INSTRUCTIONS MANUAL AND TROUBLESHOOTING

LAST LAP

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I N T R O D U C T I O N

The machine "LAST LAP", Solid State System has been designed employing the new technique of MICRO-PROCESSORS. Such a system has numberless advantages as: high reliability, absence of interferences and spectacular reduction of necessary components. All that reduces infinitely the failure probability.

For more versatility, easy failure and common stock pieces location in the distinct models of machines the electronic circuits unit has been divided into different modules:

1.- RELAYS MODULE
Its function consists in driving current to the distinct electromagnets necessary for the play and cutting the current to these electromagnets in case of Tilt or Game Over.

2.- TARGET RELAY
Its function consists in raising the targets.

3.- THYRISTOR MODULE
Its function consists in controlling the different lights that are to be lighted during the play.

4.- BELLS MODULE
Its function is transforming and amplifying some voltage impulses to the different frequencies that are characteristic for each note.

5.- DISPLAYS MODULE
Has as function to visualize in digital form the score of the players.

6.- DECODER MODULE
Its work consists in helping the MPU module to control balls, cone, displays and relays module.

7.- CREDIT AND MATCH FEATURE MODULE
Has as function to visualize, in digital form, the credit and match feature.

8.- MPU MODULE
Its work consists in receiving information from the different contacts of the machine, processing this information and using it to govern the distinct modules.

GENERAL INSTRUCTIONS

When you receive the machine, or, after a long time (two months), without using it, and you connect the machine, it is possible that some numbers of the displays do not turn on and that the credit shows a number different from zero. You must make the necessary adjustments in order to put the machine ready for playing and the problem will be solved.

All the MPU inputs and outputs have voltages around 5V, but at very high frequencies. Because of that, it is impossible to measure them with a normal voltimeter.

All the wires that go in and out the MPU have a series resistors to limit the maximum shortcircuit current.

Due to the small intensity that goes through the wires going in and out the MPU, it can be derived to ground through the human body when touching a wire. It is absolutely normal and it does not affect the normal operation of the machine.

For better operation of the electronic part of the machine a special and independent winding has been made in the supply transformer. Try, naturally, to avoid shortcircuits with any other winding.

Be always sure not to apply more than the correct voltage to MPU. If higher voltage is applied, an internal protection circuit will operate blocking the machine. The symptons that will be produced are: none of the lights will turn on, the digital counters for credit and match feature will be off and the displays will keep the same scores without appearing the SCORE TO DAY.

The 3 Amp.fuses, that feed the lamps, have been calibrated to blow in case of shortcircuit in a lamp socket. So, do not use fuses of a higher value, since the diode and the thyristor could get damaged, instead of blown the fuses.

All the contacts that are placed on the playfield, form a matrix. Due to this configuration, there are five common conductors and always only one of them will have current. First conductor A, afterwards B, then C, D and finally E. And the cycle will be repeated.

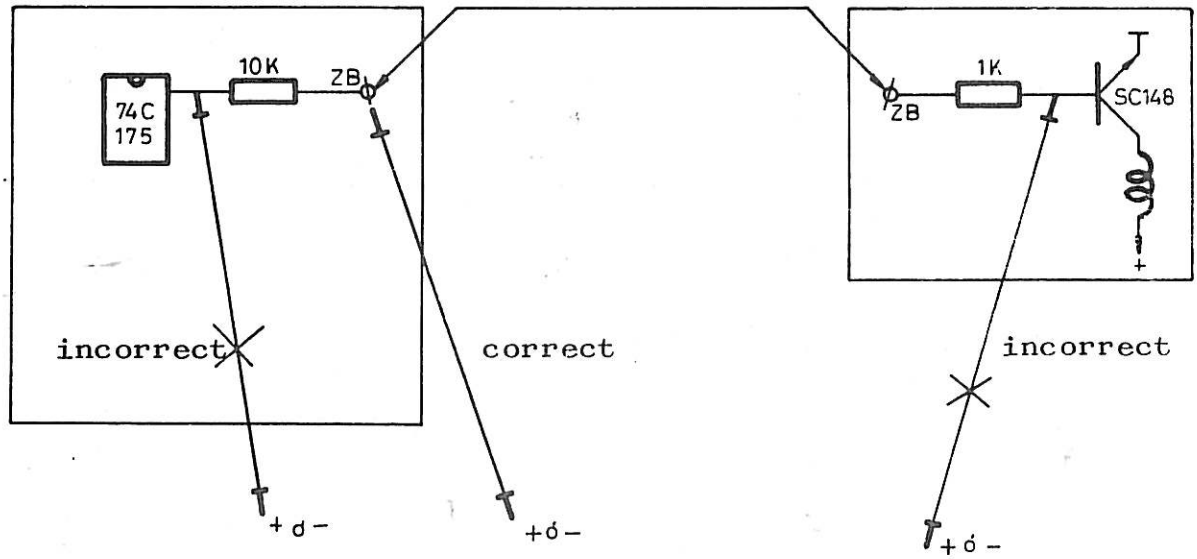
When the machine is in Game Over, the cycle will be between A and B. At the beginning of the play the whole cycle will occur.

With this matrix location, it is easy for MPU to know which is the closed contact, since MPU knows which column, by the moment, has current and also trhough which input returns the current.
If anyone of the contacts remain closed, MPU is programmed to overlook it and to act as if that contact were always open.

The information, which is visualized on the displays, is refreshed 30 times in a minute, because it could be lost due to the interferences. This is the reason why we will see the test lamp blinking, when we test the command signals L1 to L8 with the test point.

For checking and in case of failure, it is possible to make bridges to positive or to negative. It is important, when making these bridges, not to make them directly from the inputs or the outputs of an integrated circuit or from the base of a transistor, but always through a resistor, that normally is connected to them.

Example:



IMPORTANT REMARK

In the preseries the memories used are EPROM. For supply they need special voltages: +5 VDC ± 0'5 V at pins 24 (This is the same voltage supply for the integrated circuits placed in the module), +12 VDC ± 0,5 V at pins 19; -5 VDC ± 0,5 V at pins 21.

In the series the memories will be ROM and for them no special voltage supply is needed. In these machines the supply voltage will be + 10 VDC ± 0,5 V, just the same as the voltage used for integrated circuits. In these machines the components used for the special voltages will be supressed.

The troubleshootings in the MPU module are explained for the preseries machines, that means, with voltages + 5V,+12V and - 5V. For the rest of the series it will be easy the interpretation by changing + 5V by + 10V.

In the DECODER module and for the preseries there have been used integrated circuits LM 324, whose function is to raise the voltage level from 5 volts coming from MPU to 10 volts which is the voltage of duty at DECODER module. When the memories are ROM all these circuits will disappear since the duty voltages in MPU and DECODER module are the same.

GAME ADJUSTMENTS

At the moment of connecting the machine to the voltage line, at the credit and match feature counters, the numbers 1 to 6 will appear. These numbers correspond to the test which verifies the MPU module. When the machine is at the Game Over state, there is a continous movement of the lights on the board. It is at this moment that the adjust or control push buttons, as described below, can be operated.

1.- Push-button 1 M (Located at the coin door)
When pushed, the number of coins, that have passed through the first coin selector, is visualized at the first player display. After two seconds this information is erased although the button is still pushed. To visualize the number of coins again, it is necessary to push the button once more.

2.- Push-button 2 M (Located at the coin door)
When pushed, the number of coins, that have passed through the second coin selector is visualized at the first player display. After two seconds this information is erased although the button is still pushed. To visualize the number of coins again, it is necessary to push the button again.

3.- Push-button 3 M (Placed at the coin door)
When pushed, the number of coins, that have passed through the third coin selector is visualized at the first player display. After two seconds this information is erased although the button is still pushed. To visualize the number of coins again, it is necessary to push the button once more.

4.- Push-button Credit by coins (Placed at the coin door)
When pushed, the total number of coins by credit, that have passed through any of the coin selector, is visualized at the first player display. After two seconds this information is erased although the button is still pushed. To visualize the number again, it is necessary to push the button once more.

5.- Push-button Credit by Awards. (Placed at the coin door) When pushed the credit, that the players have reached by Special, points, "Score to date" and Match Feature is visualized at the fist player display. After two seconds this information is erased although the button is still pushed. To visualize this number again, it is necessary to push the button onece more.

6.- Push-button first credit by score (points). (Placed at the coin door). When pushed, it is visualized at the first player display at which score will be given the first credit. If the button continues pushed, after two seconds, the score will begin to raise by adding 10.000 points each two seconds. When the desired score is reached, leave the button free. If not desired to give any credit by score, set the score to 000.000.

7.- Push-button second credit by score (placed at the coin door). When pushed, at the first player display is visualized at which score will be given the second credit. If the button continues pushed, after two seconds the score will begin to raise by adding 10.000 points each two seconds. When the desired score is reached, leave the button free. If desired not to give any credit by score, set the score to 000.000.

8.- Push-button third credit by score (Placed at the coin door)
When pushed, at the first player display is visualized at which score will be given the third credit. If the button cintinues pushed, after two seconds, the score will begin to raise by adding 10.000 points each two seconds. When the desired score is reached, leave the button free. If desired not to give a third credit by score, set the score to 000.000.

9.- Push-button Score to Date. (Placed at the coin door) When pushed, the score at which teh "Score to Date" is regulated, falls down instantaneously to 500.000 points in order to allow to put the "Score to Date"s score at a quantity less than the one obtained by the players. If the button continues pushed, after two seconds the score will begin to raise by adding 10.000 points. When the desired score is reached, leave the button free. The award of Score to Date is given by the machine when surpassing in 100, 1000, or 10.000 points the established score and once obtained follows the score of the player who it has obtained.

When a player reaches the "Score to Date"s score the machine will give him 3 credits, a special music will sound and a frontal light, showing "Score to Date" will turn on. This light will remain on during the whole game indicating in this way that one player has surpassed the highest score and if another player wants to obtain the award of the "Score to Date", he should beat him.
If desired to disable the "Score to Date" award, it is enough to set the score to 000.000.

In case a player should surpass the quantity of 999.000 points, the machine remains automatically regulated at 999.000 points, independently of the score he should surpass.

10.- Push-button Test (Placed at the coin door)
It is used to verify the correct operation of the machine.
When the push-button is pushed, it works as explained below:

1/ The frontal lights are on, except those of the four players and the playfield lights, which do not operate during the light play, that takes place during the Game Over, enabling so to check if there are any defective lights.

2/ The taca sounds, the targets appear , a ball is dispensed and also the game current supplied. So, flippers, bumpers and kickers can be operated. With the test is possible to verify the correct operation of the electromagnets parts.

3/ The displays of the four players have to show 8888 except the one of the first player which will show 8888?? and in the tenths and unities the number of the contact that at that moment is closed.
The Credit and Match feature will be at 18 and 800 respectively.

With this can be verified that the segments of the displays, credit counters and match feature do not have any defect. Now it is possible to check if there are no closed contacts, except the suede contact, which must be closed. If we open this contact for a moment, the display will show the number 00.
It is also possible to check all open and dirty contacts, moving the ball through lanes, buttons and rebounds. Each contact will force the display to show its number.

Switch 5 ball - 3 balls (Placed in the M.P.U. Module light box).
In a match 3 or 5 balls will be available depending on the state of the switch.

Switch EXTRA BALL - GAME (placed in the light box, module M.P.U.)
In Game position, the credit counter will add the credits obtained through Specials, Score, Score to Date and Match features.
In EXTRA-BALL position, an extra ball will be available, when during the game Specials, Score awards or Score to Date awards have been obtained.
In this positions the match feature is cancelled.

Switch second selector (Placed in the light box, module M.P.U.).
With this conmutator, the number of credits which the second coin selector will produce, when putting a coin can be regulated.The available positions are: 1/2, 1, 3/2, 2, 3, 4, 5, 6 credits.

If we have the switch in the 1/2 position and introduce a coin, no credit will be given, but introducing a second coin a credit will appear at the counter.
If we have the switch in the 3"3 position and introduce a coin, one credit will appear at the credit counter and1/2 credit will be memorized waiting for the second coin. If in this moment we set the machine in play, the half credit will be kept until Game Over and at this moment this half credit will be cancelled.

Switch third selector (Placed in the light box, M.P.U. module).
With this switch can be regulated the number of credits the third selector will give when introducing a coin.
The available positions are: 3,4,5,6,7,8,9 and 10 credits.

In the machines, which have installed three selectors, the first selector always gives only one credit.

11.- Push-button Reset. (Placed at the light box)
When pushing this button, the information contained in memories of push-buttons 1,2,3,4 and 5 is set to zero. It also sets to zero the credit counter.

DETAIL OF THE ELECTRONIC COMPONENTS USED IN THIS MACHINE

In the procedures of troubleshooting some methods of verifications are used:

1.- Test voltages with the voltimeter.
Having this instrument, it will be set to read continuous or alternated voltage depending on the kind of voltage we need to measure. The negative plug of the voltimeter will be connected to the negative pin of the MPU and with the positive plug the different points will be checked.

2.- Continuity test with ohmeter.
For this test, it is necessary to disconnect the machine from the voltage line. Once the machine is disconnected, continuity can be checked between the desired points.

3.- Test if TL (Test Lamp) gets lighted.
In the DECODER module a little lamp has been incorporated. This little lamp gets lighted with voltages of 2,5 V. To check if there is enough voltage in a certain point, just touch the point with the incoporated plug.

RESISTOR

It is a component that offers a resistance or difficulty to the pass of the current. Its function in the machine is to create a voltage drop (Bumper lights) and to limitate the current, that flows to a certain component. (Thyristor, transistor .....).

CAPACITOR

It is a component which stores an electrical charge and supplies this charge, when the voltage, which has produced this accumulation disappears. Its function in the machine is to provide pure continuous voltage (electrolitics) and eliminate the parasites produced in the alternated current.

DIODE

It is a component that only allows the pass of the current in one sense. When the anode is positive and the cathode more positive, the diode behaves as an open circuit, but if the cathode is more negative the diode behaves as a short circuit. (See fig.1)

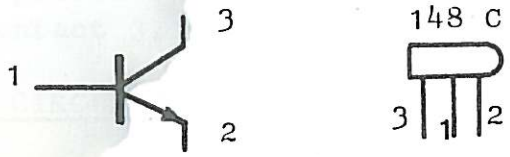
Fig. 1



TRANSISTOR

The function of the transistor in these machines is called switching. (See Fig. 2)

Fig. 2

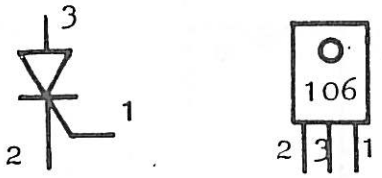


Pin 2 (emitter) is connected to the negative. Pin 3 (collector) is connected to the positive through a load (ex. coil relay). When we apply a positive current to the base (pin 1), the transistor will switch, remaining joined electrically pins 2 and 3. In this way we have the load between the positive and negative potential. When the current at pin 1 stops the transistor will be opened, leaving an open circuit for the negative potential. (See fig.4)

THYRISTOR

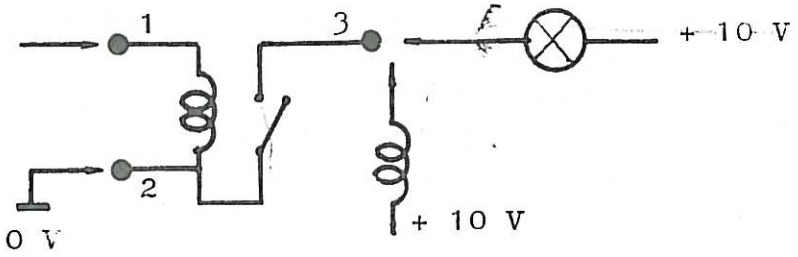
It is a controlled diode. Pin 2 (cathode) is connected to the negative potential. If we apply a potential of 1 volt with a current of 1 Ma. (0.001 A.) to pin 1 (gate), the diode will allow the pass of current, if pin 3 (anode) is positive. When the voltage in pin 3 becomes negative, the diode will stop conducting if the voltage in pin 1 has disappeared (See fig. 3).

Fig. 3



For easy comprension we can find for the transistor as well as for the thyristor a resemblance with an electro magnetic relay of an open contact. (see fig.4)

Fig. 4



We connect coil terminal 2 to OV voltage and also one of the little plates of the contact.
Through the coil terminal 1 we apply an impulse which necessarily has to be positive. At this moment the relay remains activated, closing the contact which passes the negative potential OV to the plate of contact 3.

INTEGRATED CIRCUITS

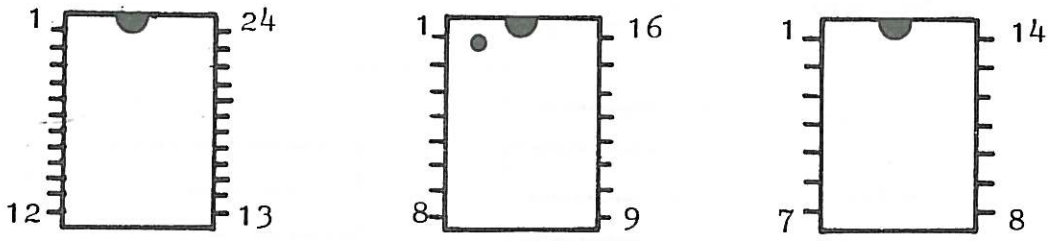
Due to the great number of electronic components (resistors, transistors, diodes...) employed in these integrated circuits, some defining symbols are used.
In this handbook the used integrated circuits are explained, but it is important to have a previous knowledge of some necessary details of its operation.

1.- Low state "0" It is defined when we have 0 volts

2.- High state "1" It is defined when there is supply voltage in a point. It will be 5V in the MPU and 10V in the Decoder.

3.- BUS It is used in the MPU module and defines a group of strips or cables which can be used by any of the modules connected to it.

4.- How the pins are numbered. Three practical examples of the numeration of pins 14, 16 and 24. (See fig.below)



For representing the integrated circuits, two different methods are used. One consists in representing them with a symbol when they are simple circuits such as logical gates. In that case an integrated circuit can be composed of 2 to 4 gates. The other method consists in representing the integrated circuits (IC) with a rectangle. This method is used when the IC is complex.

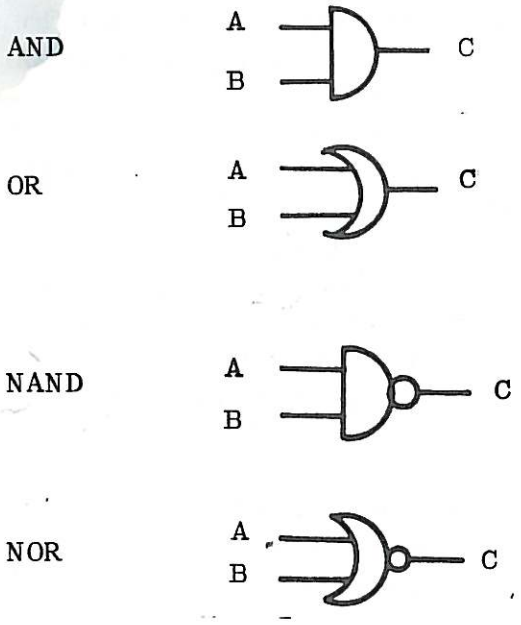
Representation with symbols:

AND GATES - when a and b are 1; c will be 1

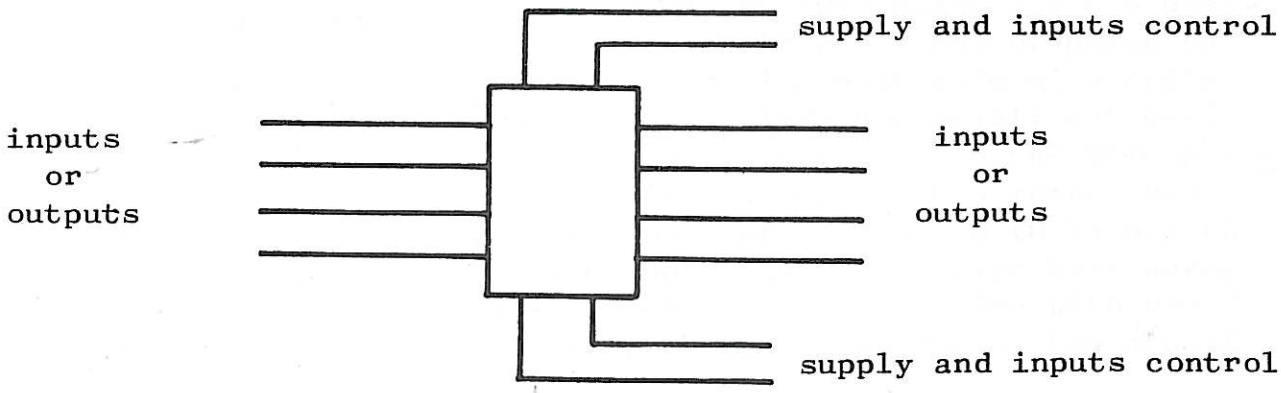
OR GATES - when a or b is 1; c will be 1

NAND GATES - when a and b are 1 then c will be 0
If one of the inputs (a or b) is 0 then c will be 1

NOR GATES - when a and b are 0 then c will be 1
If one of the inputs (a or b) is 1 then c will be 0
(See fig. below)



Representation with rectangles
(See Fig. below)



NOTE: After the troubleshooting methods of each module the function of the complex circuits is detailed.

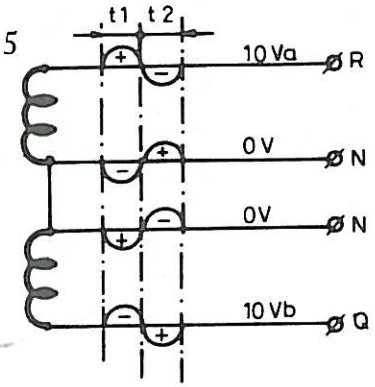
TRANSFORMERS

The primary of the main transformer is connected to the voltage through a fuse of 6A and has different inputs to be regulated according to the voltage line in each case.
The primary of the auxiliar transformer and the primary of the main transformer are joined in the 0-110V.

The secondaries of the main transformer are 0-7V, which are used to feed the lamp bulbs of the fixed lights. 0-28-30-33V, used to feed the electromagnet coils, whether in alternated current (direct from the transformer), in the case of the taca, ball dispenser, up-down targets, or through a rectifier bridge, which transforms the alternated current in continuous current, in the case of the flipper, bumpers and kickers.
The secondary of the auxiliar transformer is 10-0-10V. Its use in the machine is to feed the different electronic modules and the different lamp bulbs used during the game.

Something to emphasize for the comprehension of the thyristor function, are the waveshapes, which are present in each one of the three points. (See fig.5).

Fig.5



We will observe the waveshapes of a potential with regard to another. From 10Va to 0V and from 0V to 10 Vb.
When the 10Va point has the positive half wave, the 0V point has a negative half wave with regard to the 10Va potential; but positive with regard to the 10Vb potential, which at this moment has a negative half wave. (T1). Therefore, when the 10 Va has the negative half wave, the 0V point has a positive half wave, with regard to the 10Va potential, but negative with regard to the 10Vb potential, which at the moment has a positive half wave. (T 2).

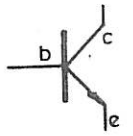
RELAYS MODULE

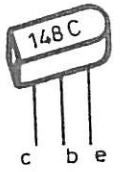
Sympton	Cause	Procedure
A) None of the relays closed	a) Supply failure	Test with a voltimeter. The voltage at the connector between + and - has to be 10 VDC $\pm$ 1,5V.
	b) 10V line open	Localize the failure in decoder module
	c) 10V line shorted	Carry out a visual inspection looking for shorts. Once localized, replace fuses in decoder module.
B) Game relay does not close	a) It does not receive the command impulse	With the test point on input Z and with the machine in game position, TL will be off. Localize failure in MPU module.
	b) Transistor open	With the test point on input Z and the machine ready for playing, TL will be on. Replace transistor.
C) Game relay is always open	a) Command impulse does not disappear	With the test point on input Z, TL will be always on. See failure in decoder module.
	b) Closed transistor	With the machine in Game Over and test point on input Z, TL has to be off. Replace transistor.
D) The balldispenser and target relays do not close.	a) Command impulse is not received.	With the test point on input SC; TL will be off. See failure in module MPU.
	b) Open transistor	TL gets on at SC input at the moment of removing the ball. Replace transistor.

Sympton	Cause	Procedure
E) The ball dispenser and target relays are always closed.	a) Command impulse does not disappear	With the test point on SC input, TL will be continously on. See failure in MPU module.
	b) Closed transistor	LT gets on at the moment of dispensing the ball when the test point is on SC input. Replace transistor.
F) The taca relays do not close	a) Command impulse is not received.	With the test point on ZB input TL will be always off. See failure in decoder module.
	b) Transistor open	With the test point on ZB input. TL will get on when a credit by award is given, Replace transistor.
G) The taca relay is always closed.	a) Command impulse does not disappear	With the test point on ZB input, TL will be always on. See failure in decoder module.
	b) Closed transistor.	With the test point on ZB input, TL will get on when a credit by award is given. Replace transistor.

COMPONENTS USED IN THE RELAYS MODULE

TRANSISTOR SC 148 C





PARTS OF THE MODULE

description	quantity
Transistor SC 148 C	3
Relay 1T 280 ohmios 15 A	3
Fuse 1K 1/4W 10%	3
Pin COMBOLINE	14
Printed circuits relays ref. 510068	1

THYRISTOR MODULE

Sympton	Cause	Procedure
A) None of the lights operates	a) Connector 10 fails	Test with a voltimeter if there is alternated voltage between the two pins of connector 10 and the potentials 10Va and 10Vb. The correct value is 10VAC. If the measured voltage is not correct, all the connectors between thyristor module and transformer should be checked.
	b) 3Amp fuses are open	Carry out a visual inspection and check fuses. Then look for shorts in lamp sockets and bulbs Replace fuses.
B) The two lights corresponding to the same thyristor are always on.	a) One of the diodes is closed.	Disconnect the corresponding connector. Test with ohmeter which diode conducts in both senses. Replace that diode.
	b) Respective thyristor remains open.	With the test point check the anode of the thyristor (central pin). TL will be off, even with command impulse. Replace thyristor.
C) A group of panel lights never get lighted.	a) Defective 3 Amp fuse.	Carry out a visual inspection. Then look for shorts in lamp sockets and bulbs. Replace defective fuses.
D) The two lights corresponding to the same thyristor do not turn on.	a) No command impulse proceding from MPU	See failure in MPU module
	b) The thyristor remains open.	With the test point, check the anode of the thyristor. TL will be on even with the command impulse. Replace thyristor.

Sympton	Cause	Procedure
E) A light never turn on	a) Fused bulb	See filament and replace bulb.
	b) Open diode	Disconnect the connector corresponding to the thyristor and diodes. With the ohmeter, check which diode conducts in both senses. Replace diode.

COMPONENTS USED IN THE THYRISTOR MODULE

THYRISTOR BT 106



DIODE SY 124



PARTS OF THE MODULE

Description	Quantity
Thyristors BT 106 A	23
Diodes SY 124	46
Fuses 10 K 1/4 W 10%	23
Pin COMBOLINE	72
Printed circuit thyristor ref. 510046	1

BELLS MODULE

Sympton	Cause	Procedure
A) The music is not heard	a) Supply failure	Test with a voltimeter in the input connector The voltage has to be 10 VDC ± 1,5V.
	b) Shorted or open 10V line	Localize failure in decoder module. Carry out a visual inspection for shorts. When the short is located, replace fuses in decoder module.
	c) Supply diode SY 124 is open	With the test point on the ± of the input connector, TL has to be on. On the cathode of the diode TL will be off. Replace diode.
	d) There is no CA5 impulse	With the test point on the + of the input connector and on the CA5 pin, TL has to be on when touching one of the playfield contacts. If it does not get on, see failure in decoder module.
	e) The loudspeaker coil is cutted	Check for continuity with the ohmeter the two terminals of the loudspeaker. If there is no continuity replace loudspeaker.
	f) Output transistors closed.	With the test point on the cathode of the supply diode, TL will be off. Replace output transistor and, if necessary, fuses in decoder module.
B) At maximum volume the music is weakly heard	a) One of the output transistors is open	Put the test point on the emitter of one of the transistors. If TL turns on when there is no music transistor MC 150 is open. If TL is off while there is no music, transistor MC 140 is open.
C) Hum is heard in the loud speaker	a) Supply diode SY 124 is open.	Try with another diode connecting it in parallel with the diode in the module. If the hum disappears, replace the diode.

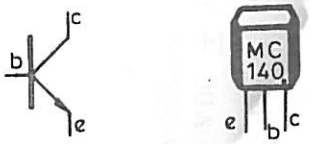
Sympton	Cause	Procedure
	b) Supply is superior to 10V.	See failure in decoder module
D) One or some notes do not sound	a) Command impulse fails	See if the command impulse arrives when touching a game contact, by testing with the test point on the pin of the input connector corresponding to the note which is not heard. If TL does not turn on, see failure in decoder module.
E) Fading is not heard	a) 4,7 uF capacitor is open,	With the test point on the positive terminal of the capacitor TL has to turn on quickly when giving a command impulse at CA 5.

COMPONENTS USED IN THE BELL MODULE

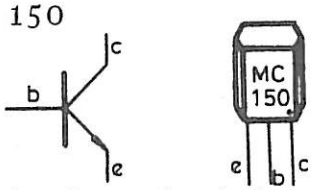
DIODE SY 124



TRANSISTOR MC 140



TRANSISTOR MC 150



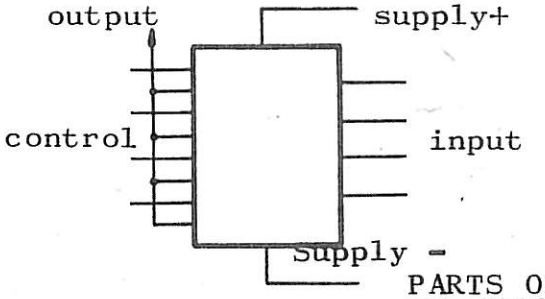
INTEGRATED CIRCUIT 4007 – When input a is 0, output b will 1 and vice versa. This circuit also amplifies the input voltage.



INTEGRATED CIRCUIT 4069 – Same function as IC 4007, but without amplification.



INTEGRATED CIRCUIT 4016 – When the control signal raises to 1, permits the pass of information from input to output.



PARTS OF THE MODULE

description	quantity	
Integrated circuit MC 14016BCP	1	
" " CD 4069 BE	1	
" " CD 4007 AE	1	
Diode SY 124	1	
Fuse 100 Ohms 1/4 W 10%	1	
" 1 K 1/4 W 10%	5	
" 100 K 1/4 W 10%	3	
" 240 K 1/4 W 2%	1	
" 330 K 1/4 W 2%	2	
" 430 K 1/4 W 2%	1	
" 560 K 1/4 W 2%	2	
" 580 K 1/4 W 10%	1	
" 1M 1/4 W 10%	2	
" 10M 1/4 W 10%	2	
Condenser styroflex 1 K 63 V 2%	1	
" electrolitic 4,7uF 10V	1	(tantalum)
" " 100 uF 16V	1	(radial)
" " 1000 uF 16V	1	(radial or axial)
" MKM 0,1 uF 250V	1	
Transistor MC 140	1	
" MC 150	1	
Potentiometer PT 15V 100 K with shaft	1	
Pin COMBOLINE	9	
Printed circuit bells ref.510067	1	

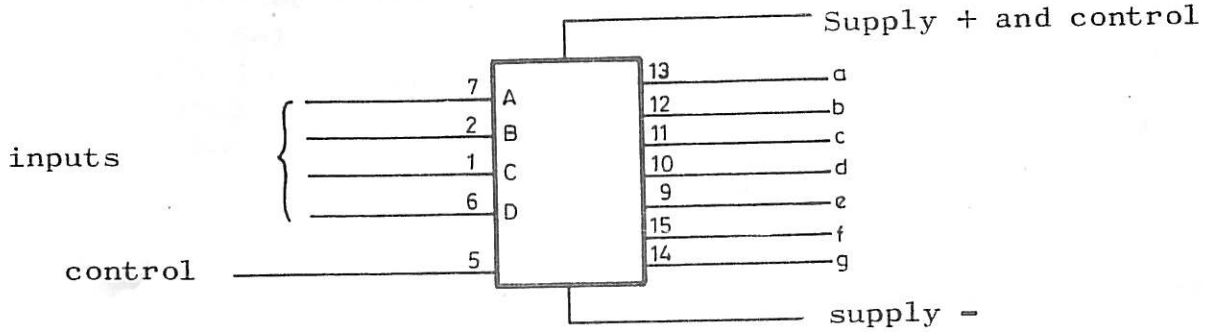
DISPLAYS MODULE

Sympton	Cause	Procedure
A) None of the numbers of the displays turns on	a) Supply failure	Test with the voltimeter the voltage at the input connector, which has to be 10 VDC $\pm$ 1,5V.
	b) Shorted or open 10V line	Localize failure in decoder module. Carry out a visual inspection for shorts. When found replace fuses in decoder module.
	c) Information superior to 9 in line L1 to L8	With the test point check in which line TL turns on. Verify with coding table and see which lines are connected to positive. Look for possible failure in decoder module.
B) A pair of numbers count even if it does not have to do so.	a) J control input is 0	Test with the test point that in input J, TL does not turn on. Look for failure in decoder module.
C) The unities hundreds and tenthousands do not count correctly.	a) One of the inputs L1, L2,L3,L4 is always 0	With test point on L1,L2,L3, and L4, TL has to blink. If not turning on, look for shorts or failure in decoder module.
	b) One of the inputs L1, L2,L3,L4 is always 1	With test point on L1.L2,L3 and L4, TL will be continously on. Look for shorts of failure in decoder module.
D) The tenths, thousands and hundredthousands do not count correctly	a) One of the inputs L5, L6,L7,L8 is always 0	With test point on L5,L6,L7 and L8, TL has to blink. If not turning on, look for shorts or failure in decoder module.
	b) One of the inputs L5, L6,L7,L8 is always 1	With the test point on these inputs TL will be continously on. Look for shorts or failure in decoder module.

Sympton	Cause	Procedure
E) A number of the display does not operate correctly.	a) Integrated circuit 4511 is damaged	Setting the test program on input D of the IC, TL has to turn on. When testing the outputs, (a,b,c,d,e,f,g,) TL has to be on in any case. If not, replace integrated circuit.
	b) Damaged number	Proceed with the same test as in point a). In this case we will see that, when checking the outputs, TL will be always on. Replace in this case, the pair of numbers.
F) The display shows the score of a player different from the one, who is playing.	a) Command impulses are not received at input J.	With the test point on the J input of the player whose score is wrong displayed, TL will be always off. Look for possible shorts or failure in decoder module.
G) A pair of numbers do not count correctly	a) Command input J does not become 0	Since 0 commands are very quick, it is impossible to test them with TL, or with a normal voltimeter. For checking we will make a bridge from J input to negative If the pair counts, the displays board is correct. In that case look for failure in decoder module.

COMPONENTS USED IN THE DISPLAYS MODULES

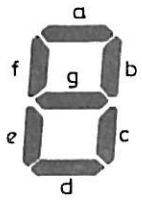
INTEGRATED CIRCUIT 4511

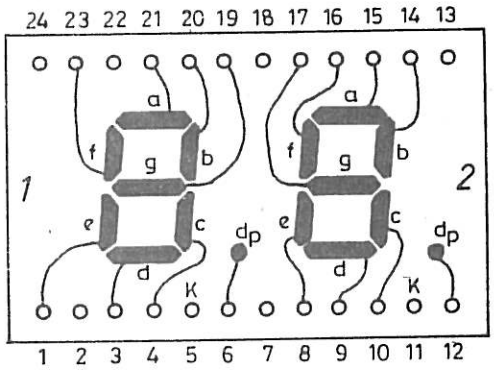


When the control signal becomes 1, the information in the ouput remains memorized. That means, if we change the inputs, the output will not change.

CONTROL	INPUTS				OUTPUTS						
	A	B	C	D	a	b	c	d	e	f	g
0	0	0	0	0	1	1	1	1	1	1	0
0	1	0	0	0	0	1	1	0	0	0	0
0	0	0	0	0	1	1	0	1	1	0	1
0	1	1	0	0	1	1	1	1	0	0	1
0	1	0	1	0	1	0	1	1	0	1	1
0	0	1	1	0	0	0	1	1	1	1	1
0	1	1	1	0	1	1	1	0	0	0	0
0	0	0	0	1	1	1	1	1	1	1	1
0	1	0	0	1	1	1	1	0	0	1	1

DISPLAY NSN 783





PARTS OF MODULE x 4 DISPLAYS

Description	quantity
Display NSN 783	9
Integrated circuit CD 4511 BE	18
Fuse 430 Ohmios 1/4 W 10%	126
" 1 K 1/4 W 10%	41
" 1K2 1/4 W 10%	4
Condenser disc 10k	9
Pin COMBOLINE	49
Printed circuitdisplays ref. 510063	4
Plastic Plate with zeros IS 147	3
" " without zeros IS 148	1

Description	Quantity
Plastic divider MG-16	12
Lampsocket B-13	3
Screw 1/8x15 c/p F-156	12
Nut 1/8 AD-2	15
Terminal F-16	3

DECODER MODULE

Symptom	Cause	Procedure
A) Loudspeaker hum or supply voltage higher than 10 ± 5V	a) Closed TIP 33 transistor	When testing with a voltimeter emitter and collector have the same voltage and basic voltage is 10 VDC ± 1,5 V. Replace transistor.
	b) Closed MC 140 transistor	When testing with a voltimeter emitter and collector have the same voltage and the basic voltage is 11 VDC ± 1,5 V. Replace transistor.
	c) Opened ZENER diode	When testing with a voltimeter, the basic voltage and collector of MC 140 is the same. Replace ZENER diode.
B) There is no voltage supply	a) Open fuses	Check possible shorts in decoder, bells, cone, relays and displays modules. Replace fuses. If the fuses would blow again, remove the connectors of the decoder module and replace fuses. If the fuses blow, the failure is localized. If the fuses do not blow, connect one by one the connectors corresponding to bells, cone etc. checking in this way when the fuses are blowing and enabling to localize the defect module. For repair see the corresponding module.
	b) Transistor TIP 33 open.	Testing with the test point TL will be on in the collector and in the base of this transistor, but not in the emitter. Replace transistor.
	c) Transistor MC 140 open	Testing with the test point TL will turn on in the collector and in the base of this transistor but not in the emitter. Replace tranistor.
	d) Zener diode closed	Testing with the test point, TL will not be on when touching the base of MC 140. Replace Zener diode.

Sympton	Cause	Procedure
	e) One of the diodes F31 closed.	Remove the fuses and check with the ohmeter for continuity in each of the diodes. Replace the shorted diode and put the fuses again.
C) bumper and players in game lights weakly illuminated	a) One of the fuses is open	Carry out an inspection for shorts in lamp sockets bulbs, cone lights, bumper lights and players in game. Replace fuses.
	b) One of the F31 diodes is closed.	Remove the fuses and check if any of the diodes are not conducting in any sense. Replace non conducting diode.
D) bumper and players in game lights do not get on.	a) Open fuses	Check possible shorts in lamp sockets, bulbs, cone lights, bumper lights and player in game lights. Check with the ohmeter if the two F31 diodes are not closed. Replace the diodes, if necessary, put the fuses again and check.
	b) One of the F31 diodes is closed.	Remove the fuses and check with the ohmeter for continuity in all diodes. Replace shorted diode and put the fuses again.
E) TL does not turn on when touching ± 10VDC	a) False contact of the female of the pin.	Observe in the test cable if the female which has to enter the pin is very open or if the cable is cut because of the use. Fix it and check again.
	b) Transistor SC 148 open	With the test point touching ± 10V, check with a voltimeter if the collector voltage is 12V and if the base voltage is 10V. Then, if the emitter voltage is 0V, replace transistor.
	c) LED diode open	Doing the same test as in point b), at the transistor emitter the voltage will be 11,5V and at the anode the voltage will be the same. Replace LED diode.

Sympton	Cause	Procedure
	d) IN4148 diode open	Testing with a voltimeter on the cathode, there will not be continous voltage. Replace LED diode.
G) One player in game lights does not turn on	a) There is no command impulse.	With the test point on the corresponding IC output, check it TL does not turn on. Then check if the gate inputs are correct or if there is a short to negative. Repair short or replace IC. Check again.
	b) Open thyristo	With the test point on the IC output, TL will turn on and also will turn on in the anode of the thyristor. Replace thyristor.
H) A pair of numbers of the display do not count correctly	a) J output does not reach 0.	Once checked that the displays board is correct, check if ther is any short to positive from the IC outputs in decoder module. If the rest of the displays operate correctly, replace IC.
I) A pair of numbers of the display are always counting.	a) J input has always 0 volts.	Test if TL does not turn on when touching the IC output. Look for possible shorts from this output to negative. If there is no short and the rest of the displays operate correctly, replace IC.
J) The display of the 4 players do not operate correctly.	a) One of the D1, D2, D3, D4 input is defective.	Check which pair of numbers do not operate corrrectly and to which player they belong. Compare this information with the decodification table of the 74C42 IC and see which is the defective line. Carry out a visual inspection for possible shorts. If there is none, test with a voltimeter on the common inputs that go to -, if the voltage is 2,7VDC $\pm$ 0,5V. If the voltage is not correct, check the voltage divider (resistors of 22 and 10K). If it is correct test the D inputs. In order to check this, make a bridge from the input connector to negative and with a voltimeter test if the voltage at the IC output is 0. Then make a bridge to the 5V positive of the MPU and test if the output is 1.

Sympton	Cause	Procedure
		If these proofs are correct, the defect has to be localized in the MPU. If they are not correct, replace LM 324 IC.
K) The 4 players counters and the player lights bells, cone ball dispenser and Taca do not operate correctly.	a) Defective D1 input.	Same procedure as in sympton J.
L) The unities hundreds and tenthousands do not operate correctly and sometimes turn off.	a) One of the lines L1,L2,L3, L4is positive shorted.	With the test point, check at which line TL is always on. Look for possible shorts. If there are no shorts, check if on the corresponding N input, TL is always on. If it is always on, see failure in MPU. If TL blinks, or is always on, IC LM 324 is defective. Replace and check it again.
M) The unities, hundreds and tenthousands do not operated correctly.	a) One of lines L1.L2,L3,L4 is negative shorted.	With the test point, check at which line TL is always off. Look for possible shorts. If there are no shorts, check if on the corresponding N input TL always is off. If this happens see failure in MPU. If TL blinks, IC LM 324 is defective. Replace and check again.
N) The tenths, thousands and hundredthousands do not operated correctly and sometimes turn off.	a) One of lines L5,L6,L7,L8 is Positive shorted.	Same procedure as for sympton L.
O) The tenths, thousands and hundredthousands do not operate correctly.	One of lines L5,L6,L7,L8, is negative shorted.	Same procedure as for sympton M

Sympton	Cause	Procedure
P) The Taca relay does not operate correctly.		
1/ Never closes	a) There is no command impulse at command output	With the test point on the IC 74C175 output, TL will not light when Taca has to operate. Look for shorts. If there are no shorts, check on input N8 if TL blinks and turns on when Taca turns on. If the TL does not blink see failure in MPU.
2/ Is always closed	a) Command output positive shorted.	With the test point on the IC 74C175 pin, TL will be always on. Look for shorts. If there are no shorts, check on the N8 input if TL blinks. If this happens, replace IC 74C175. If not, see failure in MPU.
Q) The ball dispenser and targets relays do not operate correctly.		
1/ Never closes	a) There is no pulse at command output.	Same procedure as for sympton P1.
2/ Is always closed	a) Command output positive shorted.	Same procedure as for sympton P2.
R) Bells do not sound, failure in some notes and fading.	a) Command signal never becomes positive.	Look for possible shorts. With the test point on CA5 output connector and touching any contact, TL should turn on. Chech if on input N5, TL blinks and turn on when touching the contact. If it turns on replace IC 74C175. If it does not turn on, see failure in MPU.
	b) The command signal of the note never becomes positive.	Look for possible shorts. With the test point on the output connector and touching the contact corresponding to the note to sound, TL has to be on. See in the corresponding input if TL blinks and turns on when touching the contact. If TL turns on, replace IC 74C175. If not see failure in MPU.

Sympton	Cause	Procedure
S) Bumpers light never turn on	a) Bulbs blown	With the test point on LB, TL will not light Replace bulbs.
	b) There is no command signal	With the test point on the corresponding IC pin, check if TL turns on. If it does not turn on, check on pin N4 if TL blinks. If TL blinks replace IC 74C175 and check again. If it does not blink, see failure in M.P.U.
	c) Open thyristor	When the command signal is in the IC pin and with the test point on the thyristor anode, TL turns on. Replace thyristor.

COMPONENTS USED IN THE DECODER MODULE

DIODE 1N4148



DIODE ZENER



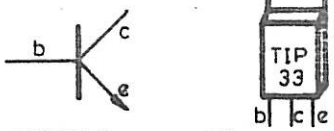
DIODE F31



TRANSISTOR MC 140 (See components in bells module)

THYRISTOR (" " in cone module)

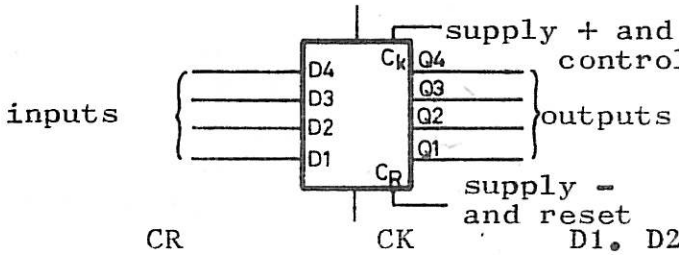
TRANSISTOR TIP 33



INTEGRATED CIRCUIT LM324 - When entrance B is more positive than entrance A; C will be 1. If B is more negative than A, C will be 0.



INTEGRATED CIRCUIT 74C175 - When anyone of the inputs is 1 and if we apply a positive flank and the "set to 0" input is 1, at the output we will have 1. If the "set to 0" (CR) input is set to 0, all the outputs will be 0.



CR	CK	D1. D2. D3. D4.	Q1. Q2. Q3. Q4.
1		1	1
1		0	0
0	anything	anything	0

INTEGRATED CIRCUIT 74C42

Output 0. (⌐¯|_) Positive flank impulse to control cone, ball dispenser, taca and bumper lights.

Output 1. (_|¯|_) Positive flank impulse to control bells and players in game.

Output 2. Controls, when becomes 0 the pair 100.000, 10.000 of the first player.

Output 3. When becomes 0, permits the pair 10.000, 100 of the first player to count.

Output 4. When becomes 0, permits to count the pair 10, 1 of the first player.

Output 5. Same as output 2, but with the second player.

Output 6. Same as output 3, but with the second player.

Output 7. Same as output 2, but with the third player.

Output 8. Same as output 3, but with the third player.

Output 9. Same as output 2, but with the fouth player.

inputs				outputs									
A	B	C	D	0	1	2	3	4	5	6	7	8	9
0	0	0	0	0	1	1	1	1	1	1	1	1	1
1	0	0	0	1	0	1	1	1	1	1	1	1	1
0	1	0	0	1	1	0	1	1	1	1	1	1	1
1	1	0	0	1	1	1	0	1	1	1	1	1	1
0	0	1	0	1	1	1	1	0	1	1	1	1	1
1	0	1	0	1	1	1	1	1	0	1	1	1	1
0	1	1	0	1	1	1	1	1	1	0	1	1	1
1	1	1	0	1	1	1	1	1	1	1	0	1	1
0	0	0	1	1	1	1	1	1	1	1	1	0	1
1	0	0	1	1	1	1	1	1	1	1	1	1	0

PARTS OF THE DECODER MODULE

description	quantity
Integrated circuit MM74C72	1
" " MM74C175	1
" " CD4001AE	1
" " CD4023AE	1
Thyristor BT106A	5
Transistor MC140	1
" TIP 33	1
" SC148C	1
Diode F31	4
" Zener 11V	1
" 1N4148	3
" LT	1
Fuses M 3A	4
Fuse-holder	8
Printed circuit decoder ref. 51066	1
Rivets printed circuit	104
Pin Comboline	87
Divider 6 mm	4
Fuse 2,7 Ohms 2W 10%	1
" 5,6 " 1W 10%	4
" 220 " 1/4W 10%	2
" 1K " 1/4W 10%	25
" 2K2 " 1/4W 10%	2
" 10k " 1/4W 10%	22
" 100K " 1/4W 10%	1
Condenser disc 10K	2
" tantalum 4,7 uF 16V	1
" electrolitic 10uF 16V radial	1
" " 47uF 16V "	1
" " 100uF 10V "or axial	1
" " 1000uF 12V radial or axial	1
" " 5000uF 16V axial	1
Radiator small thyristor	1
" big	1
Screws 1/8 x 5	5
Nuts 1/8 AD-2	5

CREDIT AND MATCH FEATURE MODULE

Sympton	Cause	Procedure
A) The 00 of the match feature or the 1 of the credits do not turn on	a) Blown bulbs	Checking with the test point on the collector of transistor 2N3794, TL has to turn on. If it does not turn on replace bulb.
	b) There is no command impulse	Checking with the test point on the transistor base TL has to turn on. If it does not turn on, see failure in MPU.
	c) Open transistor	Checking with the test point, there will be a command impulse at the base and TL will be lighted. In the collector TL will be lighted too. Replace transistor.
B) The 00 of the match feature or the 1 of credits is always on.	a) Closed transistor	Checking with the test point and with the machine on play, TL will not turn on at the base and neither at the collector. Replace transistor.
C) The LED, which shows the credits and the match feature never turn on.	a) If the LED is the match feature one, switch the ball in extra ball position	Check in the MPU module that the switch is not in Extra Ball position.
	b) Open transistor	Test with a voltimeter the base of transistor (before the resistor). The voltage will be 2VDC, at the collector we will have 5VDC. Replace transistor.
	c) There is no command impulse	Testing with a voltimeter the transistor base (before the resistor), the voltage will be 2VDC. If the voltage is different, see failure in MPU .

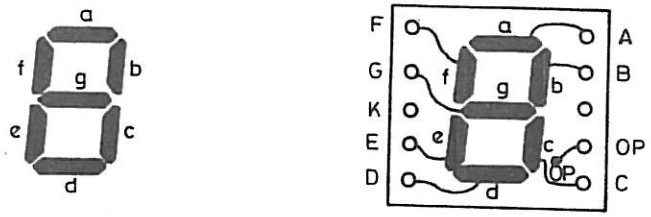
Sympton	Cause	Procedure
D) The LEDs that show the credits and the match feature are always on and show the same number.	a) Closed match feature LED transistor	Checking with a voltimeter at the base of the transistor (before the resistor), there will be 2VDC. If there is a different voltage, see failure in MPU. If not replace transistor.
E) One of the LEDs does not count correctly and appear strange numbers.	a) Defective LED.	Localize which is the segment that fails. Check if on the corresponding module input TL turns on. If this happens, replace LED.
	b) The command impulse does not arrive.	If at the module input, TL does not turn on, see failure in MPU module.

COMPONENTS USED IN THE CREDIT AND MATCH FEATURE

TRANSISTOR 2N3794



CREDIT AND MATCH FEATURE COUNTER LED MAN 74 A



PARTS OF THE MODULE

description	quantity
LED MAN 74 A	2
Lamps 12 V miniature	3
Fuse 1K 1/4W 10%	3
" 4K7 1/4W 10%	2
Transistor 2N3794	5
Condenser FACO MOA 0,22 uF 100V	1
Printed circuit ref. 510050	1
Plastic plate credit and match feature IS-149	1
Plastic divider MG-16	4
Screws 1/8 x 15 c/p F-156	4
Nut 1/8 AD-2	4

MPU MODULE

Sympton	Cause	Procedure
A) Test programm of MPU does not operate, neither the game lights turn on at the playfield.	a) Open fuses because of closed Zener diode. The Zener diode is closed because more than 10V has been applied at the input.	Remove fuses and check them. If they are open disconnect one of the pins of the Zener diode and with the ohmeter check if there is continuity in both senses. If it conducts in both senses, replace diodes and fuses. Check again.
	b) + 5V supply open or shorted 1/ Open transistor MC150	Checking with the test point on emitter and base, TL wil be on. Checking on collector, TL will be off. Replace MC150.
	2/ Open transistor SC148	Checking with the test point on the base, TL will be lighted. On the emitter and base, it will not light. Replace SC148.
	3/ Closed Zener diode.	TL will turn on when checking the emitter of transistor MC150 and will be off when checking the base of SC148. Replace Zener diode.
B) The test programm stops at a number. 1/ Stops at 0.	a) Supply failure	With a voltimeter check if the voltage of + 5VDC,+12VDC, -5VDC on the pins of the E-PROM are correct. In the series machines, it is only necessary to have + 10VDC at pin 24. If anyone of the voltages is not correct, check the voltage at the terminals of the components and replace them if defective.
	b) Address or data buses shorted or open.	Check with the ohmeter on the pins of the CPU if there is any line shorted to another to negative or to positive. That means: For checking the data bus put a plug of the ohmeter on pin 15 (B0) and check for continuity with the rest of the pins 8,9,10,11,12,13,14, with + and -.

Sympton	Cause	Procedure
		If in any of these measures the ohmeter shows 0 Ohms there is continuity because of a short; localize the short and repair. If the ohmeter shows a resistence but does not arrive at 0, everything is correct. The same steps are to be taken with the address bus (pins 25 to 32 of the CPU). In this way we will see that there are no shorted buses. When checking for open circuits, with the ohmeter and MPU schedule, we must follow the trace, looking for possible shorts. Afterwards check the whole trace for continuity.
	c) Reset circuit or synchronization with the voltage line.	The reset circuit actuates over pin 3 of the CPU. If we touch with the test point this pin and TL turns on, this is correct, then follow the trace and with TL see informations at the distinct control gates of this signal. A possible cause is, that transistor SC158 is closed. This can be checked easily because TL will not be on at the emitter. Replace transistor and check again. The synchronization circuit is composed by the gates of the circuit 23, pins 8,9,10 and 12,13,11. With the voltimeter check if on pins 10 and 11, 2 VDC is given. If this happens, everything is correct. If one of the pins does not have this voltage, then try to localize the failure in the integrated circuit, resistors or capacitors.
2/It stops at 1.	a) The CPU circuit does not remain connected to ROM A	Look for possible shorts between bus lines, to positive or to negative, as made for sympton B1b. Also check if there are open lines. If the above is correct, then check with the ohmeter the connections of the circuit 4042 (24) for any shorts or open lines.
3/ It stops at 2.	a) The CPU circuit does not remain connected to ROM B.	Look for possible shorts between the bus lines, to positive or to negative as made for sympton B1b. Also check if there are open lines. If the above is correct, then

Sympton	Cause	Procedure
		check with the ohmeter the connections of the circuit 4042 (24) for any short or open line.
4/ It stops at 3.	a) The CPU does not remain connected to RAM A.	Same procedure as for last sympton.
5/ It stops at 4.	a) The CPU does not remain connected to RAM B.	Same procedure as for last sympton
6/ It stops at 5.	a) The CPU does not remain connected to the input.	Check with the voltimeter if there is no open line between the CPU circuit and circuits 4016 (21 and 22). If the above is correct, check for continuity in the distinct outputs C1,C2,C3,C4 C5 of circuit 4028 (20). Check also if transistor SC148 placed at the second column, is not open.
7/ It stops at 6.	a) The pin 36 of the CPU does not receive signals	Check with the ohmeter if the trace between pin 36 of CPU and pin 4 of circuit 19 is correct. If this is correct, connect the machine to the voltage line and check the voltage on pin 4 of circuit 19, which has to be 5VDC. If the voltage is different, check voltages at the input. They have to be 2VDC. If this voltage is not correct, verify resistor and capacitor.
C) A contact of the machine does not add points or does not do anything when touched.	a) It is always closed.	Check if the contact does not remain closed because of a incorrect regulation. Regulate it and check again.
	b) Failure at input to MPU.	When checking with the test point at one of the contact plates, TL has to blink weakly. Then close contact and check if the signal passes to the other plate and follow the cable up to the MPU; At the same time follow the impulse over the scheme in order to know where it disappear. With this test we can localize the component, which does not allow the pass of the signal.

Sympton	Cause	Procedure
D) One or some of the game lights do not turn on and the credit and match feature counters do not operate correctly.	a) Defective issue of the command impulse from the MPU.	Localize, with the help of the letter code foreseen in each module, the defect integrated circuit. Check with the ohmeter if the input and output connections of the gates are correct, that is to say, there is no open or shorted circuit. Check also if there is continuity between MPU output and the input of the auxiliar module to verify the good contact of the connectors.
E) At the decoder module the input D or N are not correct.	a) Defective MPU command output.	The same procedure as for sympton D.
F) The coin micros do not count the correct credits.	a) Dirty credit regulation switches.	Clean with a spray the switches and let them rotate a few times. Check again.
G) When disconnecting the machine, it does not store the information in credit counters and players displays.	a) RAM B has no supply	With a voltimeter check the voltage at pin 18 of RAM B (33). When the machine is connected this voltage has to be 5VDC $\pm$ 0,5V. When the machine is disconnected this voltage has to remain at the same value. If this voltage falls down to zero, we have diode 1N4148 closed. Replace diode and check again.
H) Some game lights, the match feature or credit LEDs blink.	a) One of the transformer windings is badly soldered or shorted.	Check if the outputs 10Va, 0v and 10Vb of the transformer are well soldered and there are no shorts between the terminals.

IF WITH ALL THE ABOVE CHECKING IT WOULD NOT BE POSSIBLE TO FIND THE FAILURE AND REPAIR IT, IT WILL BE NECESSARY THAT YOU REVERT TO OUR LABORATORY WHERE SPECIALIZED STAFF AND MODERN EQUIPMENT WILL PROCEED WITH THE IMMEDIATE REPAIR. THEREFORE THE DEFECT MODULE SHOULD BE SENT TO US.

COMPONENTS USED IN THE MPU MODULE

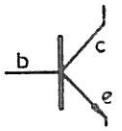
DIODE SY 124 (See components in thyristor module)

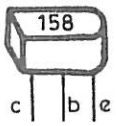
DIODE 1N4148 (See components in decoder module)

ZENER DIODE (See components in decoder module)

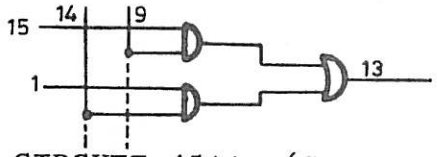
TRANSISTOR SC 148 (See components in relays module)

TRANSISTOR SC 158





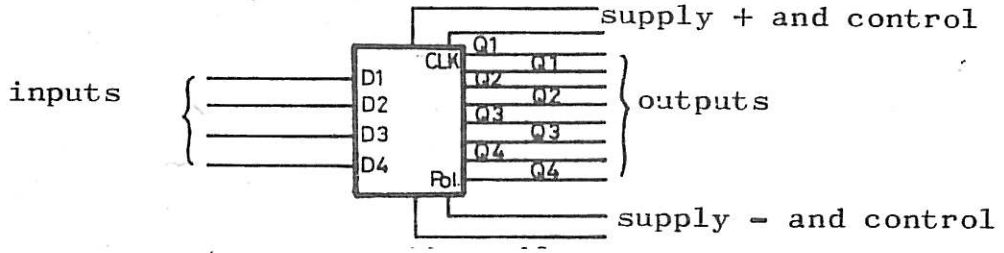
INTEGRATED CIRCUIT 4019 (11 and 12)



Four squares form one integrated circuit. One square is formed by:

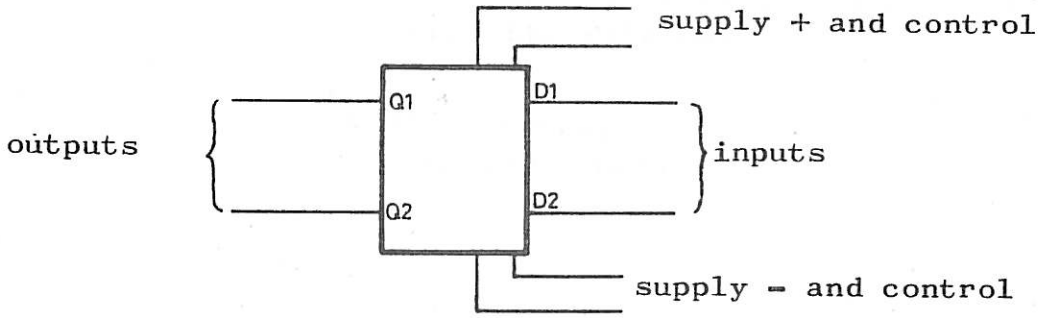
INTEGRATED CIRCUIT 4511 (See components displays module) (13)

INTEGRATED CIRCUIT 4042 (14, 17 and 24)



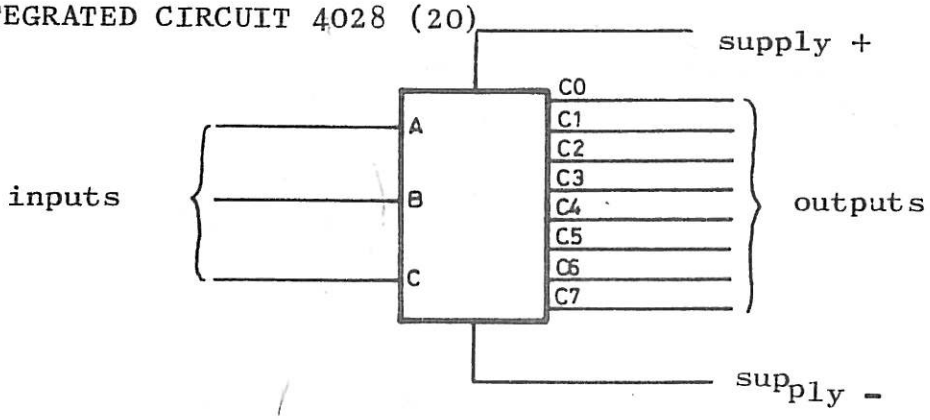
CLK	Pol.	01. 02. 03. 04.
0	0	D1 D2 D3 D4
	0	M e m o r i z e d
1	1	D1 D2 D3 D4
	1	M e m o r i z e d

INTEGRATED CIRCUIT 4013 (15)



CLK	D1. D2.	Q1. Q2.
	0	0
	1	1

INTEGRATED CIRCUIT 4028 (20)

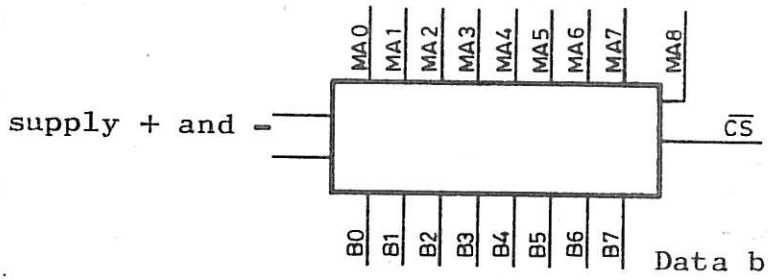


inputs			outputs							
A	B	C	C0	C1	C2	C3	C4	C5	C6	C7
0	0	0	1	0	0	0	0	0	0	0
1	0	0	0	1	0	0	0	0	0	0
0	1	0	0	0	1	0	0	0	0	0
1	1	0	0	0	0	1	0	0	0	0
0	0	1	0	0	0	0	1	0	0	0
1	0	1	0	0	0	0	0	1	0	0
0	1	1	0	0	0	0	0	0	1	0
1	1	1	0	0	0	0	0	0	0	1

INTEGRATED CIRCUIT 4016 (21 and 22) (See components bells module)

INTEGRATED CIRCUIT 4069 (25) (See components bells module)

INTEGRATED CIRCUIT ROM A and B 1834 D (26 and 30)



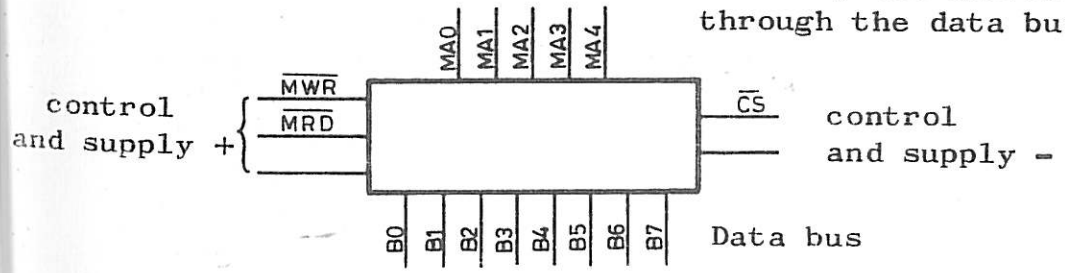
When the control signal CS falls to 0, through the 8 lines of data bus will be given the information corresponding to the adress which at the moment is in the adress bus.

INTEGRATED CIRCUIT RAM A and B 1824 D (27 and 33)

When the control signal CS gets negative, there are two possibilities:

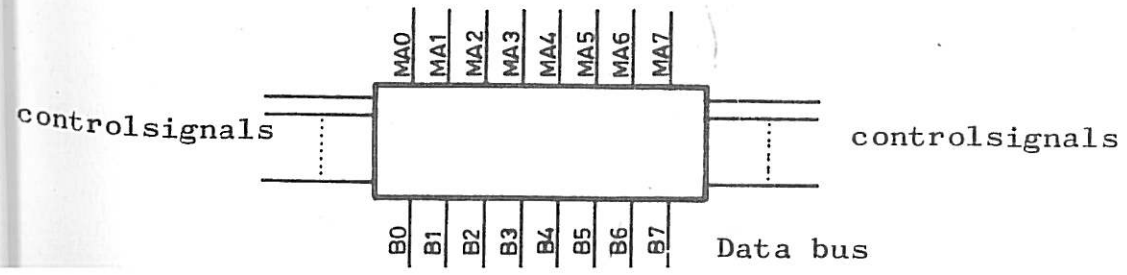
$\overline{MWR}$=0 and $\overline{MRD}$=1 - In this case the information which is in the data bus will be written in the RAM circuit at the adress indicated by the address bus.

$\overline{MWR}$=1 and $\overline{MRD}$=0 - In this case the information in the address shown by the address bus, will be leaving through the data bus.



INTEGRATED CIRCUIT CPU 1802 D (28) - Controls the rest of the circuits of the machine. Its function is quite complex.

When the input CLEAR becomes 0; the CPU is set to 0.
When giving 1 again, the address bus starts to count. It starts with 000.000, then 000.001 and so on.



PARTS OF THE MODULE M.P.U.

description	quantity
Int	
Integrated circuit CD4013AE	1
" " CD4001AE	1
" " CD4011AE	3
" " MC4016CP	2
" " CD4019AE	2
" " CD4023AE	1
" " CD4028AE	1
" " CD4042AE	3
" " CD4069BE	1
" " CD4072BE	1
" " CD4075BE	2
" " CD4081BE	8
" " CD4511BE	1
" " CPU CDP 1802 D	1
" " RAM CDP 1824 D	2
" " ROM CDP 1834 D	2
Transistor SC158	1
" MC140	1
" SC148	1
Diode SY124	4
" 1N4148	5
" 11V 400mW ZENER	1
" 15V 400mW "	1
Sliding switch 2x1	2
Fuse-holder	4
Fuse 1A	2
Pin Comboline	86
Rivets printed circuit	370
Metal plate M.P.U.	1
Switch button	2
Rotative switch 8x1	2
Printed circuit M.P.U. ref. 510049	1
Socle 40 pins	1
" 24 pins	1
Radiator	1
Dividers 10 mm	9
Screw 1/8 x 5	9
Nut 1/8 AD-2	9
Resistor 100 1/4W 10%	1
" 390 1/4W 10%	7
" 470 1/4W 10%	1
" 1K 1/4W 10%	14

description	quantity
Resistence 4K7W 1/4 10%	4
" 10K 1/4W 10%	89
" 100K 1/4W 10%	22
" 470K 1/4W 10%	2
" 1M 1/4W 10%	1
Condenser 82 pF ceramic	1
" 1K "	8
" 10K "	5
" MKM 0,01 uF 250V	2
" MKM 0,22 uF 100V	1
" MKM 0,47 uF 100V	1
" electrolitic 220 uF 16V radial	1
" " 1100 uF 16V axial	2

CODE OF THE MODULES

In all modules, close to the pins, there is a printed code number.

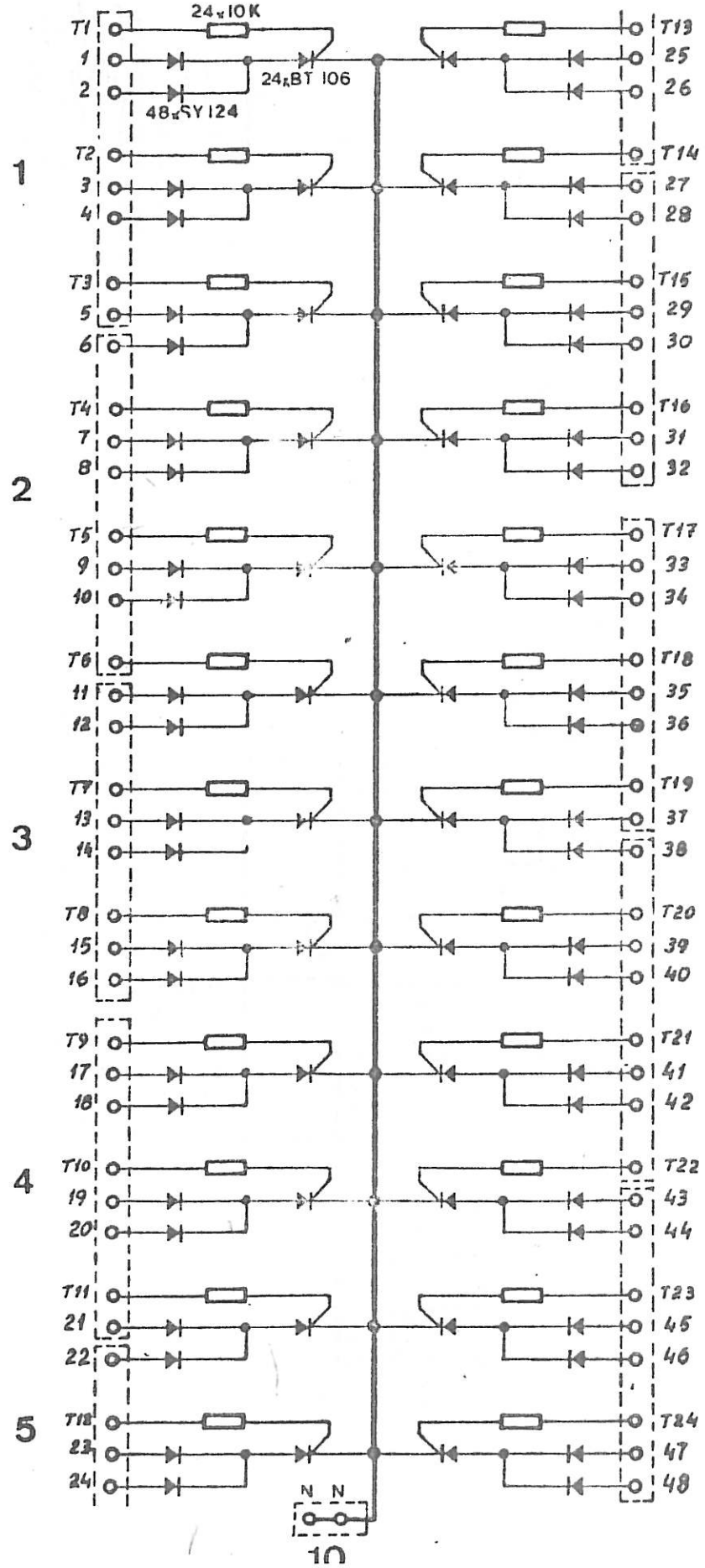
The same code number is used to indicate the output pin of a module and the one corresponding to the input of another module. Each codification defines a specific function and therefore there are not two different functions with the same code number, except the two cases as detailed below:

1.- Relation between input code of the thyristor module and the corresponding outputs of MPU module.

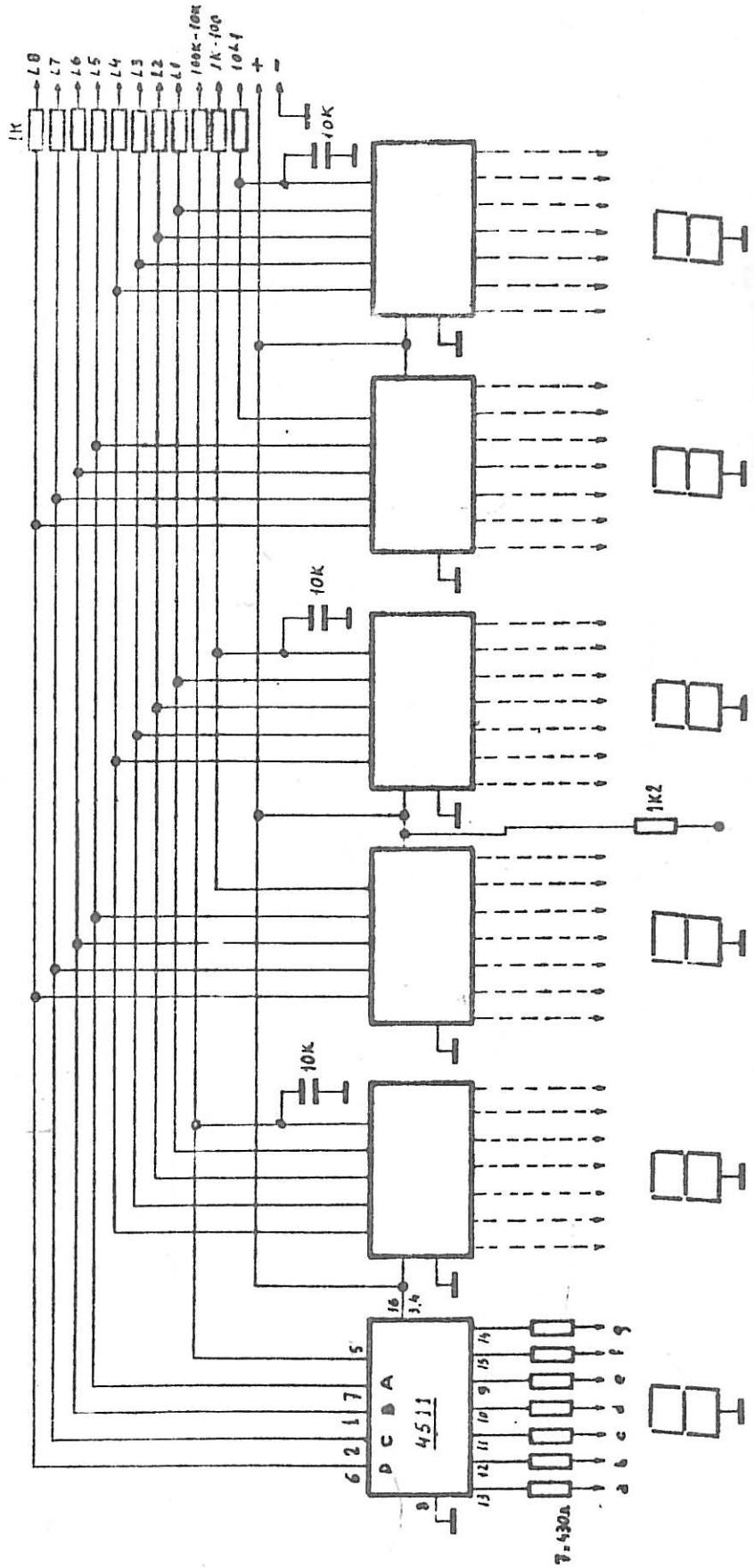
CODE THYRISTOR	CODE MPU
T1	W7
T2	U7
T3	U6
T4	U5
T5	U4
T6	U3
T7	U2
T8	U1
T9	V8
T10	V7
T11	V6
T12	V5
T13	V4
T14	V3
T15	V2
T16	V1
T17	--
T18	W4
T19	W3
T20	W2
T21	W1
T22	W8
T23	W6
T24	W5

2.- Relation between input code of Displays modules and corresponding outputs of Decoder module.
See in code diagram the indication corresponding to the pins of the connectos numbers 8-7-6 and 5 of the Decoder module with the ones corresponding to the Displays.

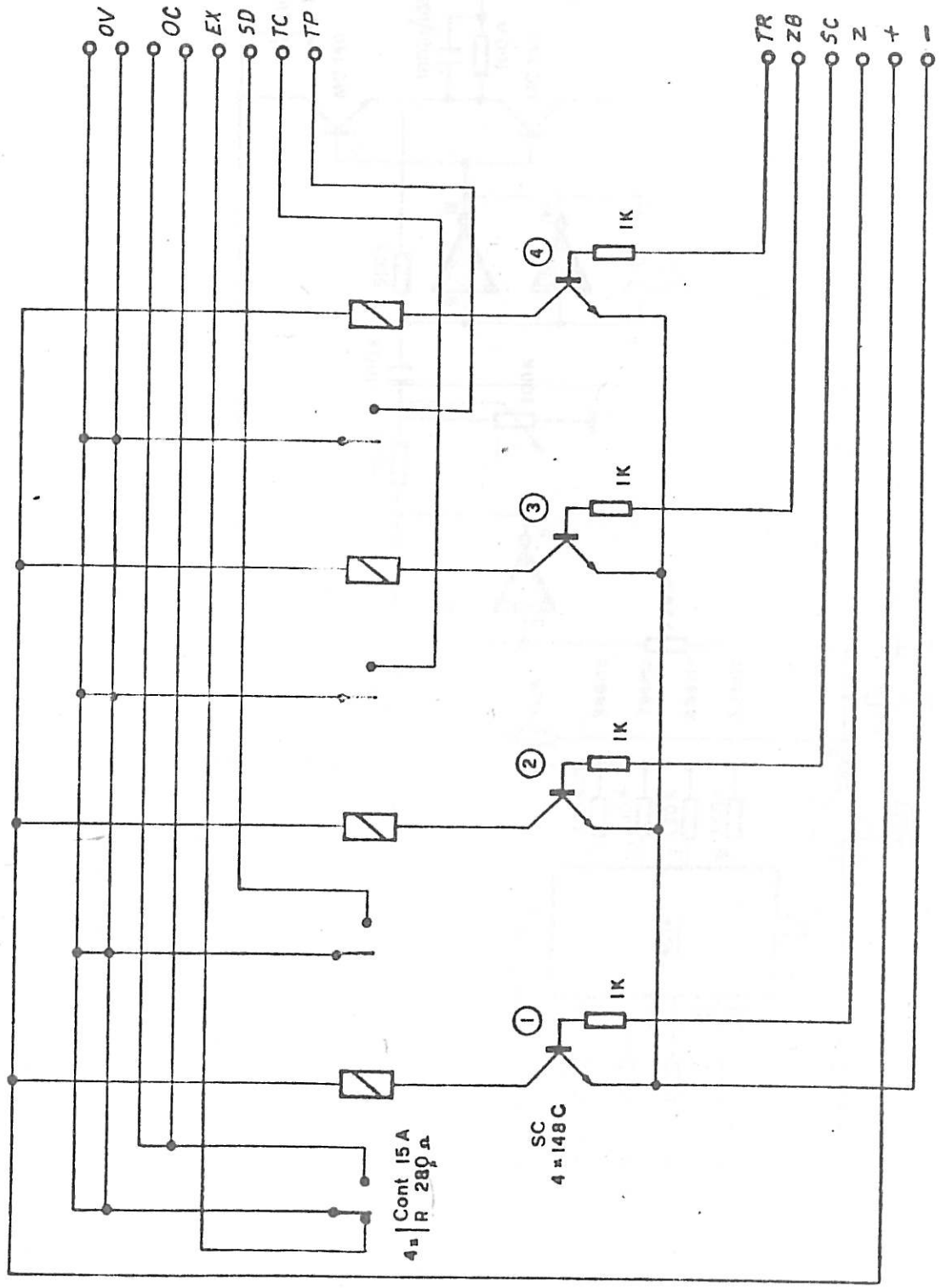
PLAYMATIC	PIN-BALL MACHINE THYRISTORS CONTROL BOARD SCHEMATIC	DIBUJADO COMPROBADO



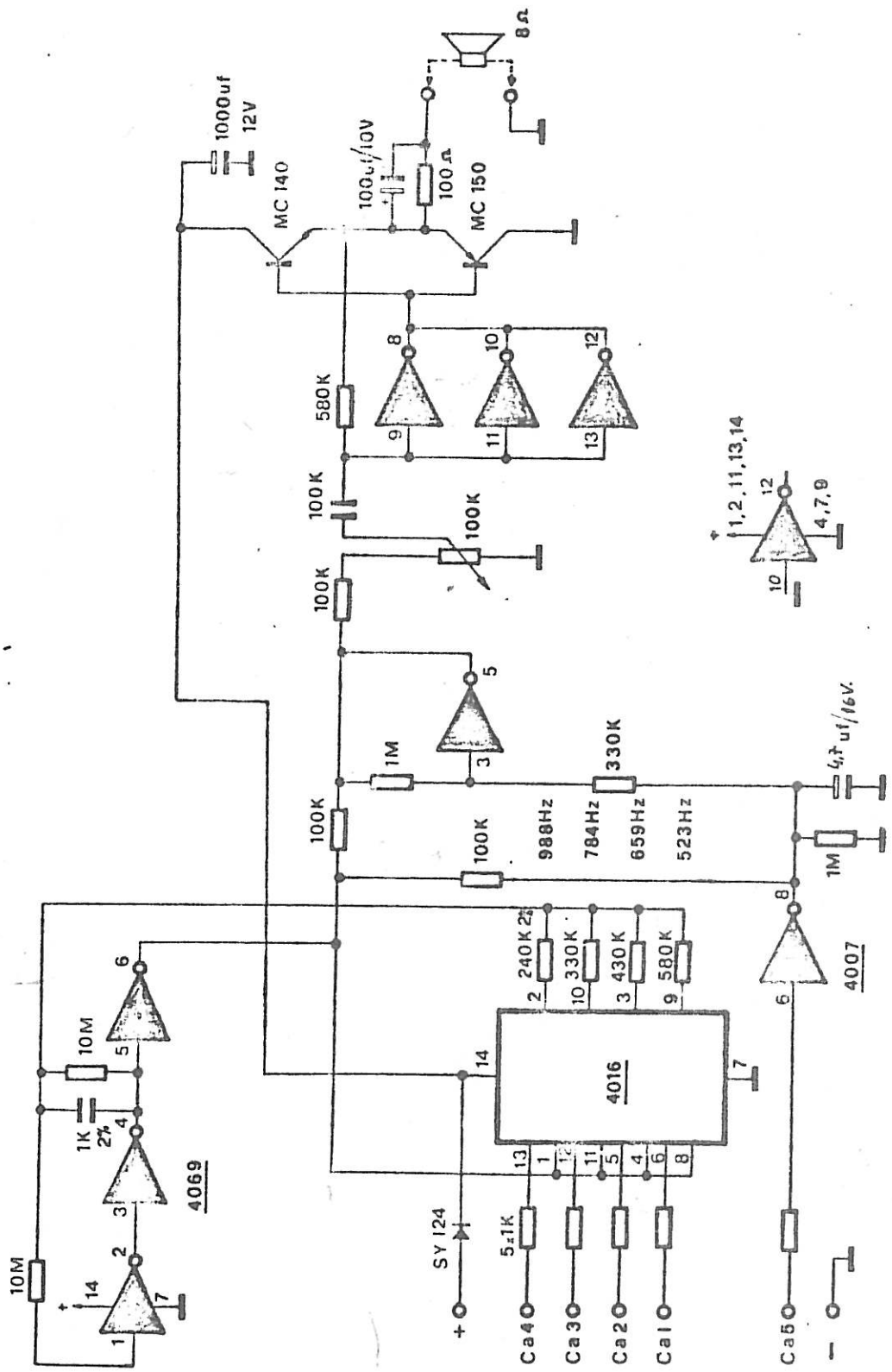
PLAYMATIC	PIN - BALL MACHINE DISPLAY DRIVER ASSYS. CONTROL BOARD SCHEMATIC	DIBUJADO COMPROBADO



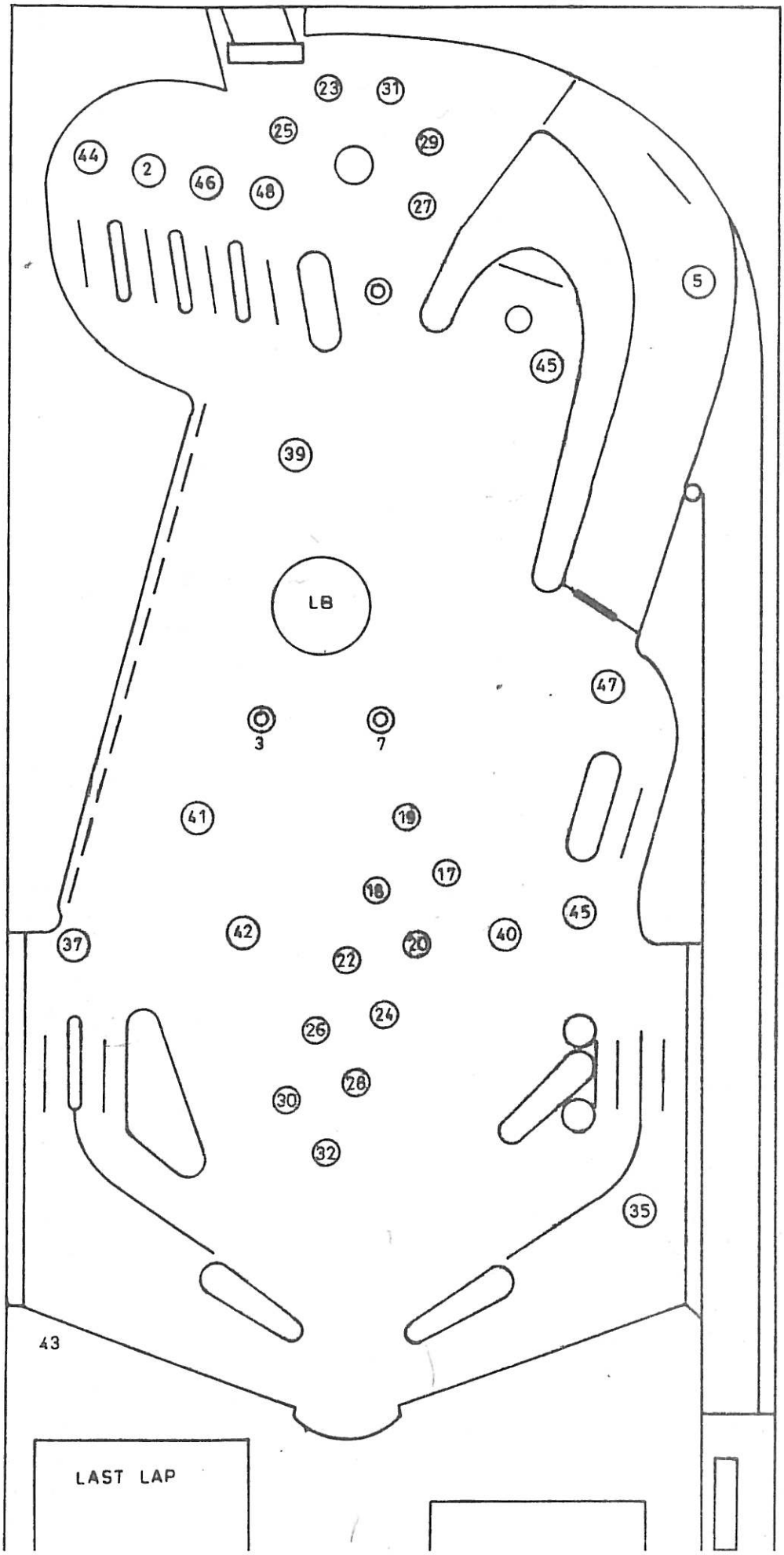
PLAYMATIC	PIN-BALL MACHINE RELAYS CONTROL BOARD SCHEMATIC	DIBUJADO COMPROBADO



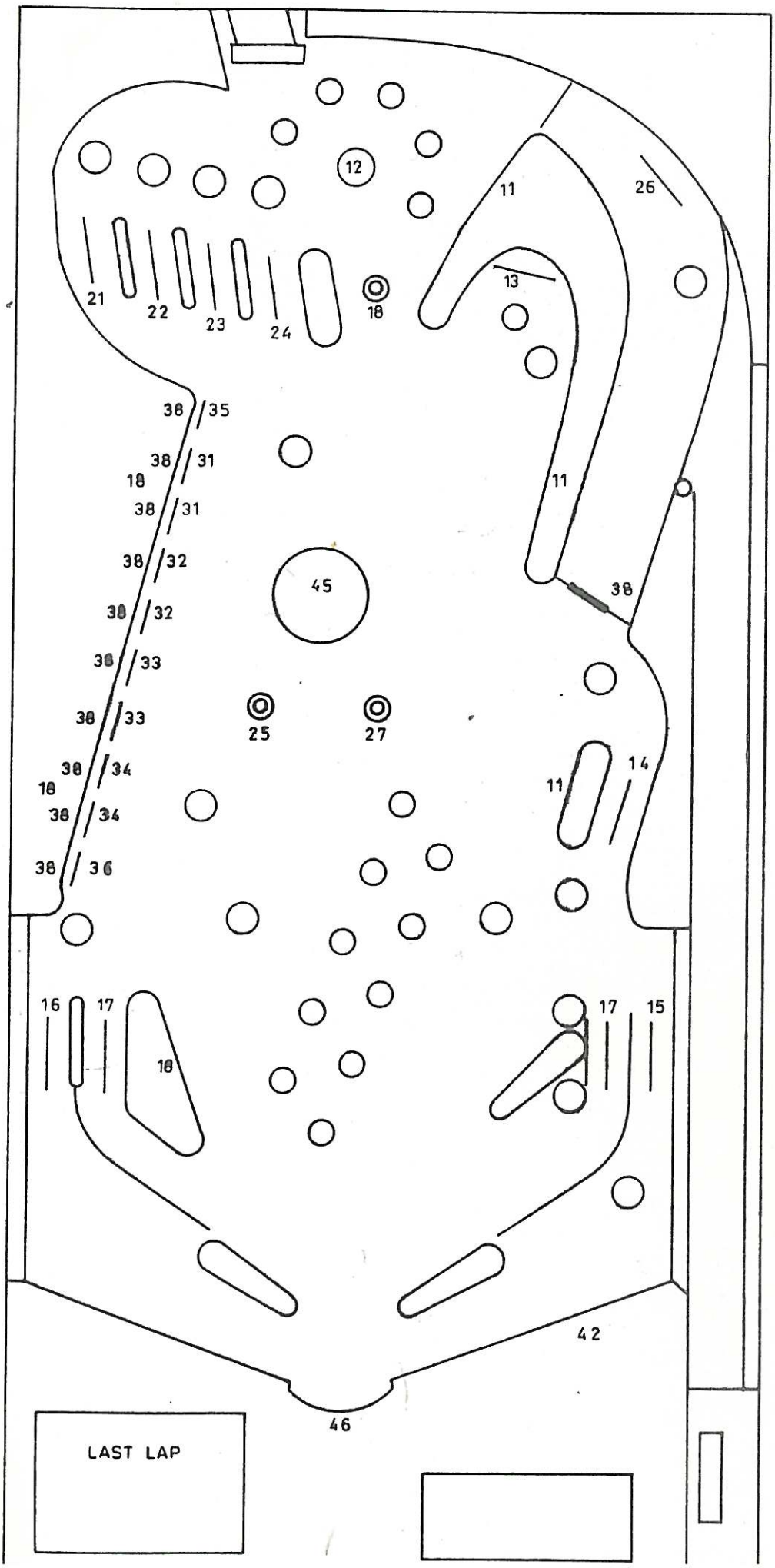
PLAYMATIC	PIN-BALL MACHINE SOUND CONTROL BOARD SCHEMATIC	DIBUJADO COMPROBADO



LITES


23
31
25
29
44
2
46
48
27
5
45
39
LB
47
3
7
41
19
17
18
45
37
42
40
20
22
24
26
28
30
32
35
43
LAST LAP

SWITCHES


12
11
26
21
22
23
24
18
13
38
35
38
31
18
38
31
11
38
32
45
38
38
32
38
33
38
33
25
27
38
34
14
18
11
38
34
38
36
16
17
17
15
18
42
46
LAST LAP