRIVER APPL
2N3055	NPN		15A	60V	115W	TO-3	-	DRIVER BOARD, FOR SOLENOIDS
2N6057	NPN	DARL	12A	60V	150W	TO-3	-	POP BUMPER DRVR; POWER SUPPLY
TIP31C	NPN		3A	100V		TO-220	BCE	POWER SUPPLY
2N4403	PNP		600mA	40V		TO-92	EBC	POWER SUPPLY, CPU
2N4401	NPN		600mA	40V		TO-92	EBC	CPU
MPS-A13	NPN	DARL	500mA	30V		TO-92	EBC	DRIVER BOARD, FOR LAMPS
2N5875	PNP		10A	60V	150W	TO-3	-	MOUNTED ON BRACKET UNDER PF
2N5879	PNP		15A	60V	160W	TO-3	-	SPECIAL FOR HH UP-KICKER
2N5876	PNP		10A	80V	150W	TO-3	-	
2N5880	PNP		15A	80V	160W	TO-3	-	
2N5883	PNP		25A	60V	200W	TO-3	-	EXPENSIVE & HARD TO FIND
2N5884	PNP		25A	80V	200W	TO-3	-	EXPENSIVE & HARD TO FIND
2N5550	NPN		600mA	140V		TO-92	EBC	POWER SUPPLY HI VOLTS SECTION
2N5551	NPN		600mA	160V		TO-92	EBC	USE FOR 2N5550

NOTES:

NPN & PNP REFER TO THE INTERNAL TECHNOLOGY OF THE TRANSISTOR CONSTRUCTION.
VERY IMPORTANT! IT MUST BE OBSERVED WHEN SUBSTITUTING!

"DARL" STANDS FOR "DARLINGTON", A TYPE OF TRANSISTOR DESIGN.
DARLINGTON TRANSITORS HAVE VERY HIGH GAIN, WHICH GIVES THEM QUICK RESPONSE.

"XSTR" IS OUR ABBREVIATION FOR "TRANSISTOR".

POWER SPECIFICATIONS ARE NOT AS IMPORTANT AS MAKING SURE DEVICE IS PROPERLY MOUNTED - IF ON A HEAT SINK ALWAYS REPLACE THE HEAT SINK! AND ALWAYS USE HEAT SINK COMPOUND WHEN REMOUNTING POWER XSTRS!

2N5879 MAY BE USED FOR ANY 2N5875, BUT IS ABOUT 50% MORE EXPENSIVE!
NOTE OTHER POSSIBLE SUBSTITUTES LISTED FOR 2N5875 & 2N5879.

Given below is a transistor and diode substitution list. This list can be used to order either exact replacement parts or permissable substitutes.

TRANSISTOR AND DIODE SUBSTITUTION GUIDE

PART NUMBER	GOTTLIEB XO NO.	SYLVANIA SUBS. ECG	RCA SUBS. SK	GEN. ELEC. SUBS. GE	INT. RECT. SUBS. IR/WEP	MOTOROLA SUBS. HEP	RADIO SHACK SUBS. MISC.	POLARITY (TYPE)	RATED I_C (A)	RATED V_{CEO} (V)	RATED V_{CBO} (V)	RATED P_T TOTAL POWER DISSIPATION (W)	RATED h_{FE} MIN.-MAX.	
PMD 10K40	XO 315					2N6057		NPN	12	40	40	150	1K-20K	
PMD 10K60	XO 311					2N6057		NPN	12	60	60	150	1K-20K	
PMD 12K40	XO 308							NPN	8.0	40	40	100	1K-20K	
T1P 31B	XO 641	184				S5000		NPN	3	80	80	16	10-50	
T1P 31C	XO 307					S5004		NPN	3	100	100	16	10-50	
T1P 105	XO 319							PNP	8	60	60	32	1K-20K	
T1P 115	XO 312							PNP	2	60	60	20	1000-	
T1P 640	XO 322	245						NPN	10	60	60	100	1000-	
2SC 945	XO 316	199	3124	20		S0015		NPN	100M	50	60		200	
2SA 1015	XO 317							NPN	5.0	50	50		70	
MPS A13	XO 304	172		64	TR69/S9100	S9100		NPN	100M	30	30	625M	10K-	
MPS A43	XO 305					S0005		NPN	30M	200	200	625M	50-200	
MPS U45	XO 306	272						NPN	2.0	40	50	10	4K-12K	
MPS A70	XO 309	159	3114	65	TR20/717	S0019		PNP	5M	40	30	350M	40-400	
MPS 6534	XO 318	159	3114	21	TR20/717	S0019		PNP	100M	40	40	350M	90-270	
2N 2222A	XO 320			20		S3001		NPN	150M	40	75	0.5	100-300	
2N 2907A	XO 321	159	3114	67	TR20/717	S0013		PNP	150M	60	60	0.4	100-300	
2N 3055	XO 301	130	3027	14	TR59/247	S7004		NPN	15	70	100	65	20-70	
2N 3416	XO 302	123A	3124	210	TR21/735	S0015		NPN	500M	50	50	360M	75	
2N 4400	XO 313	123A	3122	20	TR21/735	S0015		NPN	600M	40	60	350M	20	
2N 5550	XO 314	194	3045		TR78/	S0005		NPN	10M	140	160	625M	60-250	
2N 5875	XO 310						2N6229	PNP	10	60	60	86	20-100	
2N 6043	XO 303	261	3180			S9102		NPN	8.0	60	60	2.2	1K-20K	

Z = ZENER
• = GERMANIUM

DIODES AND ZENERS

PART NO	XO NO.	PIV (V)	I_o (A)	(W)	TOLERANCE
1N 270	XO 265	100V	200M		•
1N 703	XO 251	3.5V	250M	0.5 W	13%
1N 3445	XO 266	8.2V	2M	1.0 W	10% Z
1N 4002	XO 253	100V	1.0		
1N 4004	XO 254	400V	1.0		
1N 4148	XO 261	75V	10M		
1N 4720	XO 260	100V	3.0		
1N 4734A	XO 255	5.6V	45M	1.0 W	5% Z
1N 4738A	XO 256	8.2V	31M	1.0 W	5% Z
1N 4742A	XO 257	12V	21M	1.0 W	5% Z

PART NO.	XO NO.	PIV (V)	I_o (A)	(W)	TOLERANCE
1N 4743A	XO 262	13V	19M	1.0 W	5% Z
1N 4746A	XO 258	18V	14M	1.0 W	5% Z
1N 4751A	XO 271	30V	8.5M	1.0 W	5% Z
1N 4753	XO 259	36V	7M	1.0 W	10% Z
1N 4759A	XO 267	62V	4M	1.0 W	5% Z
1N 5225B	XO 269	3V	20M	0.5 W	5% Z
1N 5401	XO 263	100V	3.0		

SOLENOID COILS

PART NUMBER	GENERAL USAGE *	RESISTANCE (ohms)	NUMBER OF TURNS	WIRE GAUGE	WRAPPER COLOR
A-1496	kicking rubbers pop bumpers	2.95	635	#23	Yellow
A-5194	gong	4.5	780	#24	Blue
A-5195	knocker, hole kicker	12.3	1305	#26	White
A-16570	hole kicker, outhole	15.5	1450	#27	Green
A-17875	flippers	2.8/40.0	560/1100	#24/31	Yellow
A-17891	5 bank reset	3.35	850	#22	White
A-18102	3 bank reset, 7 bank reset uses 2	9.0	1430	#24	Red
A-18318	4 bank reset	6.7	1130	#24	Orange
A-19300	ball kicker	7.8	1075	#25	Orange
A-20095	super flipper	1.55/35.5	450/900	#22/31	Red

RELAY COILS

A-16890	Q, T, and coin lockout relays	231.0	4000	#35	Orange
A-17564	gate relay	156.0	3400	#34	White
A-18642	memory/ drop targets	58.0	1590	#33	White

* Coils may vary from game to game. Check game manual for exact coil usage.

Normally, all coils are powered by +24 VDC.

GOTTLIEB COIL CHART

In the past, many operators have commented that Gottlieb does not provide enough information on its coils. Hopefully, the following coil information chart will aid all operators with quick and proper coil replacement.

Next Month:

ROTO UNITS: Theory of operation and how to make repairs and adjustments.

VIDEO SERVICE: Service tips on Gottlieb's video game, New York-New York.

ON TARGET

Gottlieb Amusement Games
165 W. Lake Street
Northlake IL 60164

SUBJECT: PBLIZ PRODUCTS FOR SYSTEM 80 GAMES

FILE: BHPRODUC.DOC 12/01/94 01:06 AM

- Gottlieb Service Manual for Solid State Pinball Machines - printed 1980
  High quality copy of early manual printed by Gottlieb when "Series 80" games were introduced. Includes theory of operation, troubleshooting problem/solution lists, schematic & block diagrams, and oscilloscope traces of CPU signals. $10.00

- Replacement Pop Bumper Driver Board by The Pinball Lizard. Exact functional replacement of original. $18.00 each or 2 for $30.00

- The Black Hole/Haunted House Club Official T-shirt. Black club logo on front, System 80 game list on the back of a gray 50/50 high quality Haynes T-shirt, sizes L, XL & XXL. $10.00

- Replacement U2 (R3273-12) & U3 (R3272-12) ROMs. $25.00 each

- Game EPROMs. Requires early D102 CPU board to be modified for 2716 EPROM installation (conversion of D102 to D107 type CPU board). All D107 CPU boards are already configured for EPROMs. $15.00 each

- Game manuals - call for information & pricing.

COMING SOON:

- Copy of Gottlieb "On-Target" technical bulletins 1980-1983 $25.00

- High quality reproduction Black Hole Instruction Manuals (with corrections!), double sided copies, original style black covers & binding $25.00

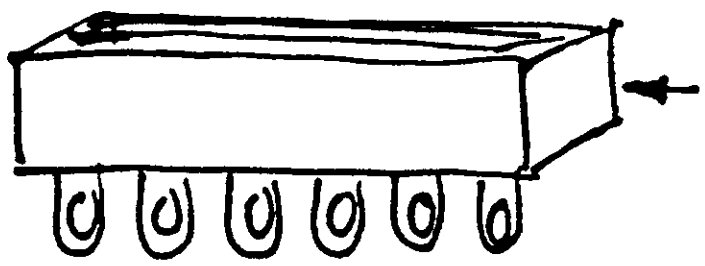
- The Black Hole/Haunted House Club Official Coffee Mug Black logo on one side, System 80 game list on the other of white ceramic mug. $10.00

- Output amplifier conversion for Sound/Speech board that originally used LM379 audio output amp. Converts to TDA2002. $TBD

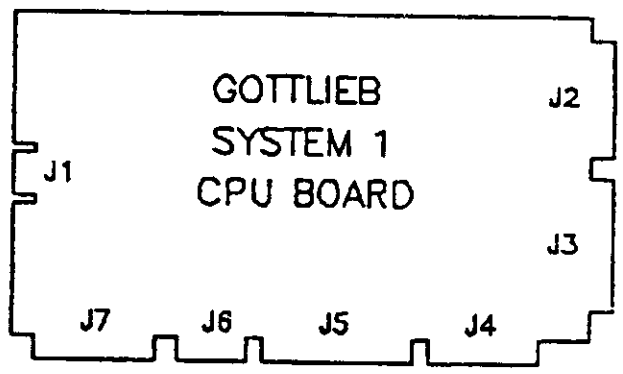
- Replacement Sound Board for first 5 System 80 games. $TBD

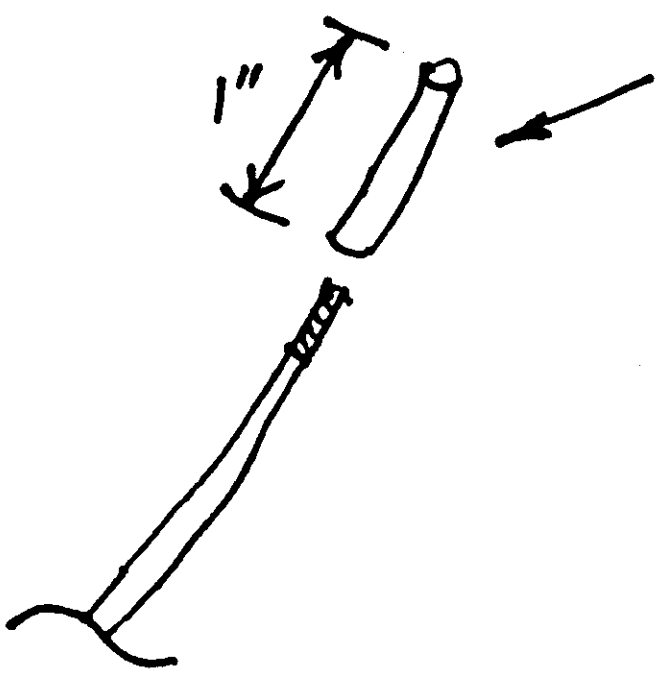
- Black Hole motor kits. Consists of 1 RPM 24VAC motor, aluminum adapter for mounting disk to motor, motor mounting plate, wiring harness and instructions. $60.00

GOTTLIEB EDGE CONNECTORS						
PRICELIST						
EDGE CONNECTOR	# PINS	BOARD FUNCTION	CONNECTOR ON BOARD IS S = SINGLE D = DOUBLE SIDED	EDAC # EQUIV	# PINS	PRICE
CPU						
GTB-1 J1	6	POWER	S	307-012-500-202	6/2	$3.05
GTB-1 J2	19	DISPLAYS	S	306-022-500-102	22	$6.45
GTB-1 J3	21	DISPLAYS	S	306-022-500-102	22	$6.45
GTB-1 J4		N/U	N/U			
GTB-1 J5	24	LAMPS & SOLENOIDS	S	307-050-500-202	25/2	$7.55
GTB-1 J6	10	SW MATRIX COIN DR	S	306-010-500-102	10	$3.60
GTB-1 J7	17	SW MATRIX PF	S	306-018-500-102	18	$5.55
CPU						
GTB-80 J1	6	POWER	S	307-012-500-202	6/2	$3.05
GTB-80 J2	48	DISPLAYS	S	307-050-500-202	25/2	$7.55
GTB-80 J3	17	DISPLAYS	S	306-018-500-102	18	$5.55
GTB-80 J4	48	LAMPS & SOLENOIDS	D	307-050-500-202	25/2	$7.55
GTB-80 J5	10	SW MATRIX COIN DR	S	306-010-500-102	10	$3.60
GTB-80 J6	19	SW MATRIX PF	S	306-022-500-102	22	$6.45
SOUND						
GTB 1 & 80	12	SOUND	S	307-024-500-202	12/2	$4.20

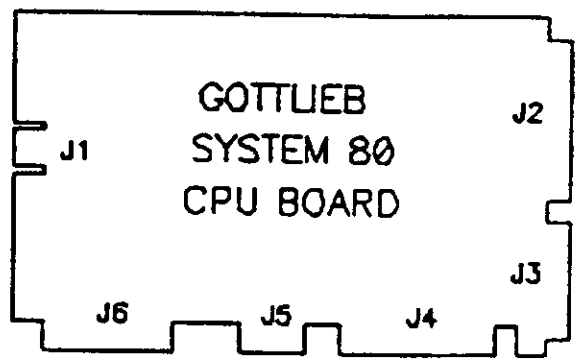


SOLDER-LOOP STYLE
EDGE CARD CONNECTOR





HEAT SHRINK TUBING
1/8" DIAMETER
$0.45/FT



- CUT OFF OLD WIRE
- STRIP WIRE 1/4"
- SLIDE 1" LONG PIECE OF HEAT SHRINK TUBING ON WIRE
- SOLDER WIRE TO LOOP
- SLIDE HEAT SHRINK OVER CONNECTION
- CHECK ALL WIRES FOR CORRECT COLOR! (DO ONE WIRE AT A TIME!)
- SHRINK TUBING WITH HEAT GUN OR HAIR DRYER

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- Replacement Pop Bumper Driver Board by The Pinball Lizard. Exact functional replacement of original. $18.00 each or 2 for $30.00

- The Black Hole/Haunted House Club Official T-shirt. Black club logo on front, System 80 game list on the back of a gray 50/50 high quality Haynes T-shirt, sizes L, XL & XXL. $10.00

- Replacement U2 (R3273-12) & U3 (R3272-12) ROMs. $25.00 each

- Game EPROMs. Requires early D102 CPU board to be modified for 2716 EPROM installation (conversion of D102 to D107 type CPU board). All D107 CPU boards are already configured for EPROMs. $15.00 each

- Game manuals - call for information & pricing.

COMING SOON:

- Copy of Gottlieb "On-Target" technical bulletins 1980-1983 $25.00

- High quality reproduction Black Hole Instruction Manuals (with corrections!), double sided copies, original style black covers & binding $25.00

- The Black Hole/Haunted House Club Official Coffee Mug Black logo on one side, System 80 game list on the other of white ceramic mug. $10.00

- Output amplifier conversion for Sound/Speech board that originally used LM379 audio output amp. Converts to TDA2002. $TBD

- Replacement Sound Board for first 5 System 80 games. $TBD

- Black Hole motor kits. Consists of 1 RPM 24VAC motor, aluminum adapter for mounting disk to motor, motor mounting plate, wiring harness and instructions. $60.00

SUBJECT: THE THUNK - WHAT YOU HEAR WHEN YOU TURN ON YOUR SYSTEM 80 GAME
FILE: BHTHUNK1.DOC
12/09/94 06:26 PM

All System 80 games make a horrible THUNK sound when the power is first turned "ON". It always is a little frightening, but this sound can also mask a serious problem with the game, such as a coil that has stuck on due to a coil failure or electronic failure somewhere in the game. A stuck coil will get very hot very quickly and will at least ruin the coil, perhaps other associated parts, and could possibly severely burn the driver board.

The THUNK sound you hear is all of the controlled solenoids being momentarily pulsed (this does NOT include the pop bumpers, which are driven directly by Pop Bumper Driver boards). We believe this design defect is universal to System 80 games and are unsure if it is a hardware or software defect or both. (We are trying to come up with a solution to solve it permanently.) A pulse actually appears on the base of the drive transistors to turn them "ON" briefly.

If you are checking out a dead game or simply turning "ON" your life's love that you have owned for may tears (Oops! a typo! should have been years), you can never be sure that every coil released and went back to normal and none stuck "ON". A BHHHC club member made a good suggestion recently on how to handle this potential problem. When turning "ON" the game, wait 1 to 2 seconds after the initial THUNK and then turn the power "OFF" and listen for a coil to "drop out". A pretty good idea for that scary first-time power-on after circuit board repair, coil replacement, or some other major work on the game.

SUBJECT: ALL SYSTEM 80 CIRCUIT BOARDS DESIGN AND MANUFACTURING ERRORS PAGE 1

FILE: BHCKTBDS.DOC
12/11/94 03:30 PM

Some people call them "haunted" boards - which has nothing to do with "Haunted House", the game! These are circuit boards that you think you have fixed, test as OK, but when you try to operate it in a game, you have yet another failure. Or maybe the game worked yesterday but not today. The following discussion contains details of what can produce a "haunted" circuit board and what needs to be done to fix the problems.

Design defects: Gottlieb did not follow basic good circuit board design practice and lay all of the power and ground traces on the circuit board first. Some boards are worse than others, but some have power and ground connections to the ICs that appear to be fit in as best as possible at the very end of the layout process. They also did not run the power output traces for the large TO-3 transistors on the Driver board directly to the edge of the board in the shortest, simplest routing. These problems were bad enough by themselves, but they were really made a problem when the poorly designed boards were frequently manufactured poorly, especially in the early years of System 80 games.

Manufacturing problems: Pads around power connections on any circuit board have an effect that causes the solder to cool too quickly and not form good connections ON THE TOP OR COMPONENT SIDE of the circuit board because of the larger surface area involved. Circuit board manufacture has improved with time and this problem can be headed off by better design and layouts, and better manufacturing techniques, but early Gottlieb System 80 boards and virtually ALL electronic pinball boards from the early years suffered this problem. Any bending of the circuit board or simply heating and cooling stresses from operation can cause whatever minimal contact to be broken, making an intermittent connection, or worse, no connection.

The poor soldering problem occurs ONLY on double-sided circuit boards, which include nearly all modern circuit boards. (Many of the circuit boards made today are multi-layer! There are from 3 to 7 layers bonded together to produce the density required for today's electronic products.) Bally avoided the double-sided problem by developing a single-sided design for all of their boards except the CPU board by using wire jumpers as a sort of component on the board. Eventually, the game manufacturers and the board suppliers in pinball as well as other industries worked out the problems to produce reliable double-sided circuit boards. Your System 80 boards generally just need detailing touch-up work to be OK.

One last comment about double sided circuit boards. To make the connections between the two sides of the circuit board, a small hole is used, called a "plated through hole" (PTH) or a "via". The actual connection is made in a chemical bath by attaching electrodes and growing copper to join both layers by deposition from the solution. Needless to say this is NOT a very strong mechanical bond! Part of circuit board specifications is that during soldering, all vias are to be filled with solder. Which leads us to the last part of this explanation, the technique of wave soldering circuit boards. (Caution! Flexing circuit boards will break via connections! Extreme flexing can even break the copper circuit traces! Whenever a socketed device is installed, the circuit board is flexed some, so be careful to lay the board on a firm, static free surface to reduce the chances of circuit board damage.)

Modern circuit boards are "stuffed" with components, then put on a conveyer belt and run over a molten fountain of solder in a wave soldering machine. Just before hitting the molten solder, the board is fluxed with hot liquid flux. While traveling along the belt, the entire board is first pre-heated to make sure the solder stays molten long enough to make connections on the TOP side of the board. All of these techniques were not that well established or at least not well executed on ALL early pinball circuit boards, including early System 80 boards.

To prevent solder from adhering to the edge card fingers on Gottlieb boards, the edge fingers were covered with a special tape before wave soldering. On many System 80 boards, the vias near the edges of the boards were not soldered, a violation of industry standards that should have been fixed during a later hand soldering touch-up process.

SUBJECT: ALL SYSTEM 80 CIRCUIT BOARDS DESIGN AND MANUFACTURING ERRORS PAGE 2

FILE: BHCKTBDS.DOC
12/11/94 03:13 PM

Another poor design and manufacturing problem of System 80 boards is seen on Driver and Pop Bumper Driver boards. A nut and screw are used to make the connection for driver transistors on these boards to the circuit trace that carries the current to the edge of the circuit board. Often these screw and nut assemblies are loose. A worse problem is that Gottlieb specified the pad under the nut to NOT be tinned. It is possible for the pad to become quite tarnished. It also sometimes is possible for the washer to not make adequate contact with the pad because of local board unevenness.

What to do to fix your System 80 circuit boards:

- Examine all IC connections on the TOP or COMPONENT side of the circuit board and resolder as needed. Look for "puckered" connections that do not make a good solder meniscus up the component lead. These are especially common at the power and ground connections at the corners of standard ICs due to the cooling effect of the larger power and ground traces associated with those pins.
- Use the same technique to resolder ANY puckered component side connection at ALL components.
- Solder all unfilled vias. Stitch them with a wire for greater strength and a more positive connection. Examine the opposite side of the board to make sure the resoldering flowed through, and clip any excess wire.
- Resolder any "belly-buttoned" or "puckered" via. Vacuum desolder and stitch with wires if you have any doubts about the quality of the connection.
- Remove the screw and nut hardware on TO-3 transistors, sand the pad clean, tin with solder, clean flux with alcohol, then reinstall the nut VERY tightly.
- Clean all edge finger pads with Scotchbrite cloth and alcohol
- Resolder all header style connectors and clean with alcohol before reinstalling the board.
- Resolder all driver transistors.
- Use only strip sockets for ALL rework since old circuit boards do not solder well. Strip sockets are rows of machine pin type sockets that can be snapped to the required length, that then allow touch up of pads on the TOP side of the circuit board after soldering the BOTTOM side. Old boards have tarnished a little, or they are a little dirty, etc. When you use a regular socket, the solder may not flow out well on the TOP side of the circuit board under the socket where you can't see. This is a major source of intermittent connections.
- Always wash off soldering flux with alcohol. It is highly reactive and can cause the circuit board to not work in some critical situations.
- All of this gets worse with any CPU board that has been corroded, since it MUST be cleaned completely down to shiny bare copper before rebuilding. Corrosion will damage the vias and any marginal connection as previously discussed.

SUBJECT: GENERAL COMMENTS REGARDING STAR TECH JOURNAL FIXES FOR SYSTEM 80 GAMES

FILE: BHSTRTEK.DOC
12/11/94 02:37 AM

In general, the items submitted to the Star Tech Journal are good for identifying problems. They are just not good about finding the right solution. However, a lot of the problem reports pertain to isolated problems caused by a single game assembly error, not to production or design errors!

We do not recommend doing any of the STJ fixes, other than original, Gottlieb/Premier generated information. (The original source is not always easy to determine.) Here are some thoughts and comments:

THINK:
If the game is OK and worked on the day it left the factory, why does it suddenly fail 6 days or 6 weeks or 6 years later? Very early failures are usually a single part failure, a so-called "infant" failure. Failures that don't show up for several months are age related, sometimes accelerated by user abuse, lack of maintenance, poor design, cheap parts, etc. ALL pinball machines suffer age related failures, but some take longer to get there. The System 80 games will work OK if they are kept in good condition and the fixes in the BHHHC are followed. Still the major cause of problems for ALL electronic pinball machines is leaky batteries!

- Do the circuit board fixes as recommended in the BHHHC notebook. These fixes will correct some design errors and remove and improve defects that occurred during manufacture of the circuit boards.

- Do NOT do the STJ recommended fixes to the Driver Board under any circumstances!

- Make sure all edge card finger contacts are clean and shiny. Clean them with alcohol and Scotchbrite sanding cloth. Clean off the sanding residue with alcohol on a cloth.

- Examine all edge card connectors for bent, burned, corroded, or broken pins. Rework or replace as required.

- Do NOT leave batteries mounted on the CPU board! (Especially if you plan on storing the game for any period of time!)

SUBJECT: PULL UP RESISTORS ADDED TO ALL PNP DRIVER TRANSISTORS LOCATED UNDER PLAYFIELD

FILE: BHPNPPU.DOC
12/10/94 01:06 AM

Black Hole and Haunted House have so many solenoids in them because of the added playfield area that Gottlieb ran out of driver transistors for driving the solenoids. To get extra drivers, they resorted to an arrangement where a lamp driver transistor on the driver board drives a power transistor mounted on a bracket on the underside of the playfield, near the solenoid to be driven. These remote mounted drive transistors are frequently overlooked by System 80 first-timers who haven't discovered all the unusual features of these games. If a solenoid doesn't work or is stuck "ON", either or both transistor could be bad.

There is also a design error associated with this transistor pair that requires a correction as shown in the diagram below. The base of each power transistor needs a 4.7k Ohm, 1/4 Watt pull up resistor to +24VDC added if not already installed. Black Hole games were modified during production, starting about #9160, so early games did NOT have these installed at the factory. Always check ANY BH or HH game and make sure they are still there and are wired correctly! The power transistor is always a PNP type transistor and is turned "ON" (operates) when the normally high base of the transistor is taken to ground by a signal pulse applied to the base by the lamp driver transistor on the driver board. To make sure these power transistors never accidentally turn "ON" by themselves, the base should be tied "HI" (to +24VDC in this situation) so that it cannot "float" or "drift", to a "LO" condition all by itself, turning the transistor "ON" when not wanted. The pull up resistor shown also makes the operation of the circuit "snappier" and the transistor will turn "OFF" more quickly.

A quick review of PNP transistors. For a TO-3 package, the package, or case, of the transistor is the Collector (C), and when viewing the bottom of the transistor, with the longer space upwards as in the diagram below, the two pins are right side, the Base (B) and the left side the Emitter (E). For a PNP transistor, when the Base is "HI", the transistor is "OFF", when the Base is "LO", the transistor is "ON". For this PNP transistor, the Emitter will be connected to the grounded Collector when the base is taken "LO" or near ground. In this application, a brief "LO" pulse on the Base makes the transistor turn "ON" briefly, causing the solenoid to "fire" briefly when it is connected to ground through the completed Emitter to Collector circuit.

The original power transistor specified is a 2N5875 PNP device in a TO-3 package rated at 60 Volts and 10 Amps. This design has horrible serviceability, since you must solder wires to a round transistor pin - these guys probably missed the old E/M games and the difficult types of soldering required on them! If a power transistor burns out, it would probably be wise to change the associated control transistor on the driver board since it has possibly been severely stressed from the same failure. Equivalent devices are listed in the transistor substitution chart, but a good choice is the 2N5879 since it has the best cost/price/performance trade off for the application. Note that it has a 15A current rating, with the same specifications for everything else as the 2N5875. It does cost more. Also of note is that Gottlieb issued bulletins that recommended the 2N5879 as the transistor to be used for the BH and HH up kickers. If you are buying spare driver transistors, it would make sense to have 2 or 3 spare 2N5879's which then should handle any remote driver transistor application in these games.

Power dissipation is NOT an issue with these transistors, but the higher current rated devices give a little more safety margin against transistor failure caused by the very large in-rush current when the solenoid is activated. The momentary theoretical current calculates out to be about 10 Amps, so a 12 or 15 Amp device can even be operated continuously without failing, which is why your coil melts-down when a transistor sticks "ON"! Note: it is possible that one of these transistors fails and sticks "ON" because too much current flowed through it, just a tiny bit too much current such that it doesn't totally ruin the internals of the transistor but only fuses the Emitter to Collector junction, making a "permanent" connection to ground, and burns up your solenoid coil. This is a common type of failure for these transistors.

(Continued on next page....)

SUBJECT: PULL UP RESISTORS ADDED TO ALL PNP DRIVER TRANSISTORS LOCATED UNDER PLAYFIELD

FILE: BHPNPPU.DOC
12/10/94 01:06 AM

Summary of the Gottlieb bulletin, with PBL additions:

BH ball lift kicker transistor should be changed from 2N5875 to 2N5879.
BH ball lift kicker is PNP Q5, located on the lower playfield and is driven by Q15 on the driver board.
Note: There are 5 PNP remote power transistors in BH, 3 in HH.
Note: It is an improvement to upgrade ALL remote driver transistors to 2N5879.
Note: The designation PNP Q5 is NOT the same as the Q5 driver transistor on the driver board.

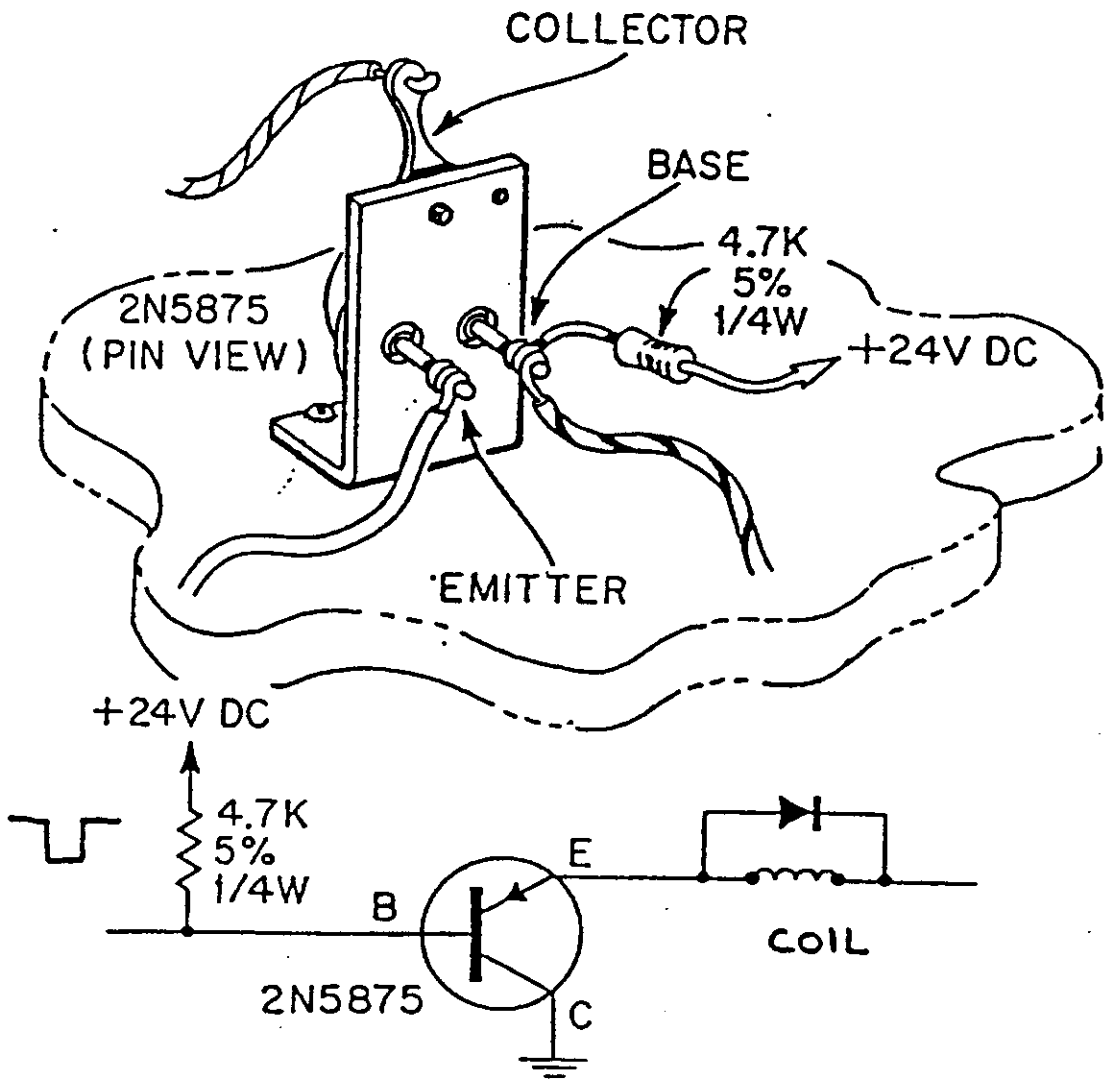
All remote PNP driver transistors must have a 4.7k Ohm pull up resistor added to their base pin. The other end of the resistor is connected to +24VDC, red-red-red wires in these games (color code 222). Some transistors may have some other value resistor installed, but ALL should be 4.7k OHM, 1/4 Watt (yellow-purple-red).

Summary of remote PNP driver transistors:

Black Hole	
PNP Q1	Hole kicker, captive hole, Upper Playfield
PNP Q2	Ball release to shooter lane, Upper PF
PNP Q3	Ball return gate to ball lift kicker, Lower PF
PNP Q4	Hole kicker, captive hole, Lower PF
PNP Q5	Ball Lift kicker to upper playfield, Lower PF
Haunted House	
PNP Q1	Right side kicker, Main PF
PNP Q2	Trap door, Main PF
PNP Q3	5-bank target reset, Cellar PF

- BH games with serial numbers less than #8926 require the transistor change at PNP Q5, 2N5875 to 2N5879.
- BH games with serial numbers less than #9160 require the resistor additions. Games with serial numbers greater than #9160 should have both modifications already done to them.
- BH games with serial numbers between #6271 and #9160 have a 10k Ohm resistor connected to the base of PNP Q5. Replace it with a 4.7k Ohm resistor when changing the transistor to the 2N5879 part.

Note: Serial numbers are stamped in the cabinet on the right inside wall just above the ball runway.



SUBJECT: WARNING REGARDING MODIFIED SOUND/SPEECH AND SOUND/SPEECH POWER SUPPLY BOARDS
FILE: BHSSWARN.DOC
12/10/94 10:24 PM

Gottlieb used a very unusual power output amplifier, the LM379, on the Sound/Speech board used in Mars and later games, including BH and HH. This part was so unique it became unavailable within 3 years or less after they first started building this S/S board. In order to save the cost of a total board redesign and new layout, they designed a small "patch board", also called a "diving board", "annex board", or "mezzanine board" to carry the more commonly available TDA2002 audio amplifier. This second, small circuit board generally fits in the same area of the main board where the original amplifier was located, but sits up above the board on a set of long connecting pins. (See additional bulletins covering these boards and applications. The Liz is making a similar but much improved version of this replacement board.)

In order for this newer audio amp to work, the accompanying Sound Power Supply needed to also be modified to provide a lower supply voltage, +18 VDC versus the original +30 VDC output. This required changing two components on the Sound Power Supply. (See GTB bulletins)

IT IS VERY IMPORTANT TO USE CAUTION WHEN SWAPPING SOUND POWER SUPPLIES AND SOUND/SPEECH BOARDS TO VERIFY FIRST IF THEY HAVE BEEN MODIFIED. THIS MUST BE DONE BEFORE APPLYING POWER!

Obviously, the problem here would occur when a modified S/S board, easily recognized with its "patch board" was connected to an unmodified Sound Power Supply. The Liz's design will allow the original power supply to be used without modification, which eliminates this hazard.

SUBJECT: 3.3UF CAPS AND EXTRA FUSES
FILE: BH33FUSE.DOC
12/11/94 01:24 AM

3.3 uF, 100VDC, non-polarized capacitors - $0.92 each, 12/$10.00

High quality block-style fuse holder, with mounting screws - $1.55 each

Slow Blow fuses - $0.40 each, 10/$3.50 (all same value)

GOTTLIEB

SWITCH ARCING MODIFICATION

Games Affected:

All pinball (flipper games) using +38 VDC for kicking rubbers and kicking targets.

"Haunted House" (669 Samples Only) – Kicking targets, kicking rubber on main playfield and the K switch contacts on lower playfield. "Haunted House" production games have capacitors already attached (Part no. X0-300, 3.3 UFD, 100V non-polarized) on kicking targets, kicking rubber, and K-switch contacts.

"Black Hole" (668) – Upper playfield kicking rubbers – See page 45 in game manual.

"Volcano" (667) – Kicking rubbers, kicking target – See page 35 in game manual.

"Pink Panther" (664) – Kicking rubbers – See page 22 in game manual.

Subject:

Eliminate switch arcing and burning which may be potentially hazardous when using +38 VDC.

Recommended Action:

Solder a capacitor in the range of 2.2 UF to 10 UF, 100 VDC (or higher) across the kicking rubber or kicking target coils using +38 VDC. Electrolytic capacitors are normally polarized and must be connected properly. Capacitors identify which is the positive (+) lead or which is the negative (−) lead. The positive lead is soldered to the coil terminal where the diode cathode connects and the positive voltage is applied. See Figure 1.

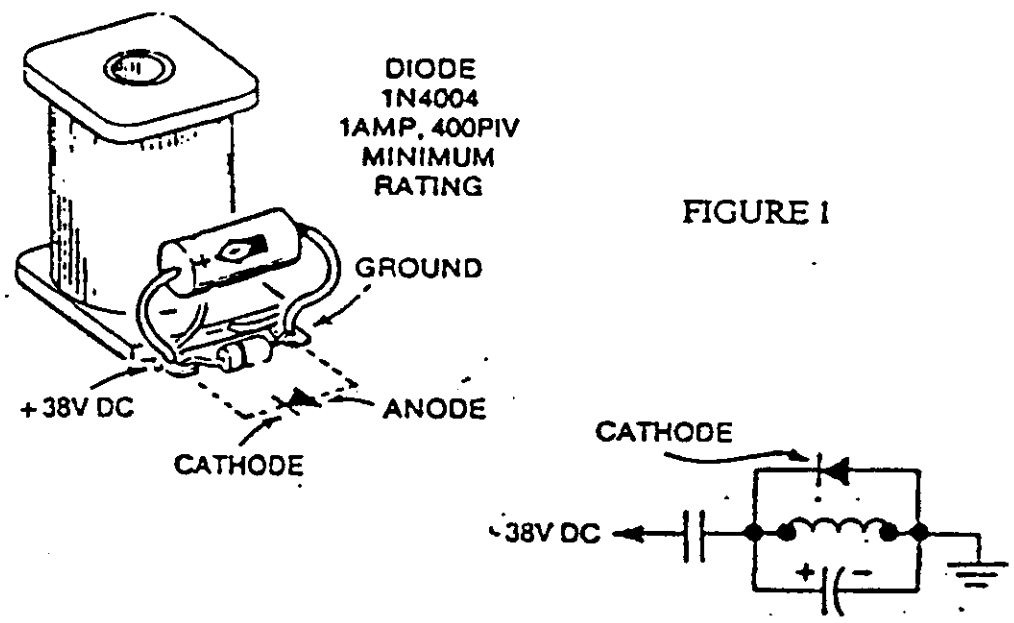
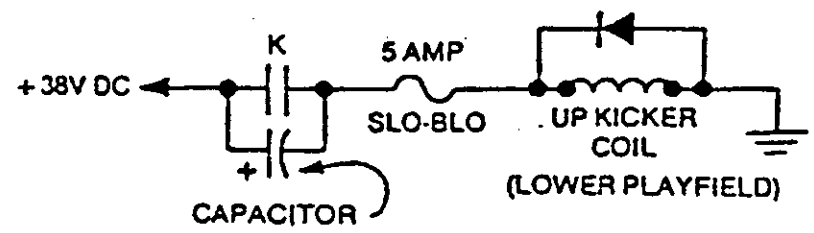


FIGURE 1

Attention:

1. On "Haunted House" samples, connect the capacitor across the K-switch contacts and not across the lower playfield up-kicker coil.



2. It is recommended to add a 5 amp slo blo fuse between the K contacts and the lower level up-kicker coil to avoid coil burn-out if the K contacts remain closed due to improper switch contact adjustment. Fuses and #350-308 fuse holders should be available at Gottlieb distributors. Production games with serial numbers higher than #05950 already have the fuse and fuse holder.
3. Please check your game(s) serial number(s) prior to acquiring any of the above mentioned parts.

SUBJECT: BURNED TRANSISTORS
FILE: BHBURNXS.DOC
12/11/94 02:01 AM

Whenever a solenoid coil has been burned from being stuck "ON" in an electronic pinball machine, the associated driver transistor has probably failed (which is the most likely cause of the burned out coil!) Electronic components often fail "domino" style. Several devices are ruined in a chain reaction as each draws too much current, subsequently damaging the next device in the circuit.

It is good practice to always replace both parts of transistor pairs whenever a coil fails. For Gottlieb System 80 games this means also replacing a MPS-U45 pre-driver transistor. If you have your driver transistors immediately burning out again after replacement, or they get incredibly hot instantly, the pre-driver needs to also be replaced:

- There are 3 sets of 2N3055/MPS-U45 driver pairs on System 80 Driver Boards. (Typically used for drop target reset)
- The extra 2N5875, 2N5876, or 2N5879 PNP driver transistors added in later System 80 games somewhere on the underside of the playfield are always driven by a MPS-U45 transistor on the Driver Board.
- Pop Bumper Driver boards are more complex. They need to be troubleshot more carefully for failed gate(s) on the PBD itself since they are NOT driven by the CPU or the Driver Board, but are simply direct acting, turning "ON" when the associated Pop Bumper switch is activated.

SUBJECT: BLACK HOLE SOLENOID TEST
FILE: BHSOLTST.DOC
11/28/94 07:26 AM

The Black Hole Manual has an error on page 13 for the results of the STEP 17-Solenoid Test. The correct solenoid assignments are as follows: (The numbers correspond to the number shown in the Credit Display located in the ball return tray during the test.)

NOTE A: **SOLENOID ASSIGNMENTS**

* 1. 4 Position Bank Reset, "HOLE" targets, Upper PF
* 2. 5 Position Bank Reset, "BLACK" targets, Upper PF
3. Left Coin Counter (Optional)
4. Right Coin Counter (Optional)
* 5. 4 Position Bank Reset, Yellow targets, Lower PF
* 6. 3 Position Bank Reset, White targets, Lower PF
7. Center Coin Counter (Optional)
* 8. Knocker
* 9. Outhole

* Solenoids marked with an asterisk are the ONLY ones that are activated during the Solenoid Test!

GOTTLIEB SYSTEM 80 DRIVER BOARD - BLACK HOLE

BY TRANSISTOR Q NUMBER

LINE #	IC-PIN#	R	TRANSISTOR	TYPE	CONNECTOR	FUNCTION	DEVICE
1	Z1-2	R1	Q1	MPS-U45	A3J3-/A	GAME OVER RELAY "Q" (BOTTOM SIDE OF UPPER PF)	RELAY
2	Z1-7	R2	Q2	MPS-U45	A3J3-/B	TILT RELAY "T" (BOTTOM SIDE OF UPPER PF)	RELAY
3	Z1-10	R3	Q3	MPS-U45	A3J5-2	COIN LOCKOUT COIL (ON COIN DOOR)	COIL
4	Z1-15	R4	Q4	MPS-U45	A3J3-/C	L3 - SHOOT AGAIN (UPPER PF)	PURPLE CIR
5	"	"	"	"	A3J2-1	L2 - SHOOT AGAIN (LIGHTBOX)	LAMP
6	Z2-2	R5	Q5	MPS-A13	A3J2-2	L4 - 3 POSITION BANK SPECIAL (LOWER PF)	RED CIRCLE
7	Z2-7	R6	Q6	MPS-A13	A3J2-3	L5 - "+ 2X" SCORING, LEFT (LOWER PF)	AMBER CIRC
8	Z2-10	R7	Q7	MPS-A13	A3J2-4	L6 - "+ 3X" SCORING, RIGHT (LOWER PF)	AMBER CIRC
9	Z2-15	R8	Q8	MPS-A13	A3J2-5	L7 - LEFT SPINNING TARGET (UPPER PF)	GREEN CIRC
10	Z3-2	R9	Q9	MPS-A13	A3J2-10	L8 - BALL RETURN GATE TO BALL LIFT KICKER, Q3, 2N5875 (LOWER PF)	XSTR
11	Z3-7	R10	Q10	MPS-A13	A3J2-9	L9 - SOUND 16 (TO SOUND BOARD)	
12	Z3-10	R11	Q11	MPS-A13	A3J2-7	L11 - HIGH GAME TO DATE (LIGHTBOX)	LAMP
13	Z3-15	R12	Q12	MPS-A13	A3J2-8	L10 - GAME OVER LIGHT (LIGHTBOX)	LAMP
14					A3J2-6	LAMP GROUND	
15	Z4-2	R13	Q13	MPS-U45	A3J3-25	L12 - HOLE KICKER, Q4, 2N5875 (LOWER PF)	XSTR
16	Z4-7	R14	Q14	MPS-U45	A3J3-24	L13 - HOLE KICKER, Q1, 2N5875 (UPPER PF)	XSTR
17	Z4-10	R15	Q15	MPS-U45	A3J3-22	L14 - BALL LIFT KICKER TO UPPER PF, Q5, 2N5879 (LOWER PF)	XSTR
18	Z4-15	R16	Q16	MPS-U45	A3J3-23	L15 - BALL RELEASE TO SHOOTER LANE, Q2, 2N5875 (UPPER PF)	XSTR
19	Z5-2	R17	Q17	MPS-U45	A3J3-13	L16 - GENERAL ILLUMINATION LIGHT RELAY "U" (UPPER PF)	RELAY
20	Z5-7	R18	Q18	MPS-U45	A3J3-14	L17 - GENERAL ILLUMINATION LIGHT RELAY "L" (LOWER PF)	RELAY
21	Z5-10	R19	Q19	MPS-U45	A3J3-16	L18 - WIREFORM BALL GATE RELAY (UPPER PF)	RELAY
22	Z5-15	R20	Q20	MPS-U45	A3J3-15	L19 - HOLE LIGHTS, ARROWS (LOWER PF)	BLUE ARRW
23					A3J3-Z	LAMP GROUND	
24	Z6-2	R21	Q21	MPS-U45	A3J3-21	L20 - LOOP LIGHTS, ARROWS (LOWER PF)	BLUE ARRW
25	Z6-7	R22	Q22	MPS-U45	A3J3-20	L21 - "B" DROP TARGET LIGHT (UPPER PF)	AMBER ARR
26	Z6-10	R23	Q23	MPS-U45	A3J3-18	L22 - "L" DROP TARGET LIGHT (UPPER PF)	AMBER ARR
27	Z6-15	R24	Q24	MPS-U45	A3J3-19	L23 - "A" DROP TARGET LIGHT (UPPER PF)	AMBER ARR
28	Z7-2	R25	Q25	MPS-U45	A3J3-9	L24 - "C" DROP TARGET LIGHT (UPPER PF)	AMBER ARR
29	Z7-7	R26	Q26	MPS-U45	A3J3-10	L25 - "K" DROP TARGET LIGHT (UPPER PF)	AMBER ARR
30	Z7-10	R27	Q27	MPS-U45	A3J3-12	L26 - "H" DROP TARGET LIGHT (UPPER PF)	AMBER ARR
31	Z7-15	R28	Q28	MPS-U45	A3J3-11	L27 - "O" DROP TARGET LIGHT (UPPER PF)	AMBER ARR
32					A3J3-17	LAMP GROUND	
33	Z8-2	R29	Q29	MPS-U45	A3J3-Y	L28 - "L" DROP TARGET LIGHT (UPPER PF)	AMBER ARR
34	Z8-7	R30	Q30	MPS-U45	A3J3-X	L29 - "E" DROP TARGET LIGHT (UPPER PF)	AMBER ARR
35	Z8-10	R31	Q31	MPS-U45	A3J3-V	L30 - 2X MULTIPLIER (UPPER PF)	WHITE CIRC
36	Z8-15	R32	Q32	MPS-U45	A3J3-W	L31 - 3X MULTIPLIER (UPPER PF)	WHITE CIRC
37	Z9-2	R33	Q33	MPS-A13	A3J3-5	L32 - 4X MULTIPLIER (UPPER PF)	WHITE CIRC
38	Z9-7	R34	Q34	MPS-A13	A3J3-6	L33 - 5X MULTIPLIER (UPPER PF)	WHITE CIRC
39	Z9-10	R35	Q35	MPS-A13	A3J3-K	L34 - TOP LANE #1, 10,000 (UPPER PF)	WHITE CIRC
40	Z9-15	R36	Q36	MPS-A13	A3J3-7	L35 - TOP LANE #2, EXTRA BALL (UPPER PF)	PURPLE CIR
41					A3J3-U	LAMP GROUND	
42					A3J3-8,J	INDEX KEY (BOARD IS SLOTTED AT THIS POSITION)	
43	Z10-2	R37	Q37	MPS-A13	A3J4-1	L36 - TOP LANE #3, SPECIAL (UPPER PF)	RED CIRCLE
44	Z10-7	R38	Q38	MPS-A13	A3J4-2	L37 - TOP HOLE #1, CAPTIVE (UPPER PF)	BLUE CIRC
45	Z10-10	R39	Q39	MPS-A13	A3J4-4	L38 - TOP HOLE #2, EXTRA BALL (UPPER PF)	PURPLE CIR
46	Z10-15	R40	Q40	MPS-A13	A3J4-3	L39 - RIGHT RETURN ROLLOVER (UPPER PF)	GREEN ARR
47					A3J4-5	LAMP GROUND	
48	Z11-2	R41	Q41	MPS-A13	A3J3-4	L40 - RIGHT SIDE ROLLOVER (UPPER PF)	GREEN CIRC
49	Z11-7	R42	Q42	MPS-A13	A3J3-3	L41 - TOP ROLLOVER #1 (UPPER PF)	RED CIRCLE
50	Z11-10	R43	Q43	MPS-A13	A3J3-T	L42 - TOP ROLLOVER #2 (UPPER PF)	RED CIRCLE
51	Z11-15	R44	Q44	MPS-A13	A3J3-2	L43 - TOP ROLLOVER #3 (UPPER PF)	RED CIRCLE
52					A3J3-S	LAMP GROUND	
53	Z12-2	R45	Q45	MPS-U45	A3J3-D	L44 - #1 DROP TARGET LIGHT (LOWER PF)	YELLOW CIR
54	Z12-7	R46	Q46	MPS-U45	A3J3-F	L45 - #2 DROP TARGET LIGHT (LOWER PF)	YELLOW CIR
55	Z12-10	R47	Q47	MPS-U45	A3J3-P	L46 - #3 DROP TARGET LIGHT (LOWER PF)	YELLOW CIR
56	Z12-15	R48	Q48	MPS-U45	A3J3-M	L47 - #4 DROP TARGET LIGHT (LOWER PF)	YELLOW CIR
57	Z12-3	R49	Q49	MPS-U45	A3J3-E	L48 - #1 SPOT TARGET LIGHT (UPPER PF)	YELLOW CIR
58	Z12-6	R50	Q50	MPS-U45	A3J3-H	L49 - #2 SPOT TARGET LIGHT (UPPER PF)	YELLOW CIR
59	Z12-11	R51	Q51	MPS-U45	A3J3-R	L50 - #3 SPOT TARGET LIGHT (UPPER PF)	YELLOW CIR
60	Z12-14	R52	Q52	MPS-U46	A3J3-N	L51 - #4 SPOT TARGET LIGHT (UPPER PF)	YELLOW CIR
61					A3J3-C	LAMP GROUND	
62					A3J3-8	+5VDC	
63					A3J3-1	GROUND	
64					A3J3-A	GROUND	
65	Z13-2				A3J5-6	SOUND 1 (TO SOUND BOARD)	
66	Z13-4				A3J5-5	SOUND 2 (TO SOUND BOARD)	
67	Z13-6				A3J5-1	SOUND 4 (TO SOUND BOARD)	
68	Z13-8				A3J5-7	SOUND 8 (TO SOUND BOARD)	
69	CR1		Q53	2N6043	A3J5-8	SOLENOID 8 - KNOCKER (RIGHT SIDE MAIN CABINET)	COIL
70					A3J5-3	SOLENOID GROUND	
71	CR2		Q54	MPS-U45	A3J6-3	SOLENOID 3 - LEFT COIN COUNTER (OPTIONAL)	
72	CR3		Q55	MPS-U45	A3J6-2	SOLENOID 4 - RIGHT COIN COUNTER (OPTIONAL)	
73	CR4		Q56	MPS-U45	A3J6-1	SOLENOID 7 - CENTER COIN COUNTER (OPTIONAL)	
74					A3J6-4	SOLENOID GROUND	
75		R53	Q57, MPS-U45	Q58, 2N3055	A3J4-13	SOLENOID 2 - 5 POSITION BANK RESET, "BLACK" (UPPER PF)	COIL
76	CR5		Q59	2N6043	A3J4-8	SOLENOID 9 - OUTHOLE (UPPER PF)	COIL
77					A3J4-9	SOLENOID GROUND	
78	CR6		Q60	2N6043	A3J4-7	SOLENOID 1 - 4 POSITION BANK RESET, "HOLE" (UPPER PF)	COIL
79		R56	Q61, MPS-U45	Q62, 2N3055	A3J4-6	SOLENOID 5 - 4 POSITION BANK RESET, YELLOW (LOWER PF)	COIL
80					A3J4-14	SOLENOID GROUND	
81		R59	Q63, MPS-U45	Q64, 2N3055	A3J4-12	SOLENOID 6 - 3 POSITION BANK RESET, WHITE (LOWER PF)	COIL
82					A3J4-11	SOLENOID GROUND	
83					A3J4-10	SOLENOID GROUND	
84					A3J4-15	GROUND	

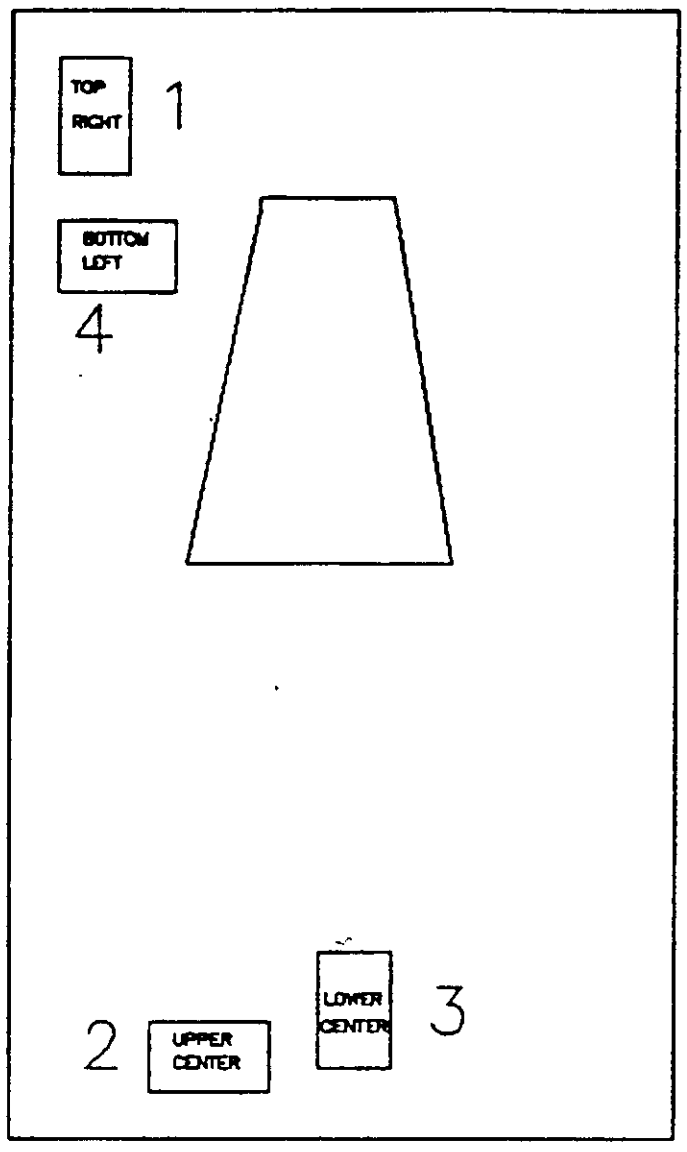
GOTTLIEB SYSTEM 80 DRIVER BOARD - BLACK HOLE

BY CONNECTOR FROM A3J2-1 TO A3J6-4

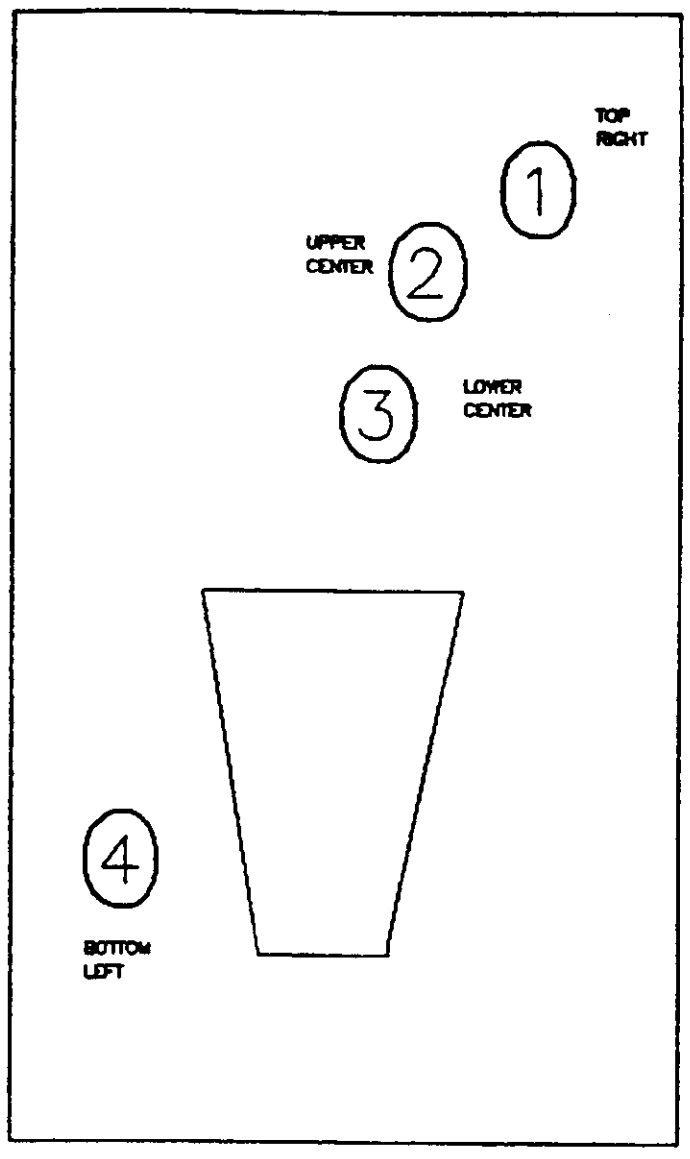
LINE #	IC-PIN#	R	TRANSISTOR	TYPE	CONNECTOR	FUNCTION	DEVICE
1	-	-	-	-	A3J2-1	L2 - SHOOT AGAIN (LIGHTBOX)	LAMP
2	Z2-2	R5	Q5	MPS-A13	A3J2-2	L4 - 3 POSITION BANK SPECIAL (LOWER PF)	RED CIRCLE
3	Z2-7	R6	Q6	MPS-A13	A3J2-3	L5 - "+2X" SCORING, LEFT (LOWER PF)	AMBER CIRC
4	Z2-10	R7	Q7	MPS-A13	A3J2-4	L6 - "+3X" SCORING, RIGHT (LOWER PF)	AMBER CIRC
5	Z2-15	R8	Q8	MPS-A13	A3J2-5	L7 - LEFT SPINNING TARGET (UPPER PF)	GREEN CIRC
6					A3J2-6	LAMP GROUND	
7	Z3-10	R11	Q11	MPS-A13	A3J2-7	L11 - HIGH GAME TO DATE (LIGHTBOX)	LAMP
8	Z3-15	R12	Q12	MPS-A13	A3J2-8	L10 - GAME OVER LIGHT (LIGHTBOX)	LAMP
9	Z3-7	R10	Q10	MPS-A13	A3J2-9	L9 - SOUND 16 (TO SOUND BOARD)	
10	Z3-2	R9	Q9	MPS-A13	A3J2-10	L8 - BALL RETURN GATE TO BALL LIFT KICKER, Q3, 2N5875 (LOWER PF)	XSTR
11							
12					A3J3-1	GROUND	
13	Z11-15	R44	Q44	MPS-A13	A3J3-2	L43 - TOP ROLLOVER #2 (UPPER PF)	RED CIRCLE
14	Z11-7	R42	Q42	MPS-A13	A3J3-3	L41 - TOP ROLLOVER #1 (UPPER PF)	RED CIRCLE
15	Z11-2	R41	Q41	MPS-A13	A3J3-4	L40 - RIGHT SIDE ROLLOVER (UPPER PF)	GREEN CIRC
16	Z9-2	R33	Q33	MPS-A13	A3J3-5	L32 - 4X MULTIPLIER (UPPER PF)	WHITE CIRC
17	Z9-7	R34	Q34	MPS-A13	A3J3-6	L33 - 5X MULTIPLIER (UPPER PF)	WHITE CIRC
18	Z9-15	R36	Q36	MPS-A13	A3J3-7	L35 - TOP LANE #2, EXTRA BALL (UPPER PF)	PURPLE CIR
19					A3J3-8	INDEX KEY (BOARD IS SLOTTED AT THIS POSITION)	
20	Z7-2	R25	Q25	MPS-U45	A3J3-9	L24 - "C" DROP TARGET LIGHT (UPPER PF)	AMBER ARR
21	Z7-7	R26	Q26	MPS-U45	A3J3-10	L25 - "K" DROP TARGET LIGHT (UPPER PF)	AMBER ARR
22	Z7-15	R28	Q28	MPS-U45	A3J3-11	L27 - "O" DROP TARGET LIGHT (UPPER PF)	AMBER ARR
23	Z7-10	R27	Q27	MPS-U45	A3J3-12	L26 - "H" DROP TARGET LIGHT (UPPER PF)	AMBER ARR
24	Z5-2	R17	Q17	MPS-U45	A3J3-13	L16 - GENERAL ILLUMINATION LIGHT RELAY "U" (UPPER PF)	RELAY
25	Z5-7	R18	Q18	MPS-U45	A3J3-14	L17 - GENERAL ILLUMINATION LIGHT RELAY "L" (LOWER PF)	RELAY
26	Z5-15	R20	Q20	MPS-U45	A3J3-15	L19 - HOLE LIGHTS, ARROWS (LOWER PF)	BLUE ARRW
27	Z5-10	R19	Q19	MPS-U45	A3J3-16	L18 - WIREFORM BALL GATE RELAY (UPPER PF)	RELAY
28					A3J3-17	LAMP GROUND	
29	Z6-10	R23	Q23	MPS-U45	A3J3-18	L22 - "L" DROP TARGET LIGHT (UPPER PF)	AMBER ARR
30	Z6-15	R24	Q24	MPS-U45	A3J3-19	L23 - "A" DROP TARGET LIGHT (UPPER PF)	AMBER ARR
31	Z6-7	R22	Q22	MPS-U45	A3J3-20	L21 - "8" DROP TARGET LIGHT (UPPER PF)	AMBER ARR
32	Z6-2	R21	Q21	MPS-U45	A3J3-21	L20 - LOOP LIGHTS, ARROWS (LOWER PF)	BLUE ARRW
33	Z4-10	R15	Q15	MPS-U45	A3J3-22	L14 - BALL LIFT KICKER TO UPPER PF, Q5, 2N5879 (LOWER PF)	XSTR
34	Z4-15	R16	Q16	MPS-U45	A3J3-23	L15 - BALL RELEASE TO SHOOTER LANE, Q2, 2N5875 (UPPER PF)	XSTR
35	Z4-7	R14	Q14	MPS-U45	A3J3-24	L13 - HOLE KICKER, Q1, 2N5875 (UPPER PF)	XSTR
36	Z4-2	R13	Q13	MPS-U45	A3J3-25	L12 - HOLE KICKER, Q4, 2N5875 (LOWER PF)	XSTR
37							
38					A3J3-A	GROUND	
39					A3J3-B	+5VDC	
40					A3J3-C	LAMP GROUND	
41	Z12-2	R45	Q45	MPS-U45	A3J3-D	L44 - #1 DROP TARGET LIGHT (LOWER PF)	YELLOW CIR
42	Z12-3	R49	Q49	MPS-U45	A3J3-E	L48 - #1 SPOT TARGET LIGHT (UPPER PF)	YELLOW CIR
43	Z12-7	R46	Q46	MPS-U45	A3J3-F	L45 - #2 DROP TARGET LIGHT (LOWER PF)	YELLOW CIR
44	Z12-6	R50	Q50	MPS-U45	A3J3-H	L49 - #2 SPOT TARGET LIGHT (UPPER PF)	YELLOW CIR
45					A3J3-J	INDEX KEY (BOARD IS SLOTTED AT THIS POSITION)	
46	Z9-10	R35	Q35	MPS-A13	A3J3-K	L34 - TOP LANE #1, 10,000 (UPPER PF)	WHITE CIRC
47					A3J3-L	(UNUSED)	
48	Z12-15	R48	Q48	MPS-U45	A3J3-M	L47 - #4 DROP TARGET LIGHT (LOWER PF)	YELLOW CIR
49	Z12-14	R52	Q52	MPS-U45	A3J3-N	L51 - #4 SPOT TARGET LIGHT (UPPER PF)	YELLOW CIR
50	Z12-10	R47	Q47	MPS-U45	A3J3-P	L46 - #3 DROP TARGET LIGHT (LOWER PF)	YELLOW CIR
51	Z12-11	R51	Q51	MPS-U45	A3J3-R	L50 - #3 SPOT TARGET LIGHT (UPPER PF)	YELLOW CIR
52					A3J3-S	LAMP GROUND	
53	Z11-10	R43	Q43	MPS-A13	A3J3-T	L42 - TOP ROLLOVER #2 (UPPER PF)	RED CIRCLE
54					A3J3-U	LAMP GROUND	
55	Z8-10	R31	Q31	MPS-U45	A3J3-V	L30 - 2X MULTIPLIER (UPPER PF)	WHITE CIRC
56	Z8-15	R32	Q32	MPS-U45	A3J3-W	L31 - 3X MULTIPLIER (UPPER PF)	WHITE CIRC
57	Z8-7	R30	Q30	MPS-U45	A3J3-X	L29 - "E" DROP TARGET LIGHT (UPPER PF)	AMBER ARR
58	Z8-2	R29	Q29	MPS-U45	A3J3-Y	L28 - "L" DROP TARGET LIGHT (UPPER PF)	AMBER ARR
59					A3J3-Z	LAMP GROUND	
60	Z1-2	R1	Q1	MPS-U45	A3J3-/A	GAME OVER RELAY "Q" (BOTTOM SIDE OF UPPER PF)	RELAY
61	Z1-7	R2	Q2	MPS-U45	A3J3-/B	TILT RELAY "T" (BOTTOM SIDE OF UPPER PF)	RELAY
62	Z1-15	R4	Q4	MPS-U45	A3J3-/C	L3 - SHOOT AGAIN (UPPER PF)	PURPLE CIR
63							
64	Z10-2	R37	Q37	MPS-A13	A3J4-1	L38 - TOP LANE #3, SPECIAL (UPPER PF)	RED CIRCLE
65	Z10-7	R38	Q38	MPS-A13	A3J4-2	L37 - TOP HOLE #1, CAPTIVE (UPPER PF)	BLUE CIRC
66	Z10-10	R39	Q39	MPS-A13	A3J4-4	L36 - TOP HOLE #2, EXTRA BALL (UPPER PF)	PURPLE CIR
67	Z10-15	R40	Q40	MPS-A13	A3J4-3	L39 - RIGHT RETURN ROLLOVER (UPPER PF)	GREEN ARR
68					A3J4-5	LAMP GROUND	
69		R56	Q61, MPS-U45	Q62, 2N3055	A3J4-6	SOLENOID 5 - 4 POSITION BANK RESET, YELLOW (LOWER PF)	COIL
70	CR6		Q60	2N6043	A3J4-7	SOLENOID 1 - 4 POSITION BANK RESET, "HOLE" (UPPER PF)	COIL
71	CR5		Q59	2N6043	A3J4-8	SOLENOID 9 - OUTHOLE (UPPER PF)	COIL
72					A3J4-9	SOLENOID GROUND	
73					A3J4-10	SOLENOID GROUND	
74					A3J4-11	SOLENOID GROUND	
75		R59	Q63, MPS-U45	Q64, 2N3055	A3J4-12	SOLENOID 6 - 3 POSITION BANK RESET, WHITE (LOWER PF)	COIL
76		R53	Q57, MPS-U45	Q58, 2N3055	A3J4-13	SOLENOID 2 - 5 POSITION BANK RESET, "BLACK" (UPPER PF)	COIL
77					A3J4-14	SOLENOID GROUND	
78					A3J4-15	GROUND	
79							
80	Z13-6				A3J5-1	SOUND 4 (TO SOUND BOARD)	
81	Z1-10	R3	Q3	MPS-U45	A3J5-2	COIN LOCKOUT COIL (ON COIN DOOR)	COIL
82					A3J5-3	SOLENOID GROUND	
83					A3J5-4	N/C	
84	Z13-4				A3J5-5	SOUND 2 (TO SOUND BOARD)	
85	Z13-2				A3J5-6	SOUND 1 (TO SOUND BOARD)	
86	Z13-8				A3J5-7	SOUND 8 (TO SOUND BOARD)	
87	CR1		Q53	2N6043	A3J5-8	SOLENOID 8 - KNOCKER (RIGHT SIDE MAIN CABINET)	COIL
88							
89	CR4		Q56	MPS-U45	A3J6-1	SOLENOID 7 - CENTER COIN COUNTER (OPTIONAL)	
90	CR3		Q55	MPS-U45	A3J6-2	SOLENOID 4 - RIGHT COIN COUNTER (OPTIONAL)	
91	CR2		Q54	MPS-U45	A3J6-3	SOLENOID 3 - LEFT COIN COUNTER (OPTIONAL)	
92							

BHPFVIEW.S01
JC – 11/26/94

BLACK HOLE
POP BUMPER DRIVER MAP



BLACK HOLE
MAIN PLAYFIELD
BOTTOM VIEW



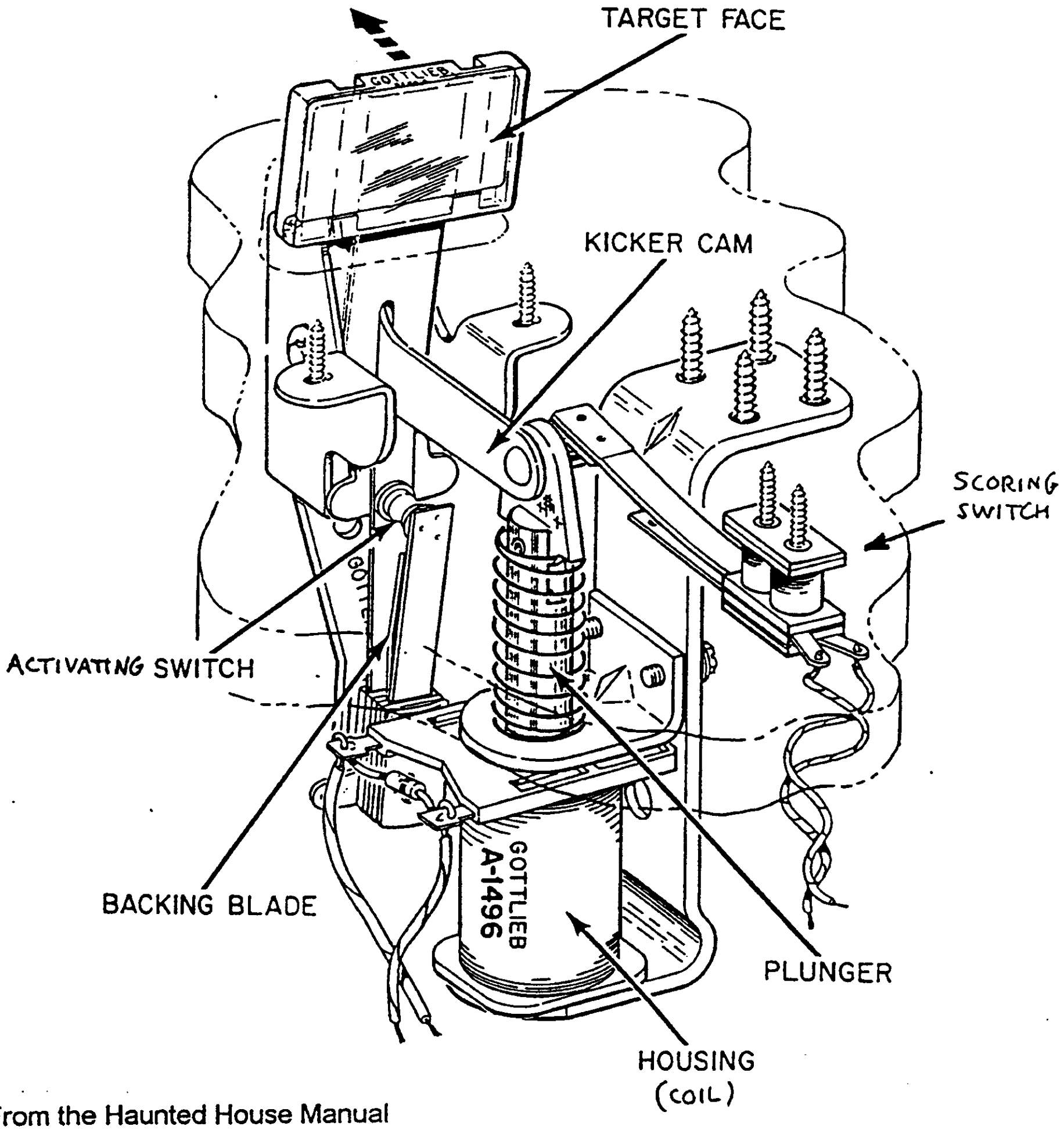
BLACK HOLE
MAIN PLAYFIELD
TOP VIEW

VI. GAME ADJUSTMENTS

E. KICKING TARGET ADJUSTMENT

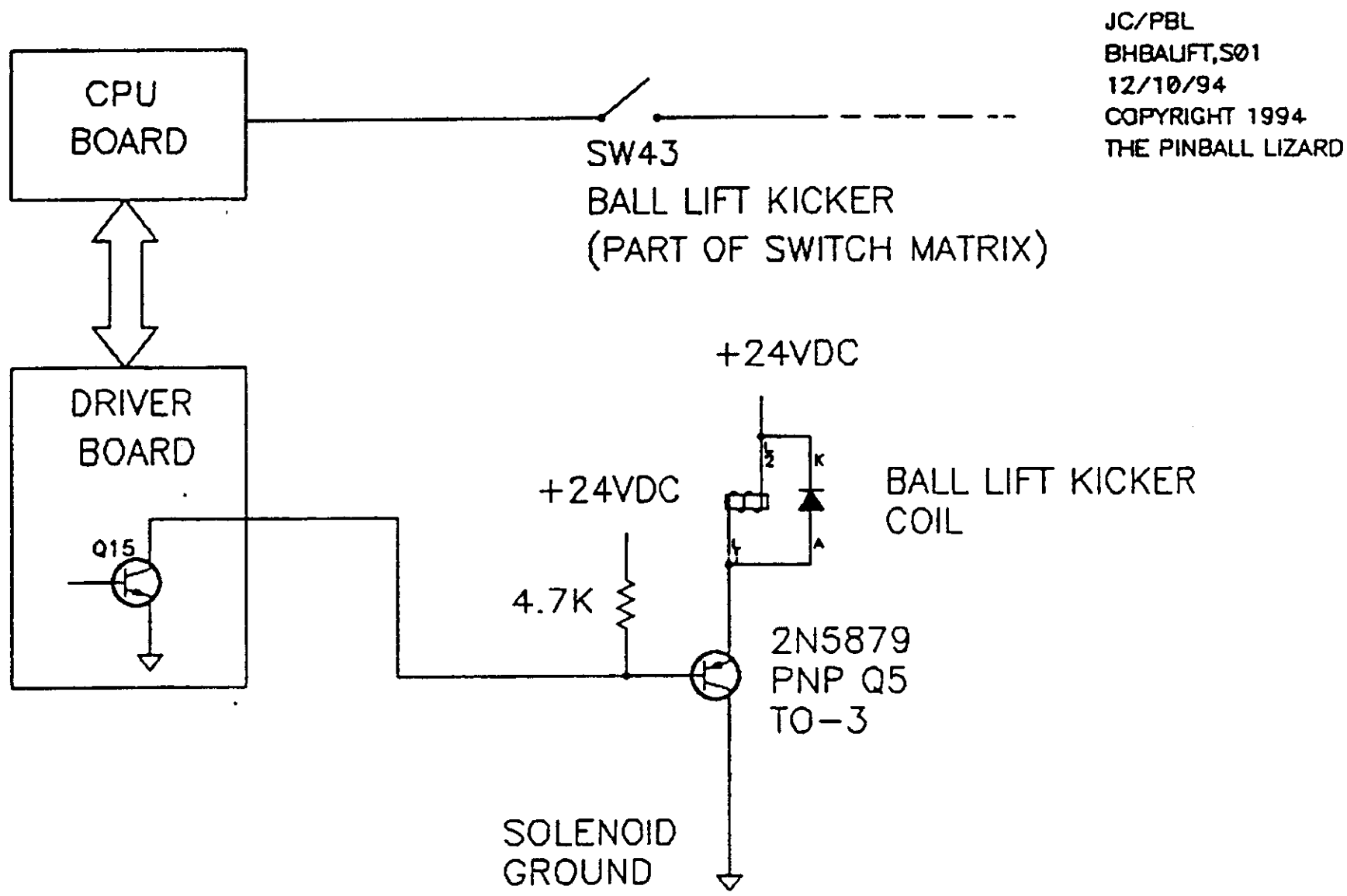
Push the PLUNGER down until it "bottoms out" in the coil HOUSING. Push the TARGET FACE in the direction of the arrow shown until it makes contact with the vertical leg of the KICKER CAM. The vertical leg of the cam is located behind the kicking target and is not shown.

Observe that the gap between the SWITCH contacts is at least 1/32nd of an inch. If not, bend the switch's BACKING BLADE in the proper direction.



From the Haunted House Manual
This target was used on the lower playfield in Black Hole (others?)

BLACK HOLE BALL LIFT KICKER ORIGINAL CIRCUIT



BLACK HOLE BALL LIFT KICKER MODIFIED TO USE POP DRIVER BOARD

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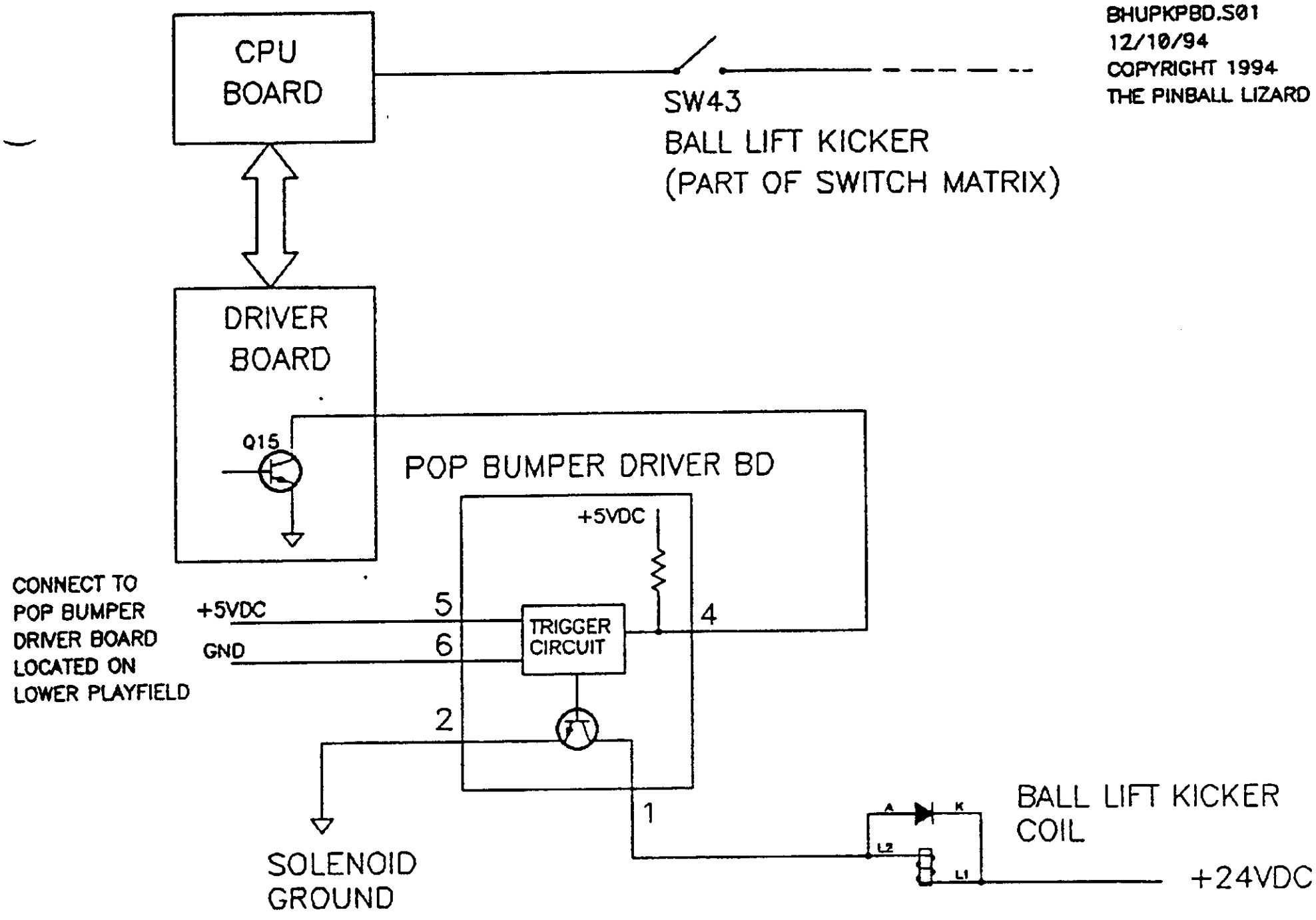
BHUPKPBD.S01
12/10/94



GOTTLIEB SYSTEM 80 DRIVER BOARD - HAUNTED HOUSE

BY TRANSISTOR Q NUMBER

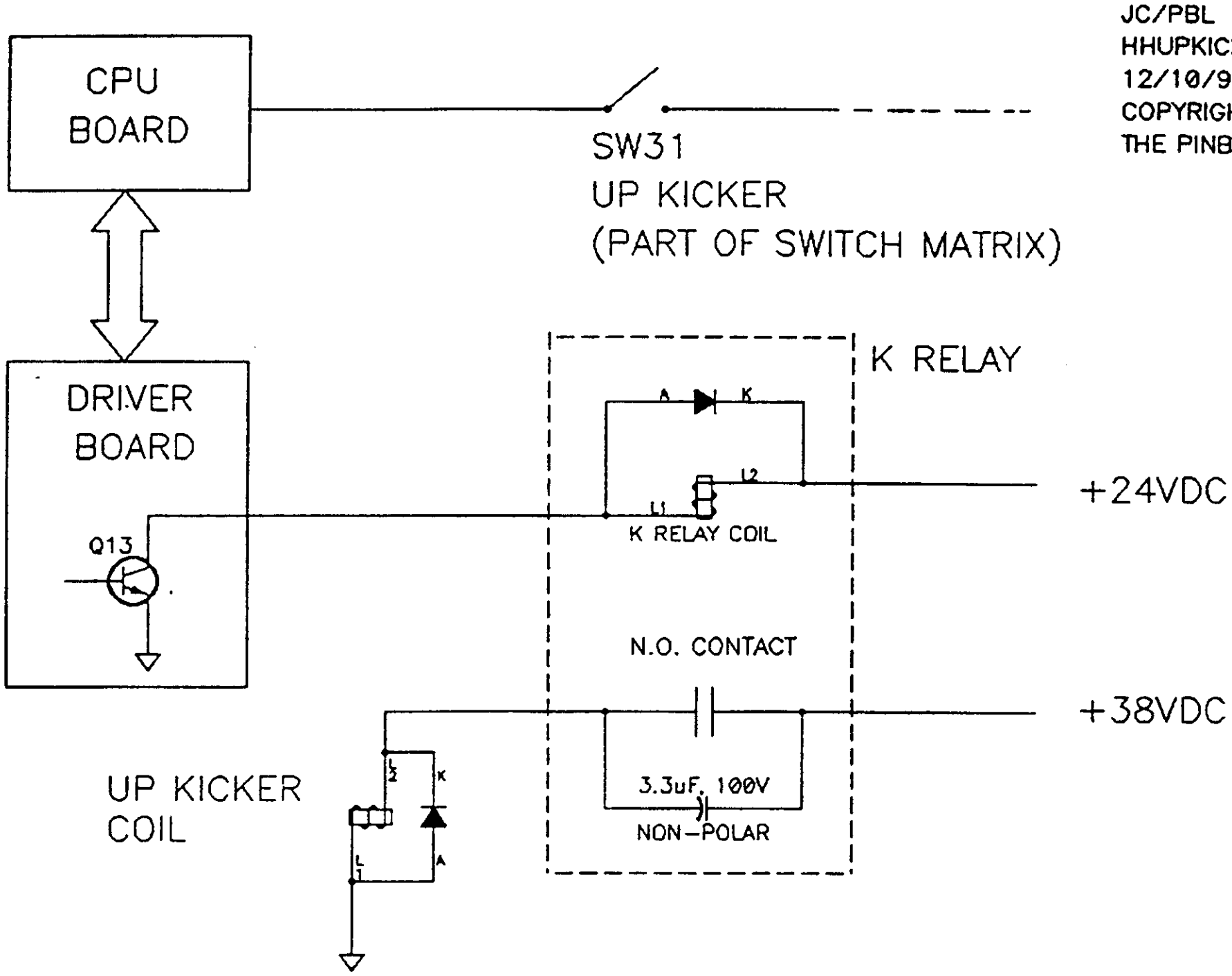
LINE #	IC-PIN#	R	TRANSISTOR	TYPE	CONNECTOR	FUNCTION	DEVICE
1	Z1-2	R1	Q1	MPS-U45	A3J3-/A	GAME OVER RELAY "Q" (BOTTOM SIDE OF MAIN PF)	RELAY
2	Z1-7	R2	Q2	MPS-U45	A3J3-/B	TILT RELAY "T" (BOTTOM SIDE OF MAIN PF)	RELAY
3	Z1-10	R3	Q3	MPS-U45	A3J5-2	COIN LOCKOUT COIL (ON COIN DOOR)	COIL
4	Z1-15	R4	Q4	MPS-U45	A3J3-/C	L3 - SHOOT AGAIN LIGHT (MAIN PF)	LAMP
5	*	*	*	*	A3J2-1	L2 - SHOOT AGAIN LIGHT (LIGHTBOX)	LAMP
6	Z2-2	R5	Q5	MPS-A13	A3J2-2	L4 -	
7	Z2-7	R6	Q6	MPS-A13	A3J2-3	L5 -	
8	Z2-10	R7	Q7	MPS-A13	A3J2-4	L6 -	
9	Z2-15	R8	Q8	MPS-A13	A3J2-5	L7 -	
10	Z3-2	R9	Q9	MPS-A13	A3J2-10	L8 - EXTRA BALL (MAIN PF)	LAMP
11	Z3-7	R10	Q10	MPS-A13	A3J2-9	L9 - SOUND 16 (TO SOUND BOARD)	
12	Z3-10	R11	Q11	MPS-A13	A3J2-7	L11 - HIGH GAME TO DATE (LIGHTBOX)	LAMP
13	Z3-15	R12	Q12	MPS-A13	A3J2-8	L10 - GAME OVER LIGHT (LIGHTBOX)	LAMP
14					A3J2-6	LAMP GROUND	
15	Z4-2	R13	Q13	MPS-U45	A3J3-25	L12 - K RELAY COIL (ACTIVATES UP KICKER) (CELLAR PF)	RELAY
16	Z4-7	R14	Q14	MPS-U45	A3J3-24	L13 - 5 BANK TARGET RESET, Q3, 2N6875 (CELLAR PF)	XSTR
17	Z4-10	R15	Q15	MPS-U45	A3J3-22	L14 -	
18	Z4-15	R16	Q16	MPS-U45	A3J3-23	L15 - RIGHT SIDE KICKER, Q1, 2N5875 (MAIN PF)	XSTR
19	Z5-2	R17	Q17	MPS-U45	A3J3-13	L16 - TRAP DOOR, Q2, 2N5875 (MAIN PF)	XSTR
20	Z5-7	R18	Q18	MPS-U45	A3J3-14	L17 - GENERAL ILLUMINATION LIGHT RELAY "U" (MAIN PF)	RELAY
21	Z5-10	R19	Q19	MPS-U45	A3J3-16	L18 - DOUBLE BONUS UPSTAIRS PF (MAIN PF)	LAMP
22	Z5-15	R20	Q20	MPS-U45	A3J3-15	L19 - DOUBLE BONUS MAIN PF (MAIN PF)	LAMP
23					A3J3-Z	LAMP GROUND	
24	Z6-2	R21	Q21	MPS-U45	A3J3-21	L20 - DOUBLE BONUS CELLAR (MAIN PF)	LAMP
25	Z6-7	R22	Q22	MPS-U45	A3J3-20	L21 - DOUBLE SCORING (UPSTAIRS PF)	LAMP
26	Z6-10	R23	Q23	MPS-U45	A3J3-18	L22 -	
27	Z6-15	R24	Q24	MPS-U45	A3J3-19	L23 - DOUBLE SCORING (CELLAR PF)	LAMP
28	Z7-2	R25	Q25	MPS-U45	A3J3-9	L24 - #1 SEQUENCE (CELLAR PF)	LAMP
29	Z7-7	R26	Q26	MPS-U45	A3J3-10	L25 - #2 SEQUENCE & LEFT TARGET (CELLAR PF)	LAMP
30	Z7-10	R27	Q27	MPS-U45	A3J3-12	L26 - #3 SEQUENCE & RIGHT TARGET (CELLAR PF)	LAMP
31	Z7-15	R28	Q28	MPS-U45	A3J3-11	L27 - TOP LEFT HOLE (MAIN PF)	LAMP
32					A3J3-17	LAMP GROUND	
33	Z8-2	R29	Q29	MPS-U45	A3J3-Y	L28 - TOP CENTER HOLE (MAIN PF)	LAMP
34	Z8-7	R30	Q30	MPS-U45	A3J3-X	L29 - TOP RIGHT HOLE (MAIN PF)	LAMP
35	Z8-10	R31	Q31	MPS-U45	A3J3-V	L30 - #1 KICKING TARGET (MAIN PF)	LAMP
36	Z8-15	R32	Q32	MPS-U45	A3J3-W	L31 - #2 KICKING TARGET (MAIN PF)	LAMP
37	Z9-2	R33	Q33	MPS-A13	A3J3-5	L32 - #3 TARGET (MAIN PF)	LAMP
38	Z9-7	R34	Q34	MPS-A13	A3J3-6	L33 - #4 TARGET (MAIN PF)	LAMP
39	Z9-10	R35	Q35	MPS-A13	A3J3-K	L34 - #5 TOP KICKING TARGET (MAIN PF)	LAMP
40	Z9-15	R36	Q36	MPS-A13	A3J3-7	L35 - 1X (MAIN PF)	LAMP
41					A3J3-U	LAMP GROUND	
42					A3J3-8,J	INDEX KEY (BOARD IS SLOTTED AT THIS POSITION)	
43	Z10-2	R37	Q37	MPS-A13	A3J4-1	L36 - 2X (MAIN PF)	LAMP
44	Z10-7	R38	Q38	MPS-A13	A3J4-2	L37 - 3X (MAIN PF)	LAMP
45	Z10-10	R39	Q39	MPS-A13	A3J4-4	L38 - 4X (MAIN PF)	LAMP
46	Z10-15	R40	Q40	MPS-A13	A3J4-3	L39 - 5X (MAIN PF)	LAMP
47					A3J4-5	LAMP GROUND	
48	Z11-2	R41	Q41	MPS-A13	A3J3-4	L40 - #2 TARGET (UPSTAIRS PF)	LAMP
49	Z11-7	R42	Q42	MPS-A13	A3J3-3	L41 - #3 TARGET (UPSTAIRS PF)	LAMP
50	Z11-10	R43	Q43	MPS-A13	A3J3-T	L42 - #4 TARGET (UPSTAIRS PF)	LAMP
51	Z11-15	R44	Q44	MPS-A13	A3J3-2	L43 -	
52					A3J3-S	LAMP GROUND	
53	Z12-2	R45	Q45	MPS-U45	A3J3-D	L44 - SPECIAL (UPSTAIRS PF)	LAMP
54	Z12-7	R46	Q46	MPS-U45	A3J3-F	L45 - SPECIAL (CELLAR PF)	LAMP
55	Z12-10	R47	Q47	MPS-U45	A3J3-P	L46 - LEFT OUTSIDE ROLLOVER (MAIN PF)	LAMP
56	Z12-15	R48	Q48	MPS-U45	A3J3-M	L47 - ROUNDABOUT (MAIN PF)	LAMP
57	Z12-3	R49	Q49	MPS-U45	A3J3-E	L48 - #1 SPOT TARGET LIGHT (UPPER PF)	LAMP
58	Z12-6	R50	Q50	MPS-U45	A3J3-H	L49 - #2 SPOT TARGET LIGHT (UPPER PF)	LAMP
59	Z12-11	R51	Q51	MPS-U45	A3J3-R	L50 - #3 SPOT TARGET LIGHT (UPPER PF)	LAMP
60	Z12-14	R52	Q52	MPS-U45	A3J3-N	L51 - ROLL DOWN TARGET (MAIN PF)	LAMP
61					A3J3-C	LAMP GROUND	
62					A3J3-B	+5VDC	
63					A3J3-1	GROUND	
64					A3J3-A	GROUND	
65	Z13-2				A3J6-6	SOUND 1 (TO SOUND BOARD)	
66	Z13-4				A3J6-5	SOUND 2 (TO SOUND BOARD)	
67	Z13-6				A3J6-1	SOUND 4 (TO SOUND BOARD)	
68	Z13-8				A3J6-7	SOUND 8 (TO SOUND BOARD)	
69	CR1		Q53	2N6043	A3J6-8	SOLENOID 8 - KNOCKER (RIGHT SIDE MAIN CABINET)	COIL
70					A3J6-3	SOLENOID GROUND	
71	CR2		Q54	MPS-U45	A3J6-3	SOLENOID 3 - LEFT COIN COUNTER (OPTIONAL)	
72	CR3		Q55	MPS-U45	A3J6-2	SOLENOID 4 - RIGHT COIN COUNTER (OPTIONAL)	
73	CR4		Q56	MPS-U45	A3J6-1	SOLENOID 7 - CENTER COIN COUNTER (OPTIONAL)	
74					A3J6-4	SOLENOID GROUND	
75		R53	Q57, MPS-U45	Q58, 2N3055	A3J4-13	SOLENOID 2 - UP KICKER (CELLAR PF TO MAIN PF) (CELLAR PF)	COIL
76	CR5		Q59	2N6043	A3J4-8	SOLENOID 9 - OUTHOLE (MAIN PF)	COIL
77					A3J4-9	SOLENOID GROUND	
78	CR6		Q60	2N6043	A3J4-7	SOLENOID 1 - TOP HOLE (MAIN PF)	COIL
79		R56	Q61, MPS-U45	Q62, 2N3055	A3J4-6	SOLENOID 5 - 4 BANK TARGET RESET (UPSTAIRS PF)	COIL
80					A3J4-14	SOLENOID GROUND	
81		R59	Q63, MPS-U45	Q64, 2N3055	A3J4-12	SOLENOID 6 - HOLE (CELLAR PF)	COIL
82					A3J4-11	SOLENOID GROUND	
83					A3J4-10	SOLENOID GROUND	
84					A3J4-15	GROUND	

GOTTLIEB SYSTEM 80 DRIVER BOARD - HAUNTED HOUSE

BY CONNECTOR FROM A3J2-1 TO A3J6-4

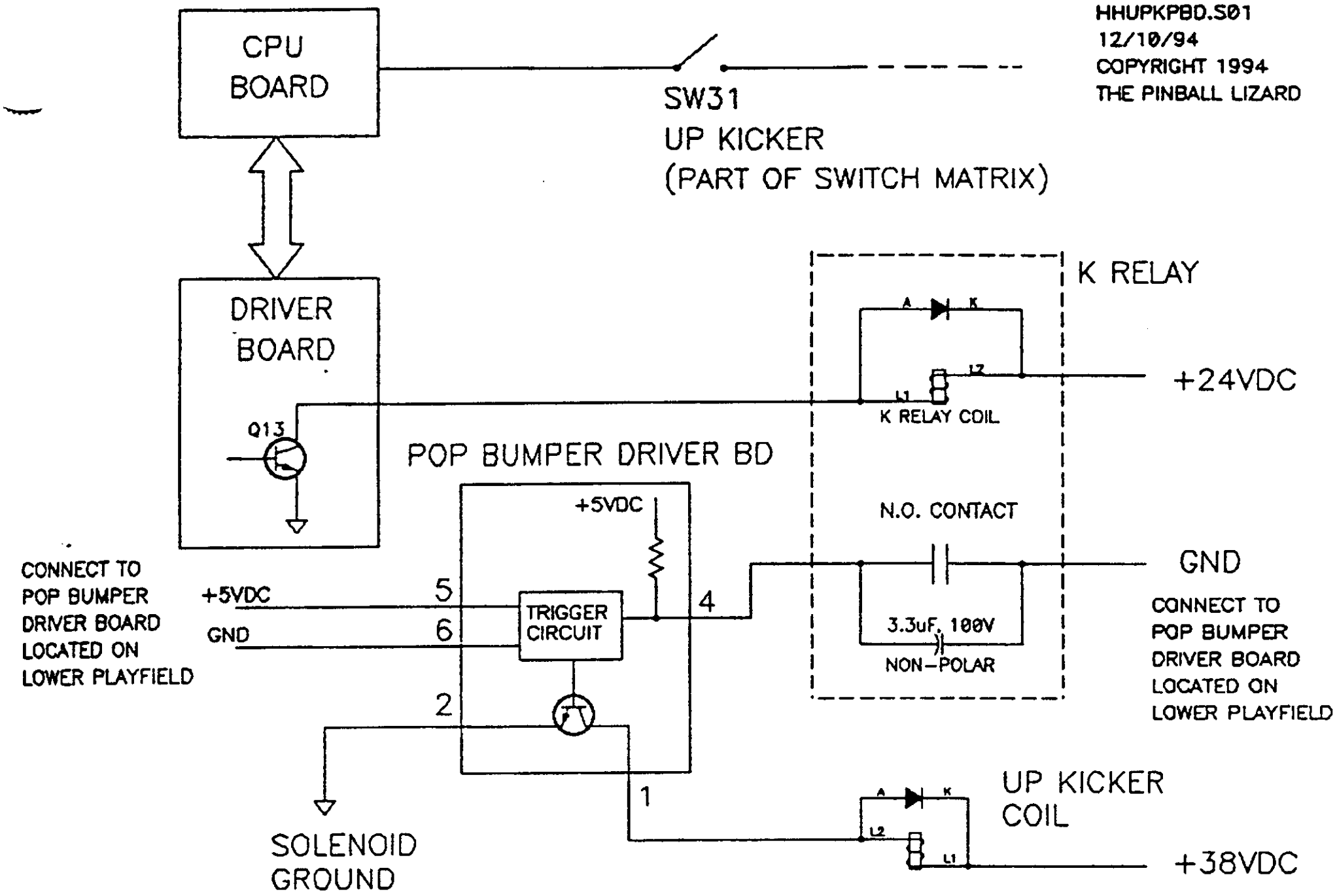
LINE #	IC-PIN#	R	TRANSISTOR	TYPE	CONNECTOR	FUNCTION	DEVICE
1	Z1-15	R4	Q4	MPS-U45	A3J2-1	L2 - SHOOT AGAIN LIGHT (LIGHTBOX)	LAMP
2	Z2-2	R5	Q5	MPS-A13	A3J2-2	L4 -	
3	Z2-7	R6	Q6	MPS-A13	A3J2-3	L5 -	
4	Z2-10	R7	Q7	MPS-A13	A3J2-4	L6 -	
5	Z2-15	R8	Q8	MPS-A13	A3J2-5	L7 -	
6					A3J2-6	LAMP GROUND	
7	Z3-10	R11	Q11	MPS-A13	A3J2-7	L11 - HIGH GAME TO DATE (LIGHTBOX)	LAMP
8	Z3-15	R12	Q12	MPS-A13	A3J2-8	L10 - GAME OVER LIGHT (LIGHTBOX)	LAMP
9	Z3-7	R10	Q10	MPS-A13	A3J2-9	L9 - SOUND 16 (TO SOUND BOARD)	
10	Z3-2	R9	Q9	MPS-A13	A3J2-10	L8 - EXTRA BALL (MAIN PF)	LAMP
11							
12					A3J3-1	GROUND	
13	Z11-15	R44	Q44	MPS-A13	A3J3-2	L43 -	
14	Z11-7	R42	Q42	MPS-A13	A3J3-3	L41 - #3 TARGET (UPSTAIRS PF)	LAMP
15	Z11-2	R41	Q41	MPS-A13	A3J3-4	L40 - #2 TARGET (UPSTAIRS PF)	LAMP
16	Z9-2	R33	Q33	MPS-A13	A3J3-5	L32 - #3 TARGET (MAIN PF)	LAMP
17	Z9-7	R34	Q34	MPS-A13	A3J3-6	L33 - #4 TARGET (MAIN PF)	LAMP
18	Z9-15	R36	Q36	MPS-A13	A3J3-7	L35 - 1X (MAIN PF)	LAMP
19					A3J3-8	INDEX KEY (BOARD IS SLOTTED AT THIS POSITION)	
20	Z7-2	R25	Q25	MPS-U45	A3J3-9	L24 - #1 SEQUENCE (CELLAR PF)	LAMP
21	Z7-7	R26	Q26	MPS-U45	A3J3-10	L25 - #2 SEQUENCE & LEFT TARGET (CELLAR PF)	LAMP
22	Z7-15	R28	Q28	MPS-U45	A3J3-11	L27 - TOP LEFT HOLE (MAIN PF)	LAMP
23	Z7-10	R27	Q27	MPS-U45	A3J3-12	L26 - #3 SEQUENCE & RIGHT TARGET (CELLAR PF)	LAMP
24	Z5-2	R17	Q17	MPS-U45	A3J3-13	L16 - TRAP DOOR, Q2, 2N5875 (MAIN PF)	XSTR
25	Z5-7	R18	Q18	MPS-U45	A3J3-14	L17 - GENERAL ILLUMINATION LIGHT RELAY "U" (MAIN PF)	RELAY
26	Z5-15	R20	Q20	MPS-U45	A3J3-15	L19 - DOUBLE BONUS MAIN PF (MAIN PF)	LAMP
27	Z5-10	R19	Q19	MPS-U45	A3J3-16	L18 - DOUBLE BONUS UPSTAIRS PF (MAIN PF)	LAMP
28					A3J3-17	LAMP GROUND	
29	Z6-10	R23	Q23	MPS-U45	A3J3-18	L22 -	
30	Z6-15	R24	Q24	MPS-U45	A3J3-19	L23 - DOUBLE SCORING (CELLAR PF)	LAMP
31	Z6-7	R22	Q22	MPS-U45	A3J3-20	L21 - DOUBLE SCORING (UPSTAIRS PF)	LAMP
32	Z6-2	R21	Q21	MPS-U45	A3J3-21	L20 - DOUBLE BONUS CELLAR (MAIN PF)	LAMP
33	Z4-10	R15	Q15	MPS-U45	A3J3-22	L14 -	
34	Z4-15	R16	Q16	MPS-U45	A3J3-23	L15 - RIGHT SIDE KICKER, Q1, 2N5875 (MAIN PF)	XSTR
35	Z4-7	R14	Q14	MPS-U45	A3J3-24	L13 - 5 BANK TARGET RESET, Q3, 2N5875 (CELLAR PF)	XSTR
36	Z4-2	R13	Q13	MPS-U45	A3J3-25	L12 - K RELAY COIL (ACTIVATES UP KICKER) (CELLAR PF)	RELAY
37							
38					A3J3-A	GROUND	
39					A3J3-B	+5VDC	
40					A3J3-C	LAMP GROUND	
41	Z12-2	R45	Q45	MPS-U45	A3J3-D	L44 - SPECIAL (UPSTAIRS PF)	LAMP
42	Z12-3	R49	Q49	MPS-U45	A3J3-E	L48 - #1 SPOT TARGET LIGHT (UPPER PF)	LAMP
43	Z12-7	R46	Q46	MPS-U45	A3J3-F	L45 - SPECIAL (CELLAR PF)	LAMP
44	Z12-6	R50	Q50	MPS-U45	A3J3-H	L49 - #2 SPOT TARGET LIGHT (UPPER PF)	LAMP
45					A3J3-J	INDEX KEY (BOARD IS SLOTTED AT THIS POSITION)	
46	Z9-10	R35	Q35	MPS-A13	A3J3-K	L34 - #5 TOP KICKING TARGET (MAIN PF)	LAMP
47					A3J3-L	(UNUSED)	
48	Z12-15	R48	Q48	MPS-U45	A3J3-M	L47 - ROUNDABOUT (MAIN PF)	LAMP
49	Z12-14	R52	Q52	MPS-U45	A3J3-N	L51 - ROLL DOWN TARGET (MAIN PF)	LAMP
50	Z12-10	R47	Q47	MPS-U45	A3J3-P	L46 - LEFT OUTSIDE ROLLOVER (MAIN PF)	LAMP
51	Z12-11	R51	Q51	MPS-U45	A3J3-R	L50 - #3 SPOT TARGET LIGHT (UPPER PF)	LAMP
52					A3J3-S	LAMP GROUND	
53	Z11-10	R43	Q43	MPS-A13	A3J3-T	L42 - #4 TARGET (UPSTAIRS PF)	LAMP
54					A3J3-U	LAMP GROUND	
55	Z8-10	R31	Q31	MPS-U45	A3J3-V	L30 - #1 KICKING TARGET (MAIN PF)	LAMP
56	Z8-15	R32	Q32	MPS-U45	A3J3-W	L31 - #2 KICKING TARGET (MAIN PF)	LAMP
57	Z8-7	R30	Q30	MPS-U45	A3J3-X	L29 - TOP RIGHT HOLE (MAIN PF)	LAMP
58	Z8-2	R29	Q29	MPS-U45	A3J3-Y	L28 - TOP CENTER HOLE (MAIN PF)	LAMP
59					A3J3-Z	LAMP GROUND	
60	Z1-2	R1	Q1	MPS-U45	A3J3-/A	GAME OVER RELAY "G" (BOTTOM SIDE OF MAIN PF)	RELAY
61	Z1-7	R2	Q2	MPS-U45	A3J3-/B	TILT RELAY "T" (BOTTOM SIDE OF MAIN PF)	RELAY
62	Z1-15	R4	Q4	MPS-U45	A3J3-/C	L3 - SHOOT AGAIN LIGHT (MAIN PF)	LAMP
63							
64	Z10-2	R37	Q37	MPS-A13	A3J4-1	L36 - 2X (MAIN PF)	LAMP
65	Z10-7	R38	Q38	MPS-A13	A3J4-2	L37 - 3X (MAIN PF)	LAMP
66	Z10-15	R40	Q40	MPS-A13	A3J4-3	L39 - 5X (MAIN PF)	LAMP
67	Z10-10	R39	Q39	MPS-A13	A3J4-4	L38 - 4X (MAIN PF)	LAMP
68					A3J4-5	LAMP GROUND	
69		R56	Q61, MPS-U45	Q62, 2N3055	A3J4-6	SOLENOID 5 - 4 BANK TARGET RESET (UPSTAIRS PF)	COIL
70	CR6		Q60	2N6043	A3J4-7	SOLENOID 1 - TOP HOLE (MAIN PF)	COIL
71	CR5		Q59	2N6043	A3J4-8	SOLENOID 9 - OUTHOLE (MAIN PF)	COIL
72					A3J4-9	SOLENOID GROUND	
73					A3J4-10	SOLENOID GROUND	
74					A3J4-11	SOLENOID GROUND	
75		R59	Q63, MPS-U45	Q64, 2N3055	A3J4-12	SOLENOID 6 - HOLE (CELLAR PF)	COIL
76		R53	Q57, MPS-U45	Q58, 2N3055	A3J4-13	SOLENOID 2 - UP KICKER (CELLAR PF TO MAIN PF) (CELLAR PF)	COIL
77					A3J4-14	SOLENOID GROUND	
78					A3J4-15	GROUND	
79							
80	Z13-6				A3J5-1	SOUND 4 (TO SOUND BOARD)	
81	Z1-10	R3	Q3	MPS-U45	A3J5-2	COIN LOCKOUT COIL (ON COIN DOOR)	COIL
82					A3J5-3	SOLENOID GROUND	
83					A3J5-4	N/C	
84	Z13-4				A3J5-5	SOUND 2 (TO SOUND BOARD)	
85	Z13-2				A3J5-6	SOUND 1 (TO SOUND BOARD)	
86	Z13-8				A3J5-7	SOUND 8 (TO SOUND BOARD)	
87	CR1		Q53	2N6043	A3J5-8	SOLENOID 8 - KNOCKER (RIGHT SIDE MAIN CABINET)	COIL
88							
89	CR4		Q56	MPS-U45	A3J6-1	SOLENOID 7 - CENTER COIN COUNTER (OPTIONAL)	
90	CR3		Q55	MPS-U45	A3J6-2	SOLENOID 4 - RIGHT COIN COUNTER (OPTIONAL)	
91	CR2		Q54	MPS-U45	A3J6-3	SOLENOID 3 - LEFT COIN COUNTER (OPTIONAL)	
92					A3J6-4	SOLENOID GROUND	

HAUNTED HOUSE UP KICKER ORIGINAL CIRCUIT



NOTE: STAR TECH JOURNAL MODIFICATION DRAWINGS THAT SHOW USING A POP DRIVER BOARD ARE INCOMPLETE AND INCORRECT AND COULD CAUSE SEVERE GAME DAMAGE IF FOLLOWED!

HAUNTED HOUSE UP KICKER MODIFIED TO USE POP DRIVER BOARD



SUBJECT: SYSTEM 80 POWER SUPPLY UPGRADES - PAGE 1
FILE: BHPOWSUP.DOC
11/28/94 12:19 PM

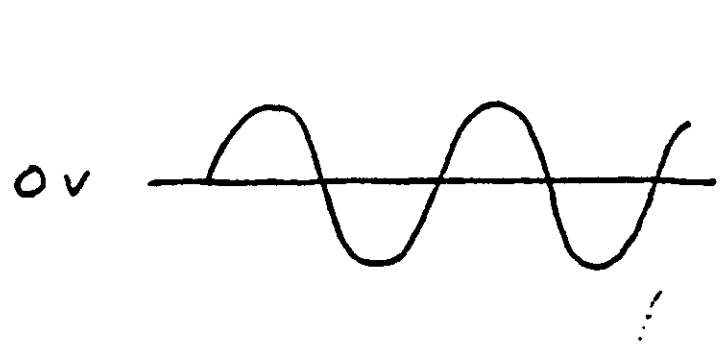
There are 3 areas of concern:

1. The unregulated +12 VDC power that is used to produce the regulated +5 VDC for the digital logic ICs comes to the power supply board from a bridge rectifier on the power transformer assembly in the bottom of the game cabinet. In order for the regulated circuit to operate correctly, the incoming unregulated power must be somewhat smoothed out. This is done by using a large value capacitor to stabilize and "smooth" the inherent ripple in a full wave rectified DC signal. The 6800 uF capacitor installed by the factory is also physically large, about 2" in diameter and 4" tall. If this capacitor is missing, it MUST be replaced! (Voice of troubleshooting experience speaking, again!) The capacitor value can be increased to 10,000 or even 15,000 uF. It should also meet the following specifications: a working voltage of 25 VDC or greater and a 105 degree C operating temperature. Physical size is not critical, as there is lots of room to mount a large capacitor. Computer grade caps are more expensive but should last longer. Cost is usually directly proportional to the quality of the part. Pay more and you will get a better capacitor.

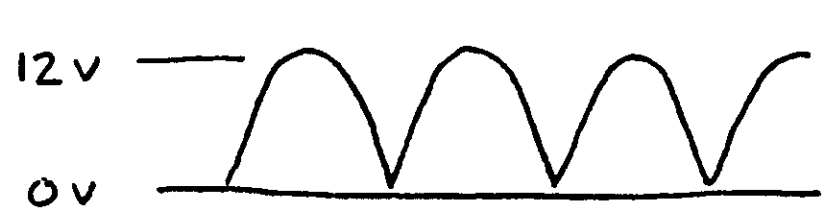
To measure the amount of ripple on the DC voltage signal, connect a voltmeter to the output and ground connections at the capacitor, and first measure the DC voltage. Set the meter to read DC volts and verify a value between about +10 and +14 Volts DC (12 VDC +/- 20%). WITHOUT removing the leads, switch the meter to read AC Volts. Most modern digital voltmeters (DVMs) will then read the AC voltage ripple that appears on the DC signal, what you would see if you hooked up an oscilloscope to the circuit. The maximum ripple allowed is 1 Volt. We replace the capacitor if the ripple exceeds 0.75 VAC, since it indicates the capacitor is nearing the end of its useful life.

Capacitors dry out from use which creates internal heat, which dries up the insulating materials used to make the cap, which is a big roll of aluminum foil and an insulating paper material all rolled up and stuffed into a little metal can. Electrical breakdown of the insulating materials inside them also occurs from trying to withstand the operating voltages imposed on the capacitor's terminals. Both of these are what leads to the term a "leaky" capacitor, where it stops being such as good capacitor but leaks electrically, internally. Sometimes caps do actually leak their liquid electrolyte, a gooey-type leak. More often they fail catastrophically by EXPLODING when they develop a short inside them, and enough gas of some kind is produced to cause the case to rupture with a big BANG! THIS ALSO WILL HAPPEN IF THE CAPACITOR IS NOT INSTALLED CORRECTLY SUCH THAT THE POLARITY MARKS ARE NOT OBSERVED! Always connect plus to "+" and minus to "-"!

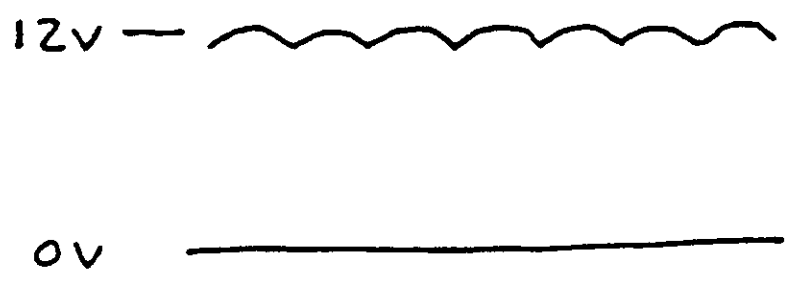
AC VOLTAGE INPUT
(NO CAPACITOR)



FULL WAVE RECTIFIED DC VOLTAGE
(NO CAPACITOR)



FULL WAVE RECTIFIED DC VOLTAGE
GOOD CAPACITOR



FULL WAVE RECTIFIED DC VOLTAGE
LEAKY CAPACITOR

SUBJECT: SYSTEM 80 POWER SUPPLY UPGRADES - PAGE 2
FILE: BHPOWSUP.DOC
11/28/94 12:19 PM

The following two upgrades need to be made to the power supply board assembly located in the game backbox.

2. Many System 80 power supplies were manufactured where the leads were clipped off too short. There is a circuit board industry specification that states the solder meniscus, the solder "mountain" that builds up around each component lead during soldering, must not be cut into when the excess lead length is cut off, but this spec is often violated. Gottlieb had a lot of boards pass through that are cut too short, such that the solder will crack away from components. Cracked solder joints happens especially at the header pins due to their large diameter, and the heating and cooling of the power supply board when the game is powered "ON" and "OFF". Inspect the solder connections and you will see an annular ring around the connector pin or component lead where it is soldered to the circuit board. Any thermal cracking is further aggravated by the action of flexing the circuit board when plugging on the mating wiring connectors.

The fix is to disassemble the power supply from its black aluminum heat sink plate and resolder all of the components on the board. Heat the joints with a small soldering pencil-type iron, and add additional solder to the joint to build up an adequate mound of solder for strength. The header pins may need to be completely replaced if they were cut off too short, or if they have been burned from overheating due to broken solder joints. When soldering is complete, the flux must be washed off with alcohol and a tooth brush and the board dried.

Note: To disassemble the power supply from the heat sink plate, the +5 VDC output transistor must be unsoldered from the circuit board. This must be done carefully using some paste flux and a vacuum type desoldering tool. It may be necessary to do the fluxing and vacuuming 2 or even 3 times to get the pins clean of solder. It also may require a second set of hands to help pull the two units apart while heating the transistor pins. The attachment points on the circuit board for this device are riveted eyelets that are MUCH stronger than simple plated trace holes, BUT they CAN be damaged if care is not used during disassembly (do NOT overheat the board!)

3. The location for the PBL upgrade to the System 80 power supply is easy to locate - look for the burned spot under the 8.2 Volt Zener diode! This circuit has a design error, which is surprising since it is almost identical to the circuit design used on System 1 power supplies which do NOT have this problem. The one difference is what causes the diode to get very HOT and burn the circuit board!

If the diode is OK, it may be left in place, but may need to be resoldered as per the item above in #2. To prevent future damage to the diode or circuit board, replace the resistor at R10 with a 680 Ohm, 1/2 Watt carbon film resistor (similar to System 1 supplies!). Once this change has been made, the Zener diode at CR7 can be replaced with a 1 Watt device (CR7 = 1N4738A, 8.2 V, 1 Watt) instead of the harder to find and MUCH more expensive 2 Watt device specified originally.

Note: It is also often necessary to replace the resistor at R3 with a new part (R3 = 12kOhm, 1/2 Watt), because the old part develops heat-induced concentric cracking that eventually propagates all the way through to the base material of the resistor, causing it to increase in resistance and eventually go open (infinite resistance). When rebuilding your power supply, it would be wise to check all resistors values and test all diodes and replace any that are damaged while the supply is apart.

Note: It is also useful to add wires to those boards without test points pins so that clip leads can be clipped to the test point. (Test points usually do not have pins on the latest production power supplies but can be added.) Solder a 1/2" piece of stiff wire into the test point hole so that it sticks out of the board.

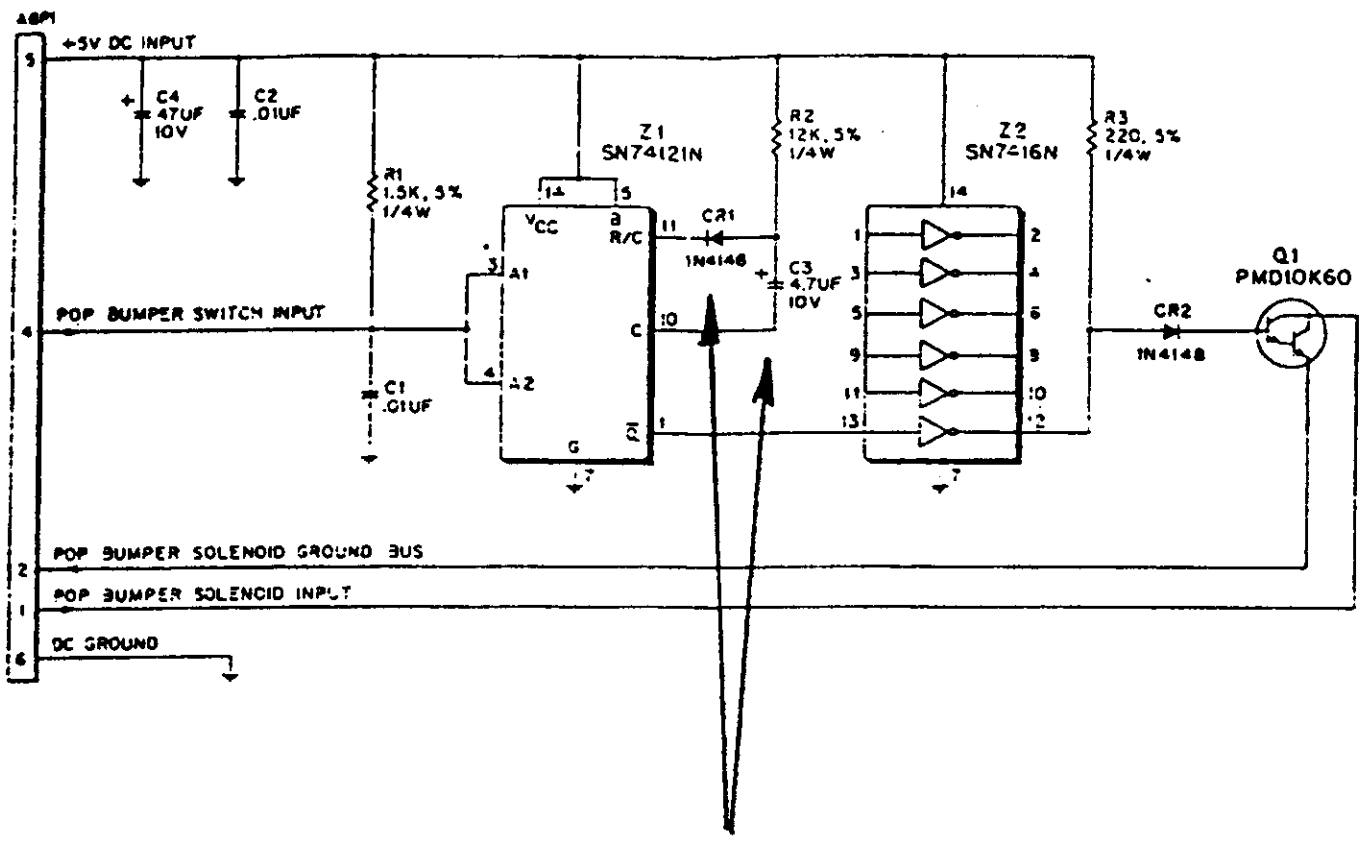
Last item: After reassembly, be sure to measure the +5 Volt supply output and adjust to +5.0 Volts. This is very important! (Allowable range: +4.8 to +5.2 Volts, but adjust as close to +5.0 as possible!) Other voltages should all be checked, but cannot be adjusted: +60 VDC, +42 VDC, +8 VDC.

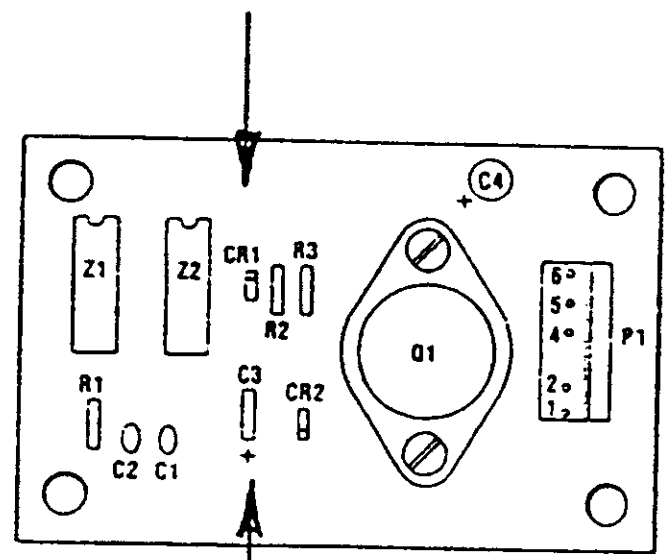
SUBJECT: OEM POP BUMPER DRIVER BOARD
FILE: BHPOPBU2.DOC
11/26/94 02:48 PM

All OEM Pop Bumper Driver boards need to be examined to see if a factory rework/upgrade has been made to them. The rework corrects a design error and increases reliability of operation. The diagrams below show the schematic changes and the component locations.

To quickly identify this rework look for: 2 diodes = NOT reworked, or, 1 diode and 1 jumper wire = reworked.

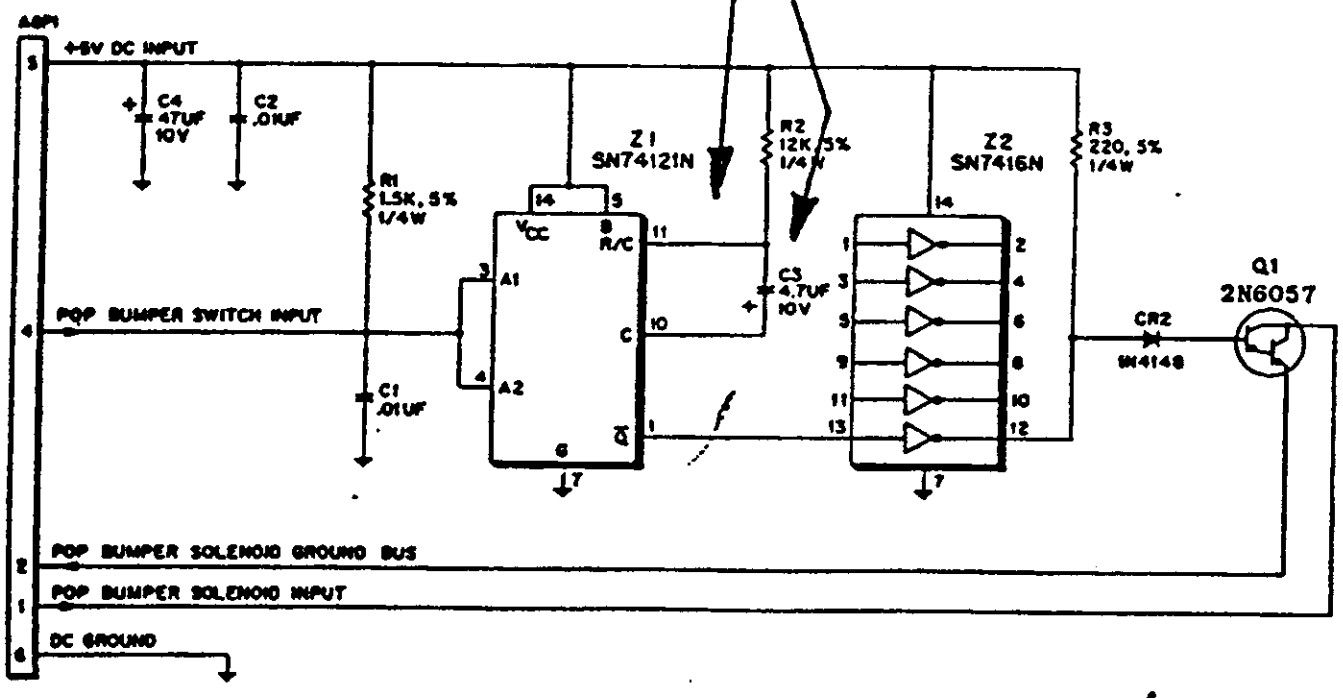
ORIGINAL DESIGN / UNMODIFIED





NOTE CHANGES!

NOTE!



FINAL DESIGN / MODIFIED

NOTE! THE CAPACITOR MUST BE REPLACED NOT SIMPLY REVERSED AND RE-USED!

Gottlieb
AMUSEMENT GAMES

D. GOTTLIEB & CO.
165 W. Lake Street • Northlake, IL 60164
(312) 562-7400 • Telex 72-8463
A Columbia Pictures Industries Company

May 20, 1983

Dear Service Manager:

Due to the unavailability of the LM379S amplifier IC from our vendor, we are now utilizing an LM2002T or TDA2002T amplifier in a piggyback configuration to replace the LM379S (U23) on all of our A6 Sound and Sound/Speech Boards. This applies to any new boards ordered from stock or boards returned for repair that require replacement of a defective LM379S. Also, the MA-483 or MA-488 Piggyback Board will be sent as a replacement for the LM379S on all service orders.

The 2002T has different power requirements than the LM379S, which requires minor changes to the +30V DC supplied to the amplifier. The attached pages explain how to modify the +30V DC as well as how to install the Piggyback Board as a replacement for the LM379S for both Pinball and Video Boards.

As a reminder, the modification kit to update the System 80 Bench Tester to the System 80A Bench Tester is now available. This kit allows the technician the ability to test all of the System 80 and all of the System 80A boards. This includes the updated Control Board, the 7-Digit Display, etc. For additional details, please feel free to call me.

Enclosed is a little note-mate with our toll-free lines to keep handy near your phone.

Thank you.

Sincerely,

D. GOTTLIEB & CO.

Abi C. Carmen
Director
Technical Marketing Services

ACC:jh

Enclosures

Gottlieb™
165 W. Lake St., Northlake, IL 60164 - (312) 562-7400 - Telex 72-8463

TECHNICAL SERVICE BULLETIN

BULLETIN #19-P0583

PAGE 1 OF 1

DATE: MAY 18, 1983

ATTENTION: GAME OPERATORS AND SERVICE MANAGERS

GAMES AFFECTED: ALL PINBALL GAMES FROM SUPER ORBIT (#680) THROUGH RACK 'EM UP (#685) INCLUSIVE

SUBJECT: PINBALL

PIGGYBACK BOARD REPLACEMENT FOR THE U23 LM379S AMPLIFIER USED ON THE A6 SOUND AND SOUND/SPEECH BOARDS AND THE ASSOCIATED A7 SOUND/SPEECH POWER SUPPLY VOLTAGE REQUIREMENTS

For replacement of the LM379S (U23) amplifier utilized on Gottlieb's Sound and Sound/Speech Boards, a Piggyback Board substitute has been designed to replace the amplifier. The new amplifier is mounted in a piggyback configuration using an LM2002T or a TDA2002T which operate at approximately one-half of the voltage required by the LM379S. This voltage requirement necessitates minor changes on the A7 Sound/Speech Power Supply Board, which supplies the amplifier voltage, because the 2002T cannot operate at the +30V DC level supplied by the MA-188 A7 Sound/Speech Power Supply Boards. The new MA-481 A7 Sound/Speech Power Supply Board supplies the correct voltage (+18V DC) to operate the piggyback amplifier. The chart below identifies the correct Sound or Sound/Speech Board and its associated piggyback configuration with the correct A7 Sound/Speech Power Supply Board to be used.

GAME	A6 SOUND OR SOUND/SPEECH (INCLUDES PIGGYBACK WHERE APPLICABLE)	PIGGYBACK	AMPLIFIER VOLTAGE	A7 SOUND/SPEECH POWER SUPPLY
SUPER ORBIT GAME #680	MA-309	NOT USED	+30V DC	MA-188
ROYAL FLUSH DELUXE EARLY PRODUCTION GAME #681	MA-309	NOT USED	+30V DC	MA-188
ROYAL FLUSH DELUXE LATER PRODUCTION GAME #681A	MA-484	MA-483	+18V DC	MA-481
AMAZON HUNT EARLY PRODUCTION GAME #684	MA-309	NOT USED	+30V DC	MA-188
AMAZON HUNT LATER PRODUCTION GAME #684	MA-490	*MA-488	+12V DC	NOT APPLICABLE
RACK 'EM UP GAME #685	MA-490	*MA-488	+12V DC	NOT APPLICABLE

* THE PIGGYBACK BOARD UTILIZED ON THE MA-490 SOUND BOARD IS NOT FOR AMPLIFIER REPLACEMENT. IT IS USED FOR ROM EXPANSION. DO NOT REPLACE THE MA-490 SOUND BOARD WITH ANY OTHER SOUND BOARD.

(OVER)

A7 SOUND/SPEECH POWER SUPPLY BOARD MODIFICATION

All A6 Sound or Sound/Speech Boards ordered from stock or returned for repair requiring a LM379S replacement will have the Piggyback Board modification.

CAUTION: WHEN A PIGGYBACK TYPE SOUND OR SOUND/SPEECH BOARD IS TO BE USED FOR REPLACEMENT PURPOSES, MAKE CERTAIN THAT THE PROPER A7 SOUND/SPEECH POWER SUPPLY BOARD IS USED.

To update an MA-188 A7 Sound/Speech Power Supply Board to the new MA-481 A7 Sound/Speech Power Supply Board, please make the following circuit board changes to the A7 Sound/Speech Power Supply Board. See Figure 1.

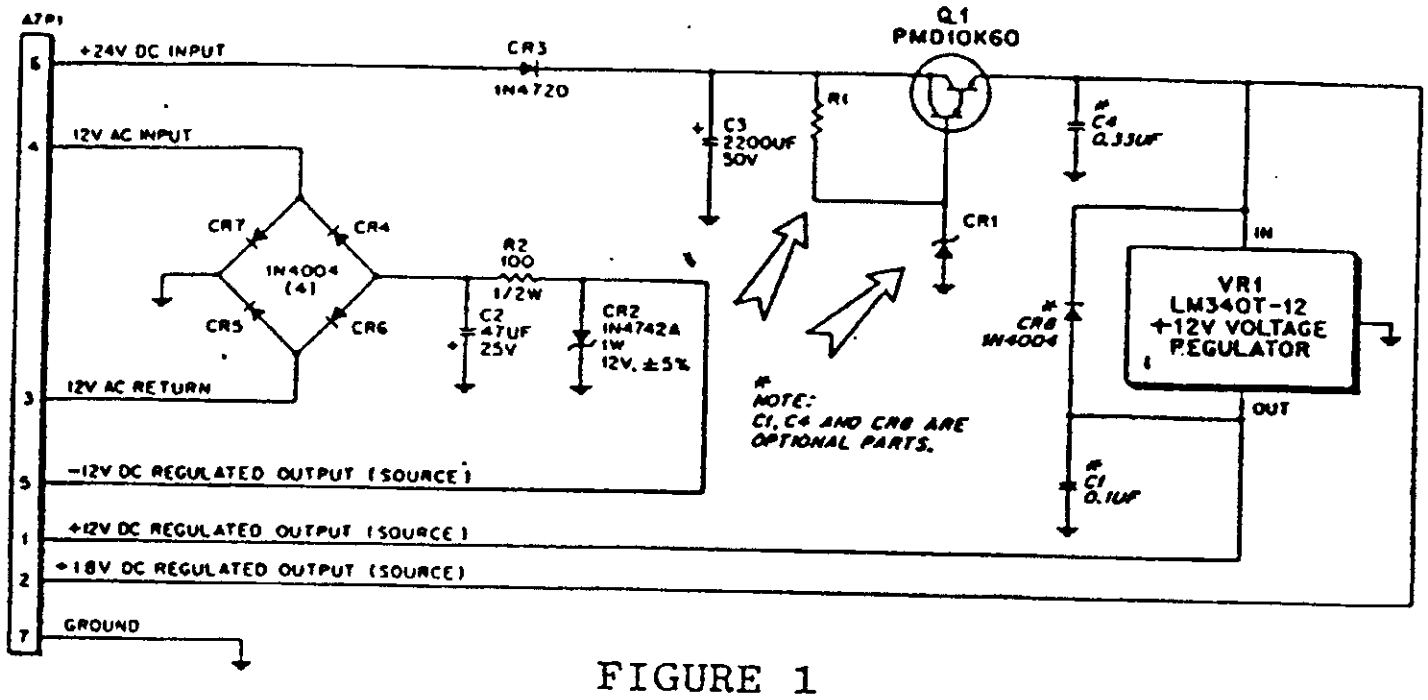


FIGURE 1

Remove:
CR1 Diode, Zener 30V, 5%, 1W, 1N4751A XO-271
and replace with:
CR1 Diode, Zener 18V, 5%, 1W, 1N4746A XO-258

Remove:
R1 Resistor, 430 ohm, 5%, 1/2W XO-54
and replace with:
R1 Resistor, 1.5K ohm, 5%, 1/2W XO-58

A6 SOUND OR SOUND/SPEECH BOARD MODIFICATION

To repair a Sound or Sound/Speech Board requiring a replacement for a defective LM379S, the new MA-483 Piggyback Board must be used as the replacement. For replacement, please follow the procedure below: See Figure 2.

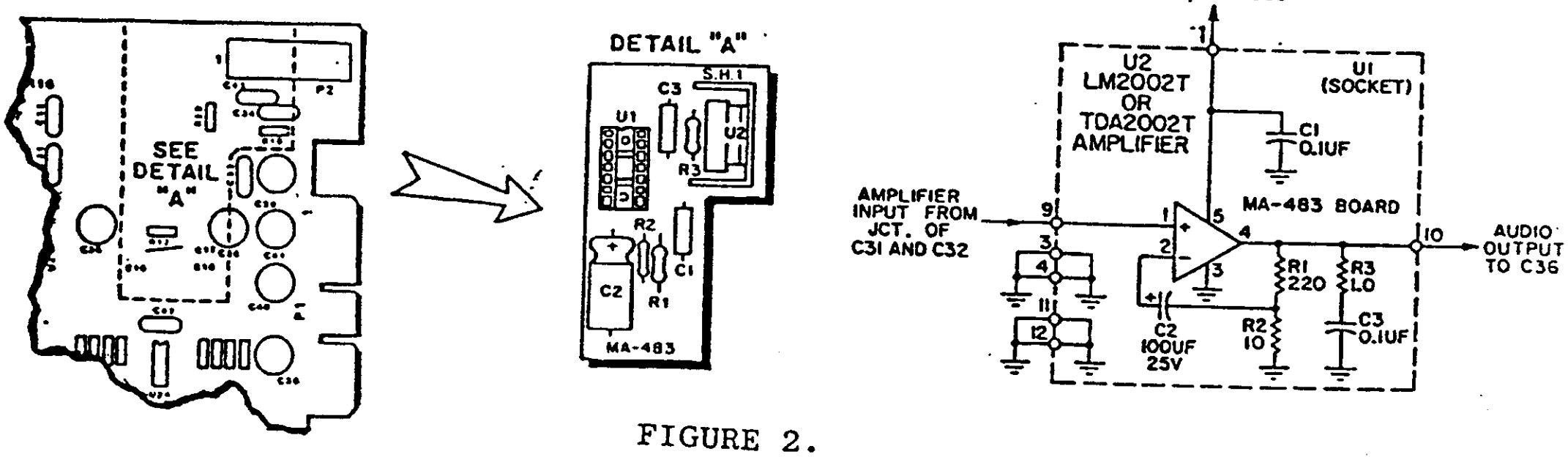


FIGURE 2.

Remove:

C37	Capacitor, 4.7UF, 35V	XO-291
R18	Resistor, 100K ohm, 5%, 1/4W	XO-45
R21		
R22	Resistor, 2K ohm, 5%, 1/4W	XO-14
U23	IC, LM379S	XO-395

Solder the leads of the U1 socket on the MA-483 Piggyback Board into the U23 feed through holes on the Sound or Sound/Speech Board.

Gottlieb™
165 W. Lake St., Northlake, IL 60164 • (312) 562-7400 • Telex 72-8463

TECHNICAL SERVICE BULLETIN

BULLETIN #18-V0583

DATE: MAY 18, 1983

ATTENTION: GAME OPERATORS AND SERVICE MANAGERS

GAMES AFFECTED: ALL VIDEO GAMES FROM REACTOR (GV-100) THROUGH KRULL (GV-105) INCLUSIVE

SUBJECT: VIDEO

PIGGYBACK BOARD REPLACEMENT FOR THE U23 LM379S AMPLIFIER USED ON THE A6 SOUND AND SOUND/SPEECH BOARDS AND THEIR ASSOCIATED A3 POWER SUPPLY VOLTAGE REQUIREMENTS

For replacement of the LM379S (U23) amplifier utilized on Gottlieb's Sound and Sound/Speech Boards, a Piggyback Board substitute has been designed to replace the amplifier. The new amplifier is mounted in a piggyback configuration using an LM2002T or a TDA2002T which operate at approximately one-half of the voltage required by the LM379S. This voltage requirement necessitates minor changes on the A3 Power Supply Board, which supplies the amplifier voltage, because the 2002T cannot operate at the +30V DC level supplied by the MA-303 or MA-430 A3 Power Supply Boards. The new MA-492 A3 Power Supply Board supplies the correct voltage (+16V DC) to operate the piggyback amplifier. The chart below identifies the correct Sound or Sound/Speech Board and its associated piggyback configuration with the correct A3 Power Supply Board to be used.

GAME	A6 SOUND OR SOUND/SPEECH (INCLUDES PIGGYBACK WHERE APPLICABLE)	PIGGYBACK	AMPLIFIER VOLTAGE	A3 POWER SUPPLY
REACTOR GV-100	MA-216	NOT USED	+30V DC	MA-303
Q*BERT GV-103, A, B	MA-216	NOT USED	+30V DC	MA-303 MA-430
Q*BERT LATER PRODUCTION GV-103B	MA-486	MA-483	+16V DC	MA-492
Q*BERT CT GV-103CT	MA-486	MA-483	+16V DC	MA-492
MAD PLANETS GV-102	MA-484	MA-483	+16V DC	MA-492
KRULL GV-105	MA-487	MA-483	+16V DC	MA-492

(OVER)

All A6 Sound or Sound/Speech Boards ordered from stock or returned for repair requiring a LM379S replacement will have the Piggyback Board modification.

> CAUTION: WHEN A PIGGYBACK TYPE SOUND OR SOUND/SPEECH BOARD IS TO BE USED FOR REPLACEMENT PURPOSES, MAKE CERTAIN THAT THE PROPER A3 POWER SUPPLY BOARD IS USED.

To update an MA-303 or MA-430 A3 Power Supply Board to the new MA-492 A3 Power Supply Board, please make the following circuit board changes to the A3 Power Supply Board. See Figure 1.

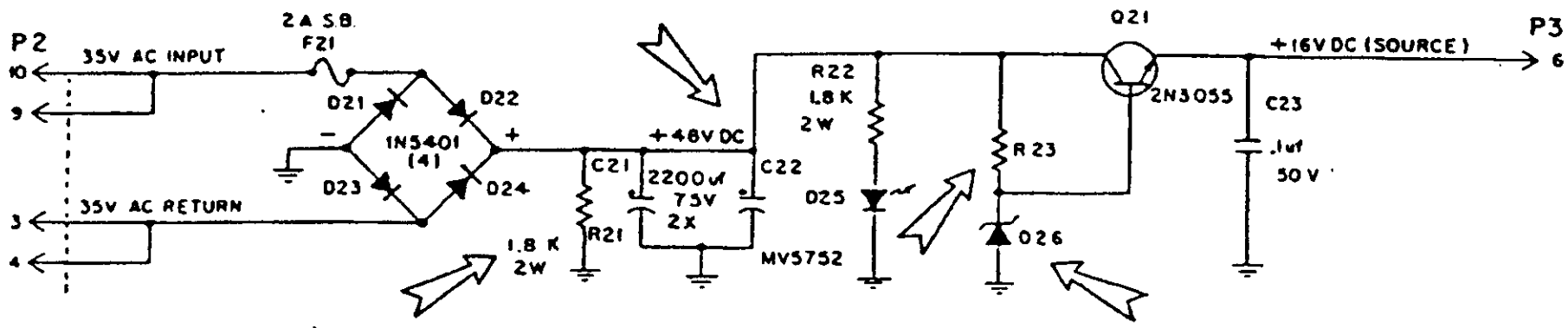


FIGURE 1.

Delete the following:

C22	Capacitor, 2200UF, 75V	XO-132
R21	Resistor, 1.8K ohm, 5%, 2W	XO-135

Remove:

D26	Diode, Zener 30V, 5%, 5W, 1N5363B	XO-273

and replace with:

D26	Diode, Zener 16V, 5%, 1W, 1N4745A	XO-620

Remove:

R23	Resistor, 200 ohm, 5%, 5W	XO-133

and replace with:

R23	Resistor, 1K ohm, 5%, 2W	XO-627

A6 SOUND OR SOUND/SPEECH BOARD MODIFICATION

To repair a Sound or Sound/Speech Board requiring a replacement for a defective LM379S, the new MA-483 Piggyback Board must be used as the replacement. For replacement, please follow the procedure below: See Figure 2.

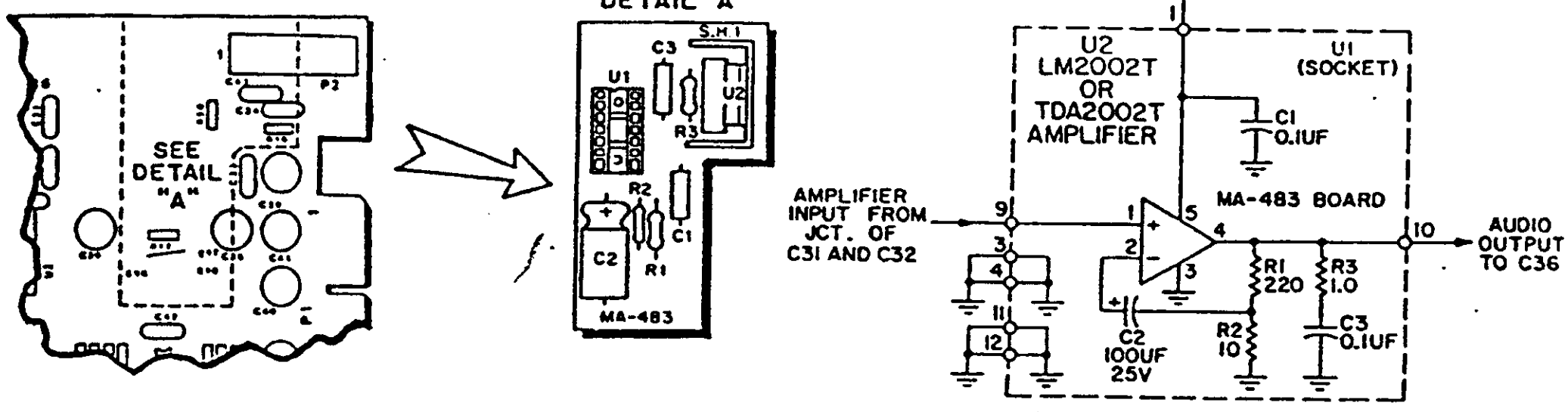


FIGURE 2.

Remove:

C37	Capacitor, 4.7UF, 35V	XO-291
R18	Resistor, 100K ohm, 5%, 1/4W	XO-45
R21		
R22	Resistor, 2K ohm, 5%, 1/4W	XO-14
U23	IC, LM379S	XO-395

Solder the leads of the U1 socket on the MA-483 Piggyback Board into the U23 feed-through holes on the A6 Sound or Sound/Speech Board.

SUBJECT: SYSTEM 80 DISPLAYS
FILE: BHDISPL1.DOC
12/01/94 12:46 AM

Gottlieb used Futaba fluorescent display tubes on all System 1 and System 80 pinball games. These tubes are very nice and bright when new, but often lose their brightness prematurely. We have the following observations from our experiences with them. (Note: 6-digit tubes seem to have these problems much more often than the 4-digit tubes.)

If the game has been sitting in storage for awhile or simply has not been turned "ON" for an extended period, the displays may be very dim or may not even show any digits when first powered "ON". If the game is left "ON" for an hour or so, we have found the displays will recover some, but not always to complete full original brightness. In fact, if you look closely at what appears to be a dead display, you can see barely visible digits, but they are very, very dim. After a few minutes of warm up they gradually become more visible and eventually reach a usable brightness.

We believe the tube-to-glass seal consists of only the molten glass hardened around the steel wire leads, without a flexible sealant. Air eventually leaks inside the tube around this seal and causes the filaments to oxidize. If left "ON" long enough, the filament burns itself clean and the tube begins working again. Obviously, this problem will likely occur to ALL of these tubes as the years of age accumulate on them. Also, anytime the game is not operated for a few days or weeks, you will have the same problem reoccur.

Some other care notes:

- Be very careful of the glass tube "nipple" where the glass envelope was sealed off. We have a great big box of dead Gottlieb displays where this was the most likely cause of tube failure. Tubes that have been powered "ON" with the nipple broken will have distinct smoky white comers from the filament burning out. Protect the nipple on your displays with a plastic pipe plug mounted over the nipple with a hot glue gun or silicone adhesive. Clean the back of the tube first to assure adhesion. Many Gottlieb displays came from the factory with a similar plastic cap.

- If the game ever "locks up", where the displays are not being strobed, turn the game "OFF" immediately. If one digit or segment is very, very bright also turn the game "OFF". This applies to ALL electronic pinball machines - Bally, Williams, Gottlieb, Stern, etc.! Display filaments or internal tube sections will burn out very quickly if left in this condition for more than a few minutes.

- Handle the tube and circuit board very carefully - it is unlikely to survive a drop to the floor, especially a hard, non-carpeted floor.

- If the original tube mounting adhesive has broken loose, we recommend the following repair to reattach the tube. (Use this same method for installing new display tubes in ALL electronic pinball machines!) In order to make the unit serviceable in the future, do NOT glue the glass tube solidly to the circuit board! We mount ours with 2 marble-sized dabs of silicone adhesive near either end, slip 2 large flat washers in between the tube and the circuit board as temporary spacers, then clamp the tube to the board at either end with a couple of wooden spring-type clothes pins, or place a weight on top of the entire unit as an alternate clamping method, and let the unit dry overnight. The important point is to use the temporary spacers to prevent the adhesive from spreading out and making it much more difficult to separate the tube from the circuit board in the future. As always, clean off the old adhesive as much as possible first by scraping, then wipe the surfaces with some alcohol before gluing.

SUBJECT: BLACK HOLE & HAUNTED HOUSE AUXILIARY LAMP DRIVER BOARD

FILE: BHAUXLMP.DOC
12/02/94 12:59 PM

It is not readily obvious, but there are at least four versions of the Auxiliary Lamp Driver Board as used on these games. Part # E-21338 is the one for Black Hole, and E-21594 is the board for Haunted House. They differ only in the timing resistor for the 555 timer at U5: BH = 270k Ohm, HH = 1.1M Ohm. See the table below for the others that we are aware of.

These boards begin to work instantly when power is applied, since the 555 timer is configured as a free running oscillator - simply apply power and away it goes! In BH this board runs the infinity lights around the outside of the backbox like a theater marquee, while the HH board runs the "lightning" flashes (or is it light-ing?) in the haunted house picture on the backglass. The particular resistor makes the HH board run slower, so....if your BH runs the lamps too slowly or your HH is flickering too quickly, look for R13, the resistor indicated in the drawing below, and confirm the value of R13 on your board. Refer to the summary table for details.

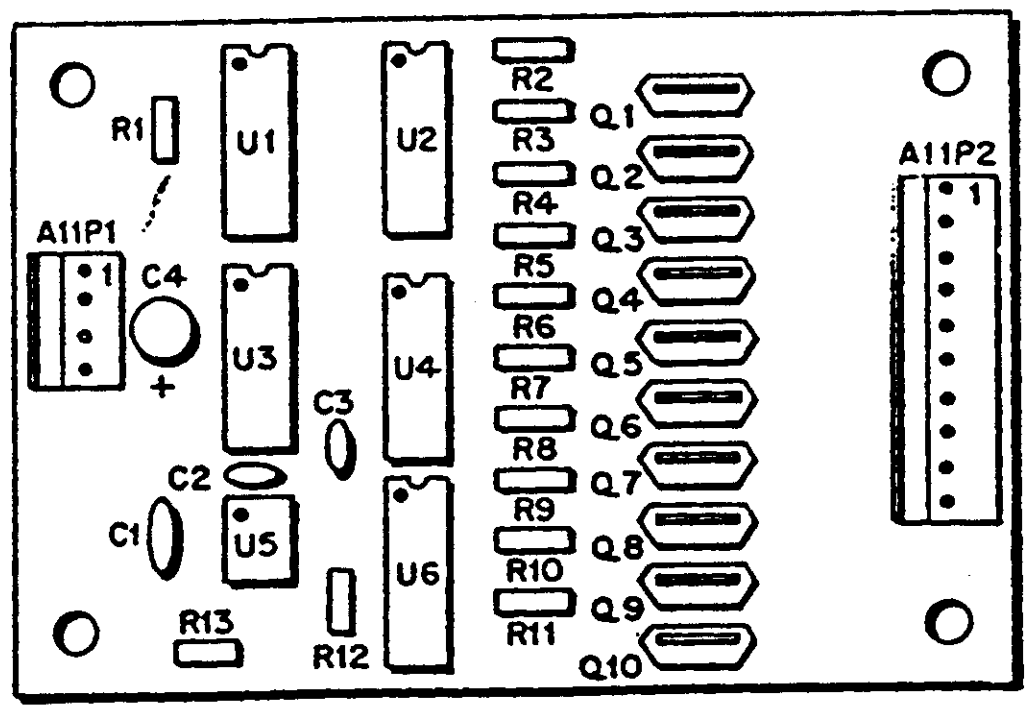
These boards are very easy to troubleshoot. You only need +5 VDC, ground, and a logic probe. Start with pin 3 of the 555 timer at U5, and look for pulsing. Just follow the schematic until it stops! If there is no pulsing, then the 555 timer is probably bad (remember - always use a strip socket!). Replace it and keep checking out the board - there may be other things wrong with it. The flow of the pulses is from left to right on the schematic. Any IC that doesn't have pulsing on its output pins (the right-hand side of each IC in the schematic diagram) is probably bad.

To test the output transistors, disconnect the 10-pin output connector. The logic probe will "blip" LO at each of the 10 output pins when the board is working. Any pin that doesn't blip could have a bad MPS-U45 drive transistor. But you need to verify from the schematic where the pulsing actually stops in the circuit, since either of the 7405 inverting buffers, U2 or U6, might have a bad gate, or the counter or decoder could have failed.

Game	Black Hole	Haunted House	Volcano	Mars, God of War
Aux Lamp Bd Part #	E-21338	E-21594	E-21111	E-20924
R13	270k Ohm	1.1M Ohm	560k Ohm	330k Ohm
Output pulse rate per output transistor	200 pulses/sec	50 pulses/sec	100 pulses/sec	165 pulses/sec

***** Please send us any additional information of other games that used this basic board *****

AUXILIARY LAMP DRIVER BOARD
(A11) COMPONENT LOCATION



SUBJECT: SYSTEM 80 RESET BOARD
FILE: BHRESET.DOC
12/12/94 12:06 AM

To prevent game damage from CPU board "lock-up", i.e., where the CPU stops running its program and leaves some things turned "ON" or in unknown states, Gottlieb made a Reset circuit board that was added to all games starting with System 80A. This board was also offered as a retrofit in May of 1981 for those operators who had problems with game lockup on earlier System 80 games. Our belief is that there is either a software or hardware design error, or both, and that ALL System 80 games are subject to this problem. If you leave your games "ON" for extended periods or if you do still operate some of these games, it would protect them against damage to install a Reset board. Components that could be damaged include the display tubes that would burn out segments from not being strobed, and coils that are stuck "ON", burn out, and also ruin the associated driver transistor, perhaps even severely burning the Driver circuit board.

There are two versions of the Gottlieb/Premier Reset board. It is impossible to distinguish between the two types without close inspection of the board circuit traces. The first version detects the presence of the /IRQ signal and/or one of the display digit strobes. If either signal stops, the Reset board puts out a reset pulse to the CPU microprocessor, pin 40, /RESET, which re-boots the game. The second version deleted the digit strobe input and monitors only /IRQ. See attached schematics. A February 1985 upgrade from Gottlieb adds a pull up resistor to the CPU R/W signal and adds a diode to provide better isolation of the /RESET signal. The second version Reset board schematic includes these latest revisions.

If your game has a Reset board, it should be mounted directly above the CPU board. There should be a 40-pin component carrier with only 4 wires attached to it plugged into the "TC1" Test Connector on the CPU board (see drawing). The Test Connector is the horizontal 40-pin socket at the top center of the CPU board. It is interesting to note that Gottlieb installed Reset boards on ALL new games shipped from the factory starting with the first System 80A game, "Devil's Dare". We recommend retrofitting one to all earlier System 80 games.

****

Our copy of the Reset bulletin was not good enough to copy. We have retyped the information below.

BULLETIN #02-P0581 DATE: May 6, 1981
Page 1 of 2

ATTENTION: Service Managers
GAME: All System 80 Pinball
SUBJECT: Reset Circuit Board - Modification Kit #MA-158

A pinball game may "lock up" due to different out-of-the-ordinary conditions. High static electricity environments, a line voltage dip, or a defective coil diode may cause the game program circuitry to lock up into an inoperable mode. This lock-up may also effect the game displays. One digit will burn brightly, eventually burning out the display filament. Usually, turning the game power off, then on, will re-initialize the game for proper operation. However, if the game is left in the inoperable mode for any period of time, a burned out display will result.

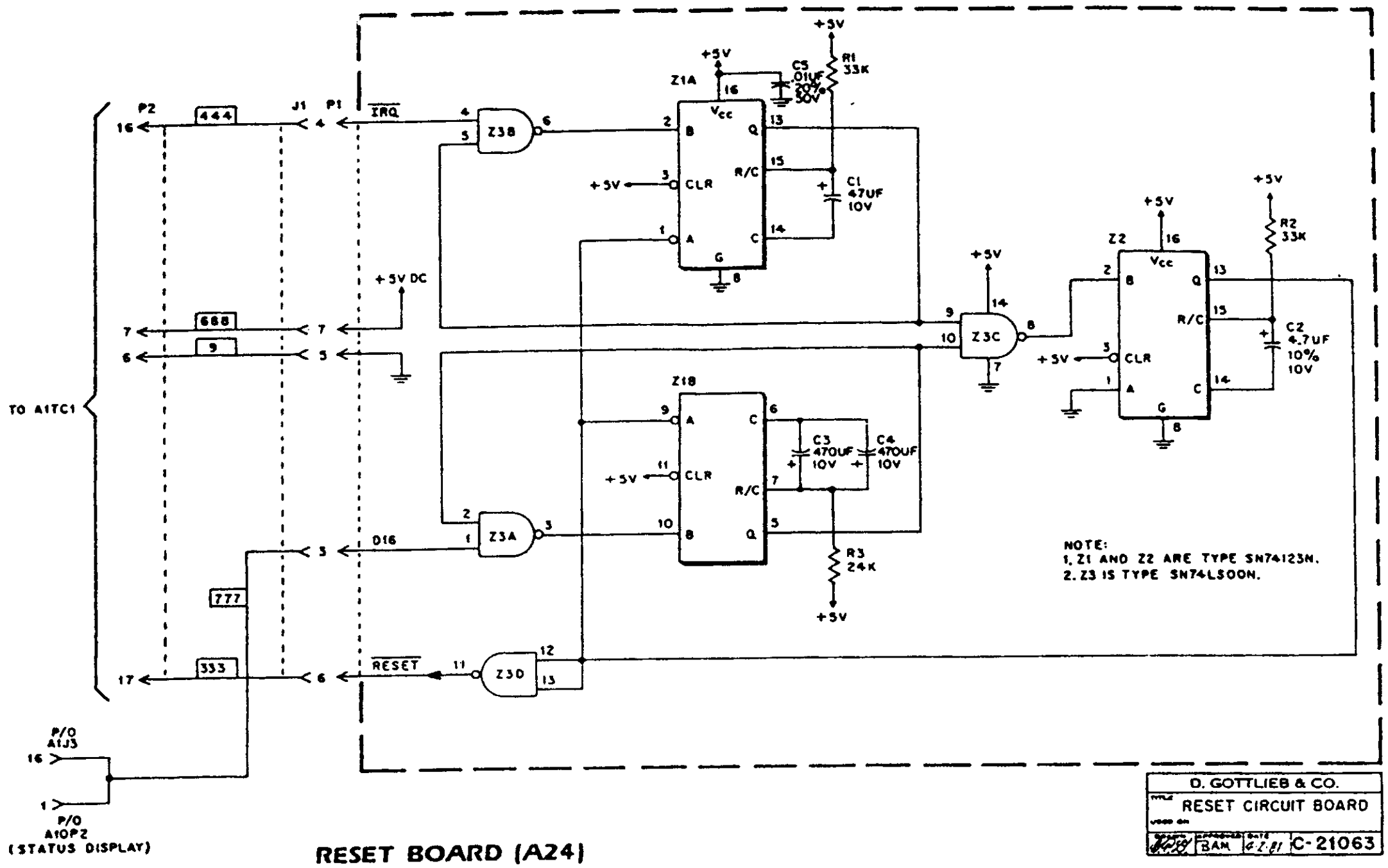
Gottlieb now has available a reset circuit modification kit that, when installed, will automatically reset the game if a lock-up condition occurs. The reset board will detect the absence of the /IRQ signal and/or a display digit strobe. Either signal missing will generate a reset pulse to the 6502 microprocessor, resetting the game to the game over mode.

The kit contains everything necessary for quick on-location installation. When ordering, specify the MA-158 Reset Circuit Modification Kit.

NOTE: The reset circuit modification is not necessary if lock-up problems are not experienced.

(Page 2 - installation instructions, and a 3rd (missing) page with a connection diagram)

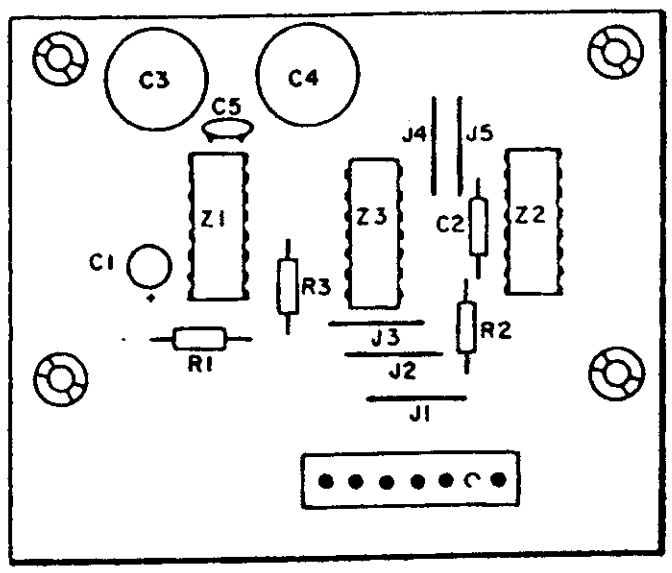
****



NOTE:
1. Z1 AND Z2 ARE TYPE SN74123N.
2. Z3 IS TYPE SN74LS00N.

D. GOTTLIEB & CO.			
RESET CIRCUIT BOARD			
	BAM	6-7-81	C-21063

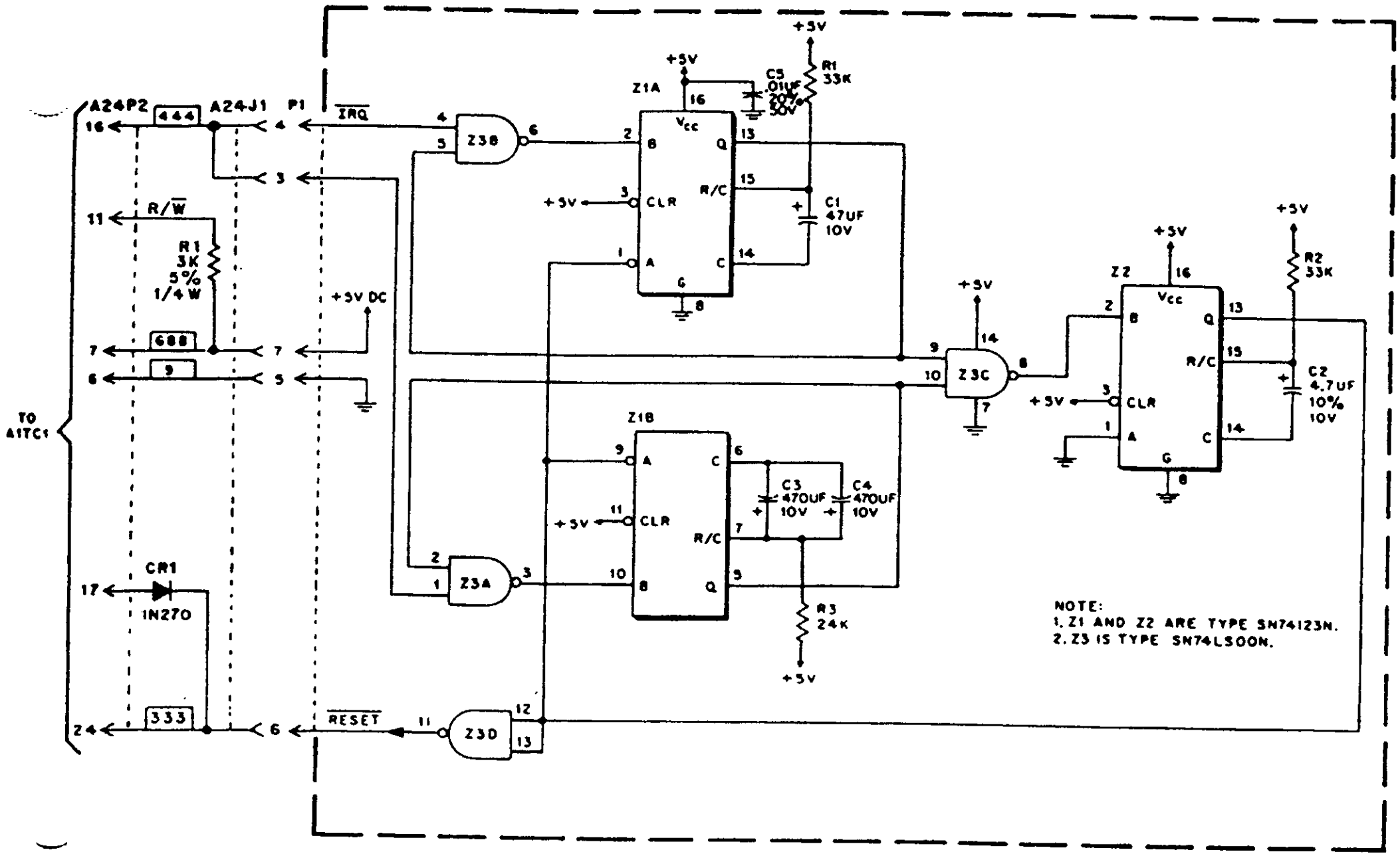
RESET BOARD (A24) COMPONENT LOCATION



RESET BOARD (A24) PARTS LIST

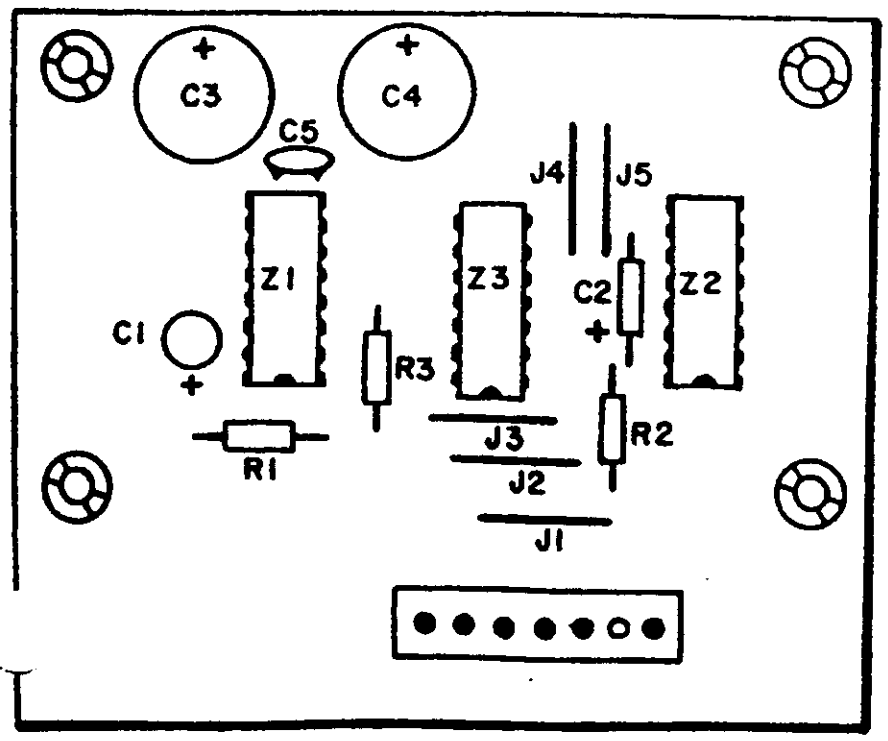
REFERENCE	DESCRIPTION	PART NUMBER
R1, R2	Resistor 33K ohm, 5%, 1/4W.	XO-43
R3	Resistor 24K ohm, 5%, 1/4W.	XO-10
C1	Capacitor 47 µfd., 10V.	XO-227
C2	Capacitor 4.7 µfd., 10V.	XO-226
C3, C4	Capacitor 470 µfd., 16V.	XO-214
C5	Capacitor .01 µfd., 50V.	XO-229
Z1, Z2	IC 74123N	XO-398
Z3	IC 74LS00N	XO-427
	7 Pin Connector	XO-526

X. WIRING AND SCHEMATIC DIAGRAMS, PARTS LISTS



Premier Technology			
TITLE: RESET CIRCUIT BOARD			
USED ON:			
DRAWN	APPROVED BAM	DATE 9-2-81	C-21063

RESET BOARD (A24)
COMPONENT LOCATION



RESET BOARD (A24) PARTS LIST

REFERENCE	DESCRIPTION	PART NUMBER
	RESET BOARD	MA-164
R1, R2	Resistor 33K ohm, 5%, ¼W.	XO-43
R3	Resistor 24K ohm, 5%, ¼W.	XO-10
C1	Capacitor 47 µfd., 10V.	XO-227
C2	Capacitor 4.7 µfd., 10V.	XO-226
C3, C4	Capacitor 470 µfd., 16V.	XO-214
C5	Capacitor .01 µfd.	XO-202
Z1, Z2	IC 74123N	XO-398
Z3	IC 74LS00N	XO-427
	7 Pin Connector	XO-526
A24P2/A24J2	Cable Assembly	MA-796

Premier Technology

RESET BOARD INTERCONNECT CABLE

ADDENDUM

ATTACHED TO AND PART OF ICE FEVER (GAME # 695)
AND ALL SUBSEQUENT GAMES
INSTRUCTION MANUALS

1. To prevent intermittent bookkeeping RAM (Z5) failures, a 3K, 5%, ¼W resistor (XO-23) has been added to the circuit in order to increase the drive capability of the R/$\overline{W}$ output of the Microprocessor (U1-34).

2. This resistor is part of the Reset Board Interconnect Cable Assembly MA-796, and is positioned on A24P2, between Pins 7 and 11. See Figure 1.

3. Diode CR1 (XO-265) has been added between Pins 17 and 24 to isolate the reset output on the Control Board (A1) from the reset output on the Reset Board (A24). Prior wire connection at Pin 17 was transferred to Pin 24.

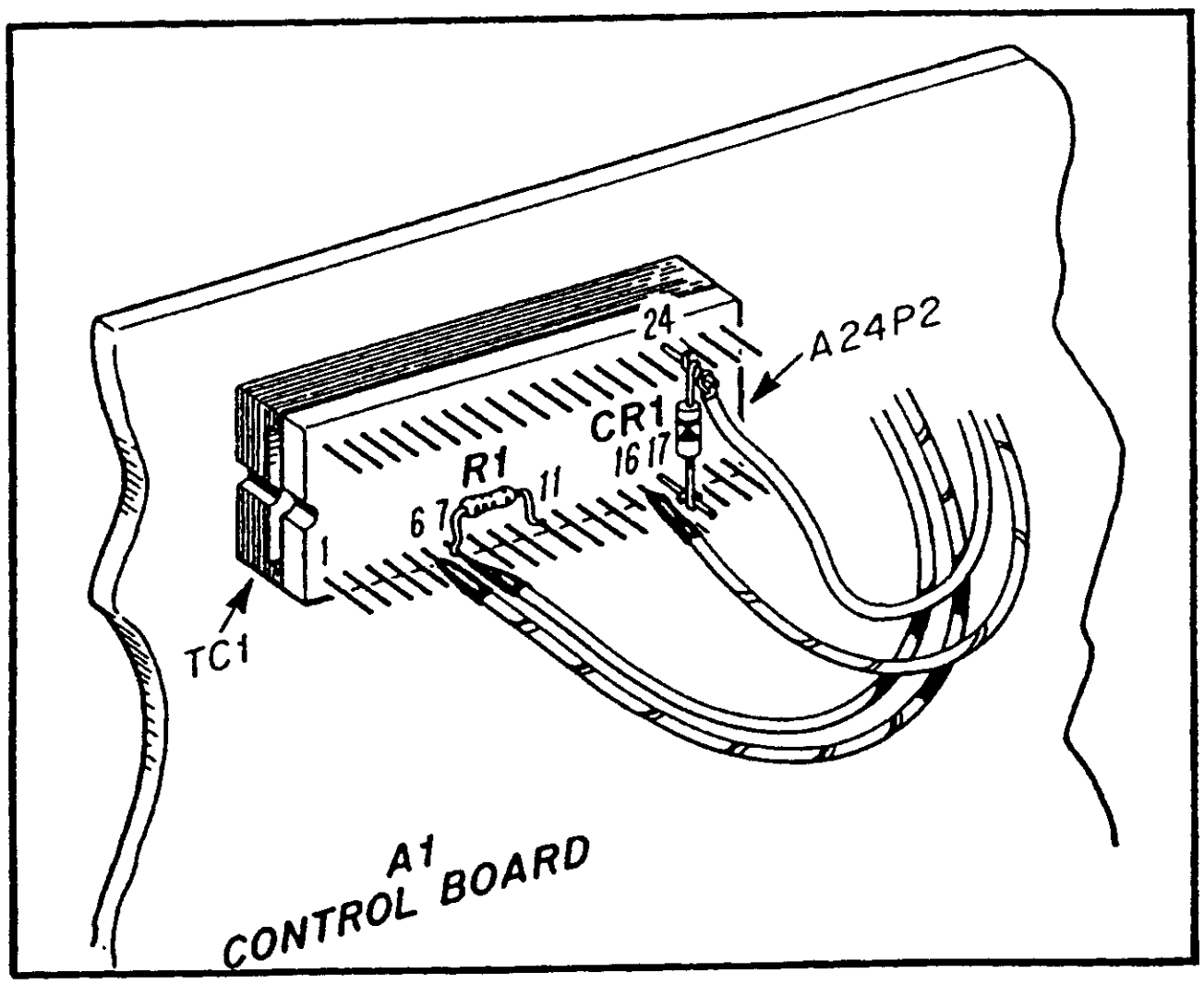


Figure 1.

SUBJECT:General Troubleshooting Guidelines
FILE: GENTSGD2.DOC
11/20/94 12:18 PM

- Suspect previous work. Other people's work may not be nearly as good as your own. (Or as poor.)

- "Go back to the scene of the crime." If you just made a change, suspect you OWN previous work first, not another new or different problem. Go back to the thing you just changed - you might not have done something correctly, left a part out, connector off, etc.

- Electronic failures often are "domino-ed". Like dominoes falling over, rarely does only one part fail. Often a failed part takes out the one before it or maybe several items in the circuit path. (The coil burns, and ruins the driver transistor, AND the control transistor, AND the control IC, AND the PIA, etc., when you are really unlucky.)

- Voltages MUST be correct, or the game is going nowhere. The first step is check ALL of the voltages. (And all of the fuses! NEVER OVER-FUSE!)

- If something breaks, of even if something in the game just doesn't seem right, TURN IT OFF and find the problem. It only will get more expensive.

- Replace socketed devices first. They are the fastest and easiest to change.

- Always cut out bad ICs to replace them (if they are not socketed). Circuit boards are MUCH more valuable (and expensive) than ICs. ALWAYS use a socket when replacing ICs! Use strip sockets to avoid poor contact problems under sockets on double-sided circuit boards.

- Suspect the chips with the most legs. Occasionally true, but don't get carried away with trying this fix.

- If it ain't broke, don't fix it! Don't over-do your fixing!

- Make only one change at a time. Go slowly, and try the circuit board or game after each fix, one step at a time. A whole lot of changes at once will make it difficult to locate a problem.

- Swap known good boards if you have them or can borrow one from a friend. BE CAREFUL OF FAILURES CAUSED BY HIGH VOLTAGE SHORTS TO THE LOGIC SUPPLY. Also, shorted coils or coil diodes can ruin a driver transistor on a substitute board. Use this method only if you have some good working knowledge of electronic games! A safer method is to compare your problem game with test results made on a second, working game.

  On Bally CPU boards, you can swap U10 and U11 to see if problems follow the IC, since they are identical devices. (They may be either 6820 or 6821 PIAs, but could also be numbered with Bally part numbers. - see schematics and other documents for details.)

44 STEPS TO GET YOUR ELECTRONIC PINBALL MACHINE UP AND RUNNING

0. DO NOT APPLY POWER UNTIL COMPLETING THE FIRST 33 ITEMS ON THIS LIST!!!! *

1. PICK UP ALL LOOSE ITEMS IN BOTTOM OF CABINET & SAVE IN COINBOX - IMPORTANT HISTORY!
2. BLOW OUT CABINET WITH COMPRESSED AIR (DO OUTDOORS IF POSSIBLE!)
3. VACUUM EVERYTHING INSIDE GAME WITH SHOP VAC. USE 2" PAINTBRUSH AS DUSTING BRUSH.
4. CHECK 3-PRONG POWER CORD PLUG - REPLACE IF MISSING 3RD PRONG OR OTHERWISE DAMAGED.
5. INSPECT ENTIRE LENGTH OF POWER CORD - REPLACE IF CUT OR DAMAGED (USE 18-3 POWER CORD).
6. REMOVE & INSPECT ALL FUSES, ONE AT A TIME, CHECK FOR CORRECT VALUE & TYPE. REINSTALL.
7. REMOVE BATTERY(S), MEASURE VOLTAGE, DISCARD OR SAVE FOR REINSTALLATION.
8. REMOVE ALL CIRCUIT BOARDS , INSPECT FOR OBVIOUS DAMAGE AND CLEAN & DRY.
9. RESOLDER ALL HEADER PINS ON ALL CIRCUIT BOARDS, CLEAN OFF FLUX WITH ALCOHOL.
10. CAREFULLY REMOVE ALL SOCKETED CHIPS, INSPECT PINS, & REINSERT CORRECTLY!
11. INSPECT BOARDS FOR BENT, BURNED, MISSING OR OTHERWISE DAMAGED COMPONENTS.
12. INSPECT BOARDS FOR PREVIOUS REPAIRS - SUSPECT POORLY DONE PREVIOUS REPAIR WORK!
13. INSTALL NEW BATTERY(S) AND LABEL WITH DATE.
14. PROTECT AGAINST CPU DAMAGE - REMOTE MOUNT BATTERY(S)!
15. RE-INSTALL ALL CIRCUIT BOARDS.
16. REMOVE ALL DISPLAY UNITS AND CLEAN (RESOLDER BALLY HEADER PINS).
17. INSPECT POWER SUPPLY CONNECTORS FOR BURNED PINS & REPLACE IF DAMAGED.
18. INSPECT ALL WIRING FOR BURNED OR DAMAGED SECTIONS - REPAIR OR REPLACE AS NEEDED.
19. REPLACE ALL #44 LAMPS WITH #47 LAMPS - POWER SUPPLIES WILL CONSUME 40% LESS POWER!
20. CLEAN & INSPECT TOP SIDE OF PLAYFIELD, REPLACE LAMPS, REPAIR BROKEN PARTS, ETC.
21. INVERT PLAYFIELD TO SERVICE POSITION & INSPECT FOR BROKEN WIRES, OTHER DAMAGE.
22. REPLACE ALL LAMPS ON BOTTOM SIDE OF PLAYFIELD WITH #47 LAMPS.
23. CLEAN & ADJUST ALL PLAYFIELD SWITCHES, BOTH ON TOP & BOTTOM OF PLAYFIELD.
24. OPERATE BY HAND ALL MOVEABLE LINKAGES TO ENSURE THEY DO NOT BIND.
25. REBUILD POP BUMPER UNITS AS NEEDED (MINOR OR MAJOR OVERHAUL).
26. REBUILD FLIPPER ASSEMBLIES AS NEEDED (MINOR OR MAJOR OVERHAUL).
27. CLEAN & LUBRICATE DROP TARGET ASSEMBLIES (MINOR OR MAJOR OVERHAUL).
28. REINSTALL CIRCUIT BOARDS, PLUGGING CONNECTORS ON/OFF 5 TIMES TO CLEAN.
29. INSPECT GROUND BRAID WITH DVM TO 3RD PRONG IN SEVERAL PLACES IN GAME. REPAIR IF NEEDED!
30. CLEAN PLAYFIELD, FLATTEN PLASTIC LIGHT SHIELDS, REPLACE RUBBER RINGS, REPLACE LAMPS.
31. INSPECT BALL(S) FOR DAMAGE, REPLACE AS NEEEDED, PUT THE CORRECT NUMBER OF BALLS IN GAME.
32. CHECK ON/OFF SWITCH WITH DVM, VERIFY "OFF" AND PLUG ONLY INTO A GROUNDED OUTLET!
33. DISCONNECT POWER SUPPLY OUTPUTS, TURN ON GAME AND TEST OUTPUT VOLTAGES.
34. IF VOLTAGES ARE OK, TURN OFF GAME AND RECONNECT POWER CONNECTORS.
35. CONNECT DVM TO HIGH VOLTAGE OUTPUT TEST POINT (BALLY).
36. OBSERVE FUSES AND TURN ON POWER - WATCH FOR FLASH OF FUSE(S).
37. ADJUST DISPLAY HIGH VOLTAGE ON BALLY & GTB-1; ONLY TEST VOLTAGE ON GTB-80 & WILLIAMS.
38. TEST ALL OTHER VOLTAGES FOR CORRECT VALUES.
39. IF GAME DID NOT BOOT, REFER TO SPECIFIC TROUBLESHOOTING SECTIONS BY GAME BRAND.
40. IF GAME BOOTED, TRY CREDIT SWITCH ON DOOR TO ADD CREDITS.
41. TEST GAME SEQUENCING OF BALL, OUTHOLE WORKS?, COUNTS 3 OR 5 BALLS?, GOES TO "GAME OVER"?
42. PERFORM DIAGNOSTIC TESTS - VARIES BY GAME BRAND - SEE GAME MANUAL.
43. REFER TO GAME SPECIFIC TROUBLESHOOTING GUIDES FOR FAILED LAMPS, SOLENOIDS, ETC.

* Computer people number things starting with zero - we are sort-of computer people (actually electronic engineers).

The Pinball Lizard

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- Compare common circuits that are duplicated in the game. If you look at the outputs of the switch matrix while it is running, and there are 8 separate outputs, and seven look the same and one does not, the one is probably faulty.

- Don't wiggle connectors to get something to work. There is probably a cracked solder joint or corroded connector. Fix it right!

- Don't eliminate connectors and solder wires to circuit boards! This is called NON-SERVICEABLE, among other things.

- Don't just "Plug 'er in and try 'er" when you get that new game home! If it LOOKS really bad, it probably IS really bad! If the CPU board has been corroded or the game was sitting in storage for a long time, save your curiosity for another occasion. Do you REALLY believe the game will work the first time in that condition? And will it work well? And keep on working?

- It may seem really obvious, but change only one connector pin at a time. It will be a little slower that way, but the slow method could save you from causing major damage to your game. Sometimes the wire colors have faded or don't agree with the schematic colors.

- Don't replace lamps in a live game or adjust switches with a metal tool in a live game. Yes, it takes longer to shut it "OFF" each time, but I promise it will take even longer to fix it if you short the solenoid voltage power into the switch or lamp matrix, or accidentally ground some circuit's output.

- "Split the system". Also called "Divide & Conquer". Pick a place somewhere and see if things work at that point. No? Then go back to another point and try there until you find a spot where things ARE working. This technique is also used to repair circuit boards. A friend calls it "Slice & Dice", which means you may need to cut a trace or two when looking for a short using this method.

- What you have just brought home is a COMPUTER, albeit a special purpose one, but just the same a computer. If you wouldn't even think of putting your TV, stereo, VCR, or home computer outside for 6 months, (or some such other adverse weather storage abuse), why would you do this to your Electronic Pinball Computer Machine?

- We are all limited by our experiences. If we haven't done something yet, we don't know what to do. Try stuff. As you continue to try things, you eventually will find something that isn't working quite right. Nobody knows everything. We are all still learning, each and every day. The more troubleshooting you do, the more things you try, the more you will learn and it will become easier to do the next time.

- **The Last Word:** There are lots of problems out there. We just haven't found them all yet.