

**AY-3-8500****AY-3-8500-1**

## Ball & Paddle

### FEATURES

- Full **COLOR** operation with AY-3-8515.
- 6 Selectable Games—Tennis, soccer, squash, practice and two rifle shooting games
- 625 Line (AY-3-8500) and 525 Line (AY-3-8500-1) versions
- Automatic Scoring
- Score display on T.V. Screen, 0 to 15
- Selectable Bat Size
- Selectable Rebound Angles
- Selectable Ball Speed
- Automatic or Manual Ball Service
- Action Sounds
- Shooting Forwards in Soccer Game
- Visually defined area for all Ball Games.

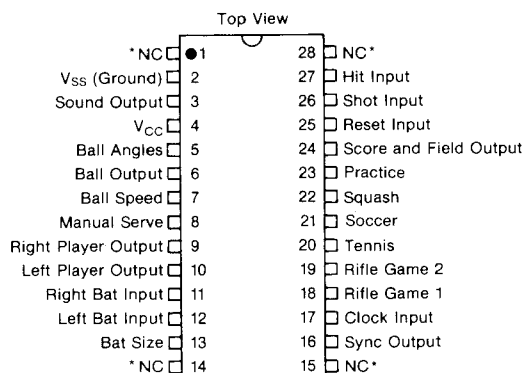
### DESCRIPTION

The AY-3-8500 and AY-3-8500-1 circuits have been designed to provide a TV 'games' function which gives active entertainment using a standard domestic television receiver.

The circuit is intended to be battery powered and a minimum number of external components are required to complete the system.

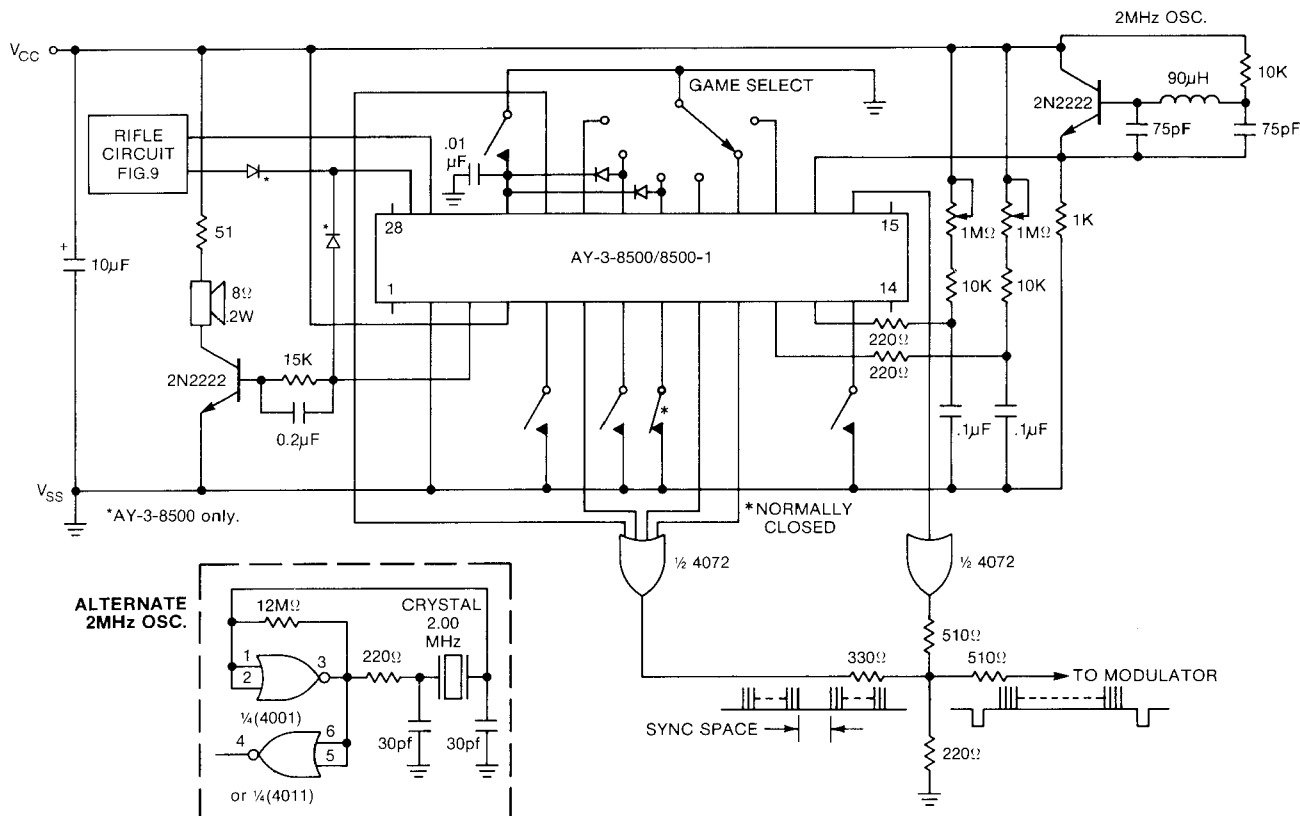
### PIN CONFIGURATION

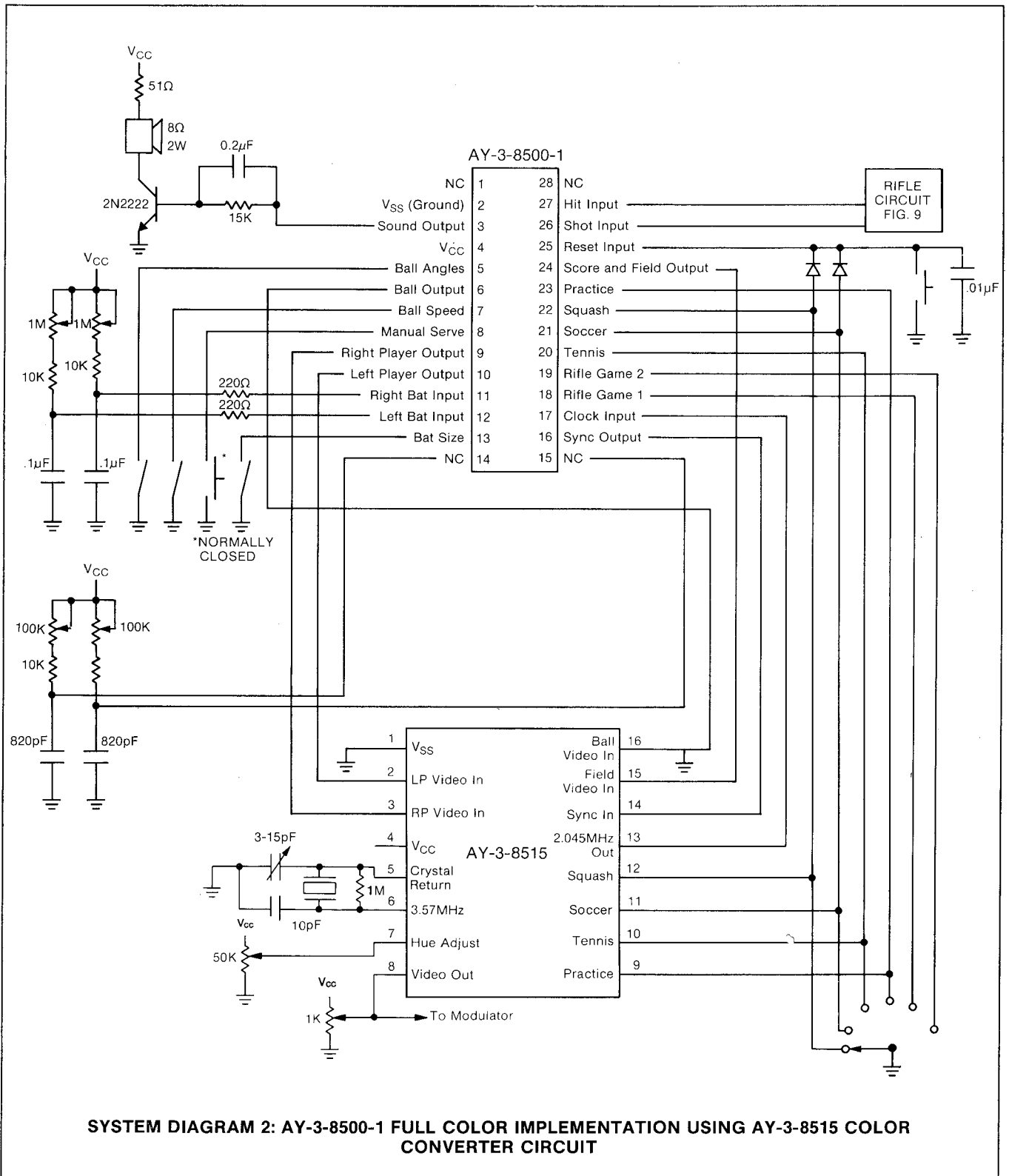
28 LEAD DUAL IN LINE



\*Do not use as tie point.

### SYSTEM DIAGRAM 1: BLACK AND WHITE IMPLEMENTATION





**PIN FUNCTIONS (Pin numbers in parentheses)****V<sub>SS</sub> (2)**

Negative supply input, nominally 0V(GND).

**Sound Output (3)**

The hit (32ms pulse/976Hz tone), boundary reflection (32ms pulse/488Hz tone) and score (32ms pulse/1.95KHz tone) sounds are output on this pin.

**V<sub>CC</sub> (4)**

Positive supply input.

**Ball Angles (5)**

This input is left open circuit (Logic '1') to select two rebound angles and connected to V<sub>SS</sub> (Logic '0') to select four rebound angles. When two angles are selected they are  $\pm 20^\circ$ , when four are selected they are  $\pm 20^\circ$  and  $\pm 40^\circ$ . See Fig. 11.

**Ball Output (6)**

The ball video signal is output on this pin.

**Ball Speed (7)**

When this input is left open-circuit, low speed is selected (1.3 seconds for ball to traverse the screen). When connected to V<sub>SS</sub> (Logic '0'), the high speed option is selected (0.65 seconds for ball to traverse the screen).

**Manual Serve (8)**

This input is connected to V<sub>SS</sub> (Logic '0') for automatic serving. When left open circuit (Logic '1') the game stops after each score. The serve is indicated by momentarily connecting this input to V<sub>SS</sub>.

**Right Player Output/Left Player Output (9,10)**

The video signals for the right and left players are output on separate pins.

**Right Bat Input/Left Bat Input (11,12)**

An R-C network connected to each of these inputs controls the vertical position of the bats. Use a 10K resistor in series with each pot.

**Bat Size (13)**

This input is left open circuit (Logic '1') to select large bats and connected to V<sub>SS</sub> (Logic '0') to select small bats. For a 19" T.V. screen, large bats are 1.9" and small bats are 0.95" high.

**Sync Output (16)**

The T.V. vertical and horizontal sync signals are output on this pin. See Fig. 1.

**Clock Input (17)**

The 2MHz master timing clock is input to this pin. The exact frequency is  $2.012160 \pm 1\%$ .

**Rifle Game 1, Rifle Game 2, Tennis, Soccer, Squash, Practice (18 thru 23)**

These inputs are normally left open circuit (Logic '1') and are connected to V<sub>SS</sub> (Logic '0') to select the desired game.

**Score and Field Output (24)**

The score and field video signal is output on this pin.

**Reset (25)**

This input is connected momentarily to V<sub>SS</sub> (Logic '0') to reset the score counters and start a new game. Normally left open circuit.

**Shot Input (26)**

This input is driven by a positive pulse output of a monostable to indicate a "shot".

**Hit Input (27)**

This input is driven by a positive pulse output of a monostable which is triggered by the shot input if the target is on the sights of the rifle.

NOTE: The "Shot" and "Hit" inputs have on-chip pull-down resistors to V<sub>SS</sub>. All other inputs (except the "Bat" inputs) have on-chip pull-up resistors to V<sub>CC</sub>.

**ELECTRICAL CHARACTERISTICS****Maximum Ratings\***

Voltage on any pin with respect to V<sub>SS</sub> pin ..... -0.3 to +12V  
Storage Temperature Range ..... -20°C to +70°C  
Ambient Operating Temperature Range ..... 0°C to +40°C

\*Exceeding these ratings could cause permanent damage. Functional operation of these devices at these conditions is not implied — operating ranges are specified below.

**Standard Conditions (unless otherwise noted)**

V<sub>CC</sub> = +6 to +7V

V<sub>SS</sub> = 0V

Operating Temperature (T<sub>A</sub>) = 0°C to +40°C

Characteristics at 25°C and V <sub>CC</sub> = +6 Volts	Min	Typ	Max	Units	Conditions
<b>Clock Input</b>					
Frequency	1.99	2.01	2.03	MHz	Maximum clock source impedance of 1K to V <sub>CC</sub> or V <sub>SS</sub> .
Logic '0'	0	—	0.5	Volts	
Logic '1'	V <sub>CC</sub> -2	—	V <sub>CC</sub>	Volts	
Pulse Width — Pos.	—	200	—	ns	
Pulse Width — Neg.	—	300	—	ns	
Capacitance	—	10	—	pF	V <sub>IN</sub> = 0V, F = 1MHz
Leakage	—	100	—	μA	
<b>Control Inputs</b>					
Logic '0'	0	—	0.5	Volts	Max. contact resistance of 1K to V <sub>SS</sub>
Logic '1'	V <sub>CC</sub> -2	—	V <sub>CC</sub>	Volts	
Input Impedance	—	1.0	—	M Ω	Pull up to V <sub>CC</sub>
Rifle Input	—	1.0	—	M Ω	Pull down to V <sub>SS</sub>
<b>Outputs</b>					
Logic '0'	—	—	1.0	Volt	I <sub>out</sub> = 0.5mA
Logic '1'	V <sub>CC</sub> -2	—	—	Volts	I <sub>out</sub> = 0.1mA
<b>Power Supply Current</b>	—	40	60	mA	at V <sub>CC</sub> = +7V

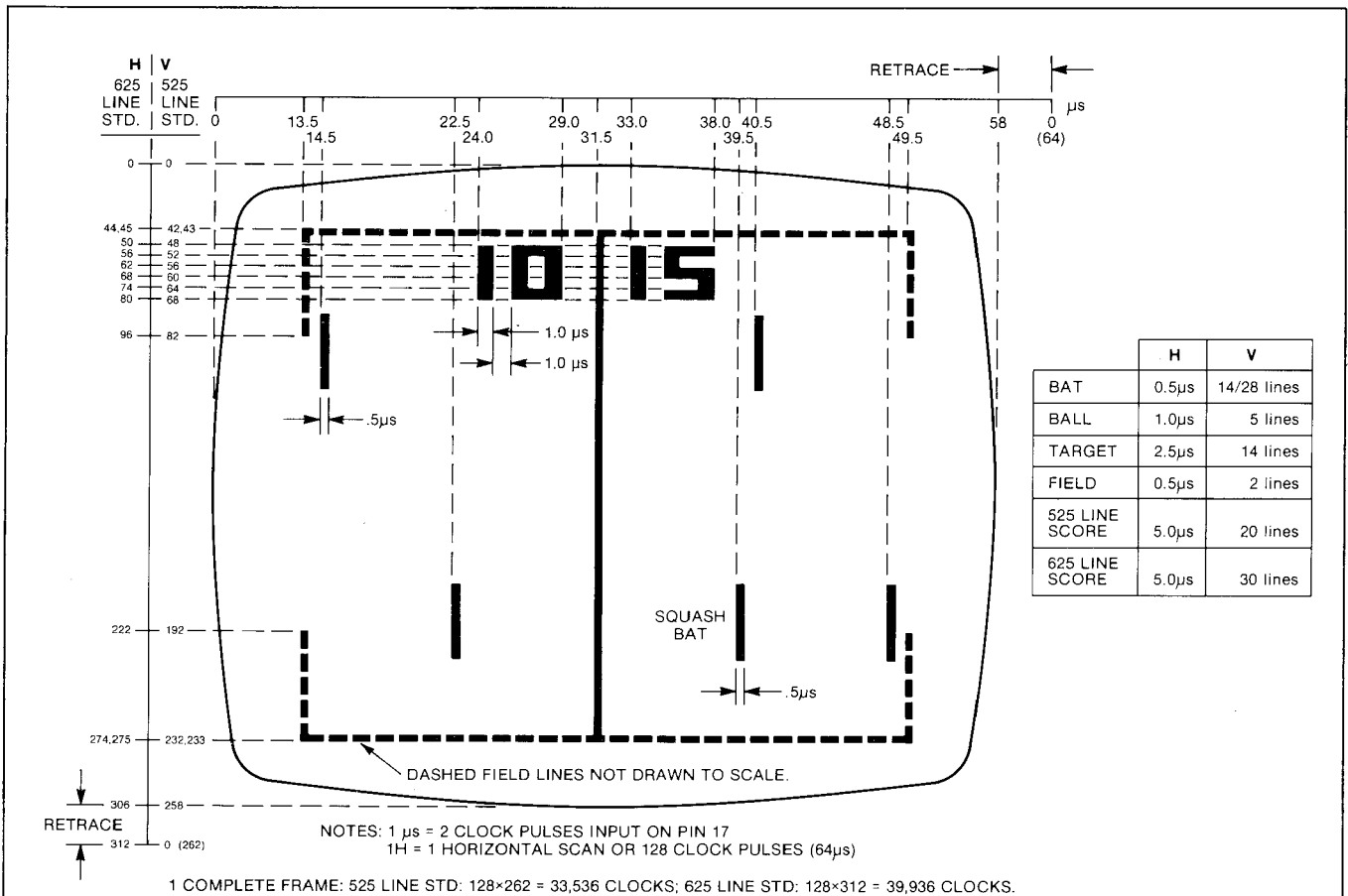


Fig.1 LOCATION OF DATA OUTPUT PULSES

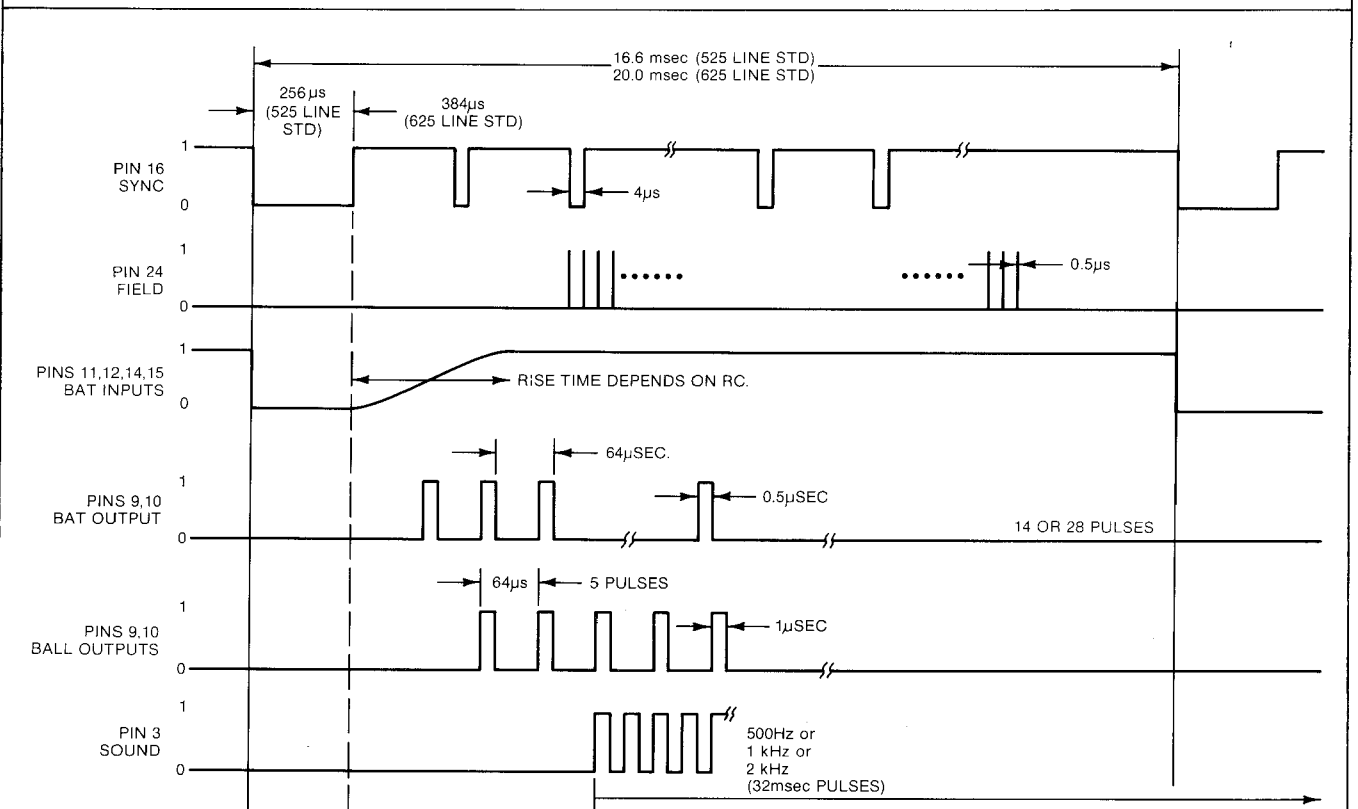


Fig.2 TIMING DIAGRAM

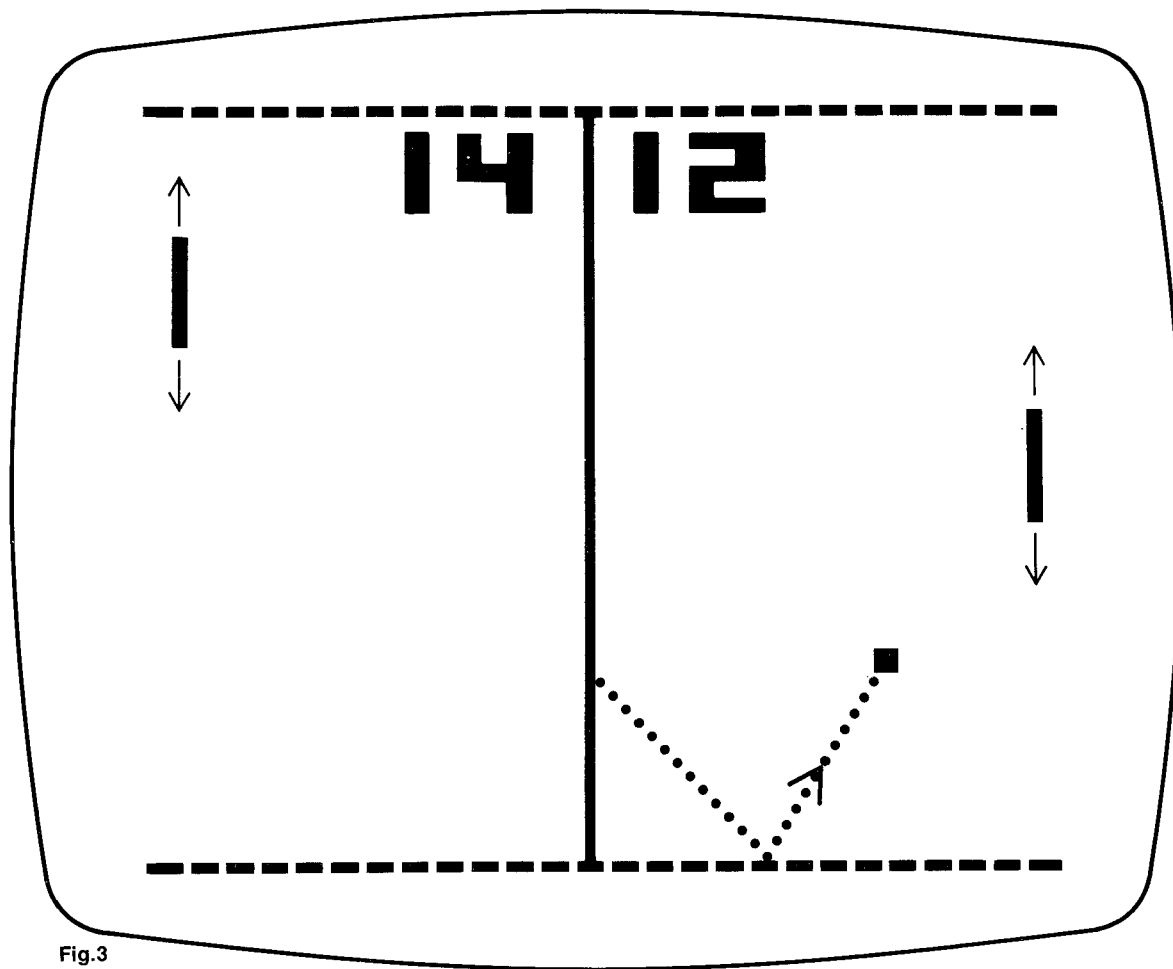


Fig.3

## Tennis

With the tennis game the picture on the television screen would be similar to Figure 3 with one 'bat' per side, a top and bottom boundary and a center net. The individual scores are counted and displayed automatically in the position shown. The detail of the game will depend upon the selection of the options. Considering the situation where small bats are used and all angles, after the reset has been applied, the scores will be 0, 0 and the ball will serve arbitrarily to one side at one of the angles. If the ball hits the top or bottom boundary it will assume the angle of reflection and continue in play. The player being served must control his bat to intersect the path of the ball. When a 'hit' is detected by the logic, the section of the bat which made the hit is used to determine the new angle of the ball.

To expand on this, all 'bats' or 'players' are divided logically into four adjacent sections of equal length. When using the four angle option it is the quarter of bat which actually hits which defines the new direction for the ball.

The direction does not depend upon the previous angle of incidence. With the two angle option the top and bottom pairs of the bats are summed together and only the two shallower angles are used to program the new direction for the ball.

The ball will then traverse towards the other player, reflecting from the top or bottom as necessary until the other player makes his 'hit'. This action is repeated until one player misses the ball. The circuitry then detects a 'score' and automatically increments the correct score counter and updates the score display. The ball will then serve automatically towards the side which has just missed. This sequence is repeated until a score of 15 is reached by one side, whereupon the game is stopped. The ball will still bounce around but no further 'hits' or 'scores' can be made. While the game is in progress, three audio tones are output by the circuit to indicate top and bottom reflections, bat hits and scores.

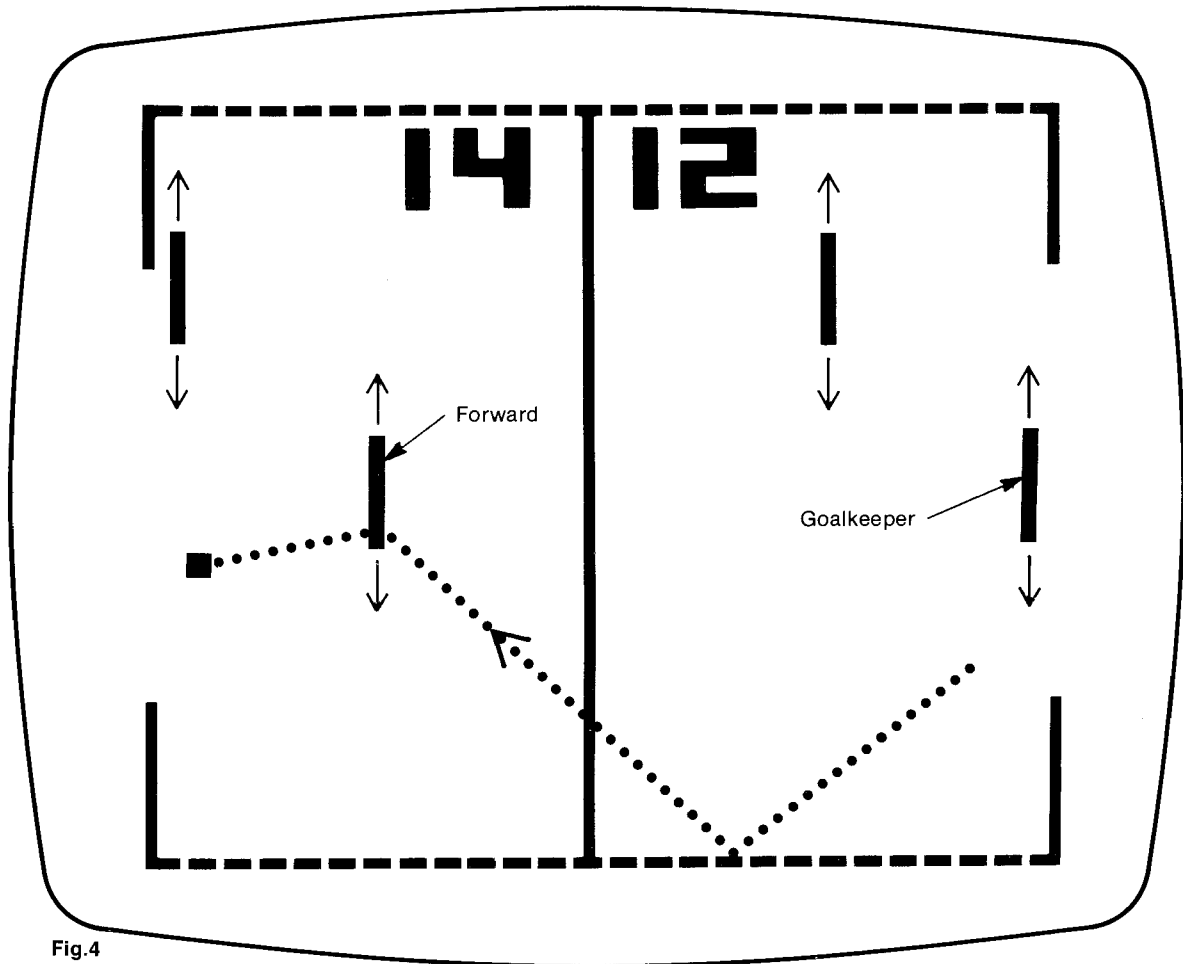


Fig.4

### Soccer

The "soccer" type game is shown in Figure 4. With this game each participant has a 'goalkeeper' and a 'forward'. The layout is such that the 'goalkeeper' is in his normal position and the 'forward' is positioned in the opponent's half of the playing area.

When the game starts, the ball will appear travelling from one goal line towards the other side. If the opponent's forward can intercept the ball, (Figure 4a), he can 'shoot' it back towards the goal. If the ball is missed it will travel to the other half of the playing area and the first team's forward will have the opportunity

of intercepting the ball and redirecting it forward at a new angle according to the 'player' section which is used (Figure 4b). If the ball is 'saved' by the 'goalkeeper' or it reflects back from the end boundary, the same forward will have the opportunity to intercept the outcoming ball and divert it back towards the 'goal'.

A 'score' is made in the "soccer" game by 'shooting' the ball through the defined goal area. The scoring and game control is done automatically as for the tennis game. The same audio signals are used to add atmosphere to the game.

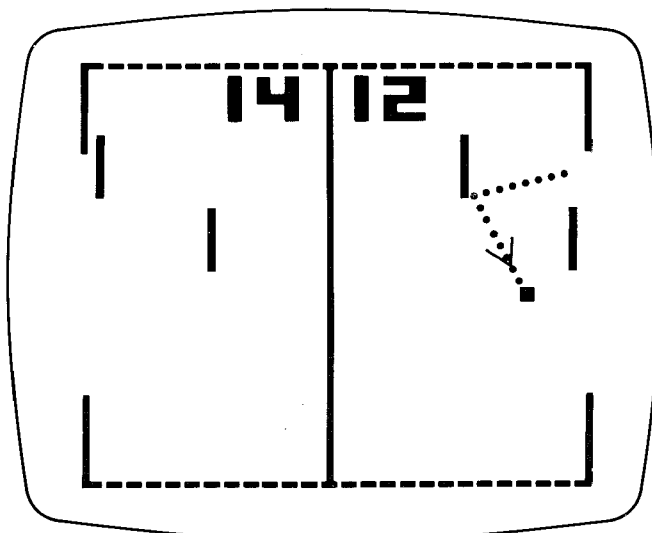


Fig.4a Return of "Goal Save"

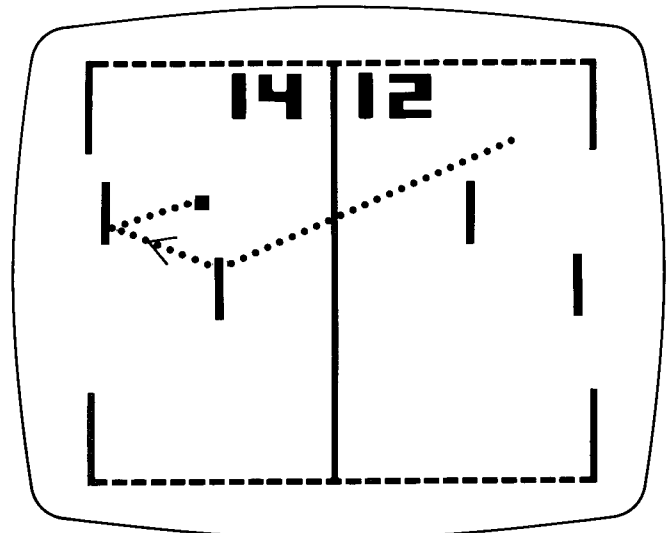


Fig.4b "Shooting" Forward

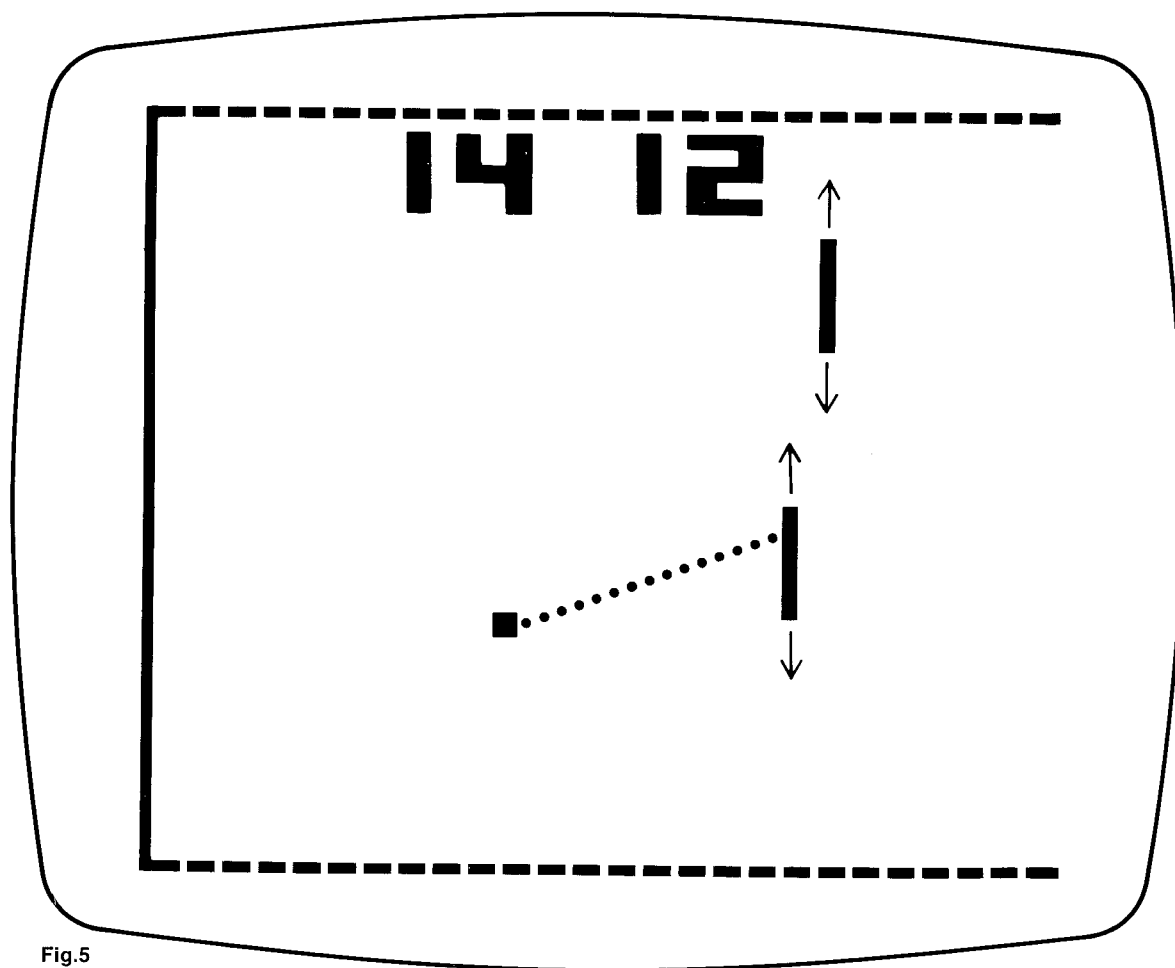


Fig.5

### Squash

This game is illustrated in Fig. 5. There are two players who alternately hit the ball into the court. The right hand player is the one that hits first; it is then the left hand player's turn. Each player is enabled alternately to ensure that the proper sequence of play is followed.

### Practice

This game is similar to squash except that there is only one player. See Fig. 6.

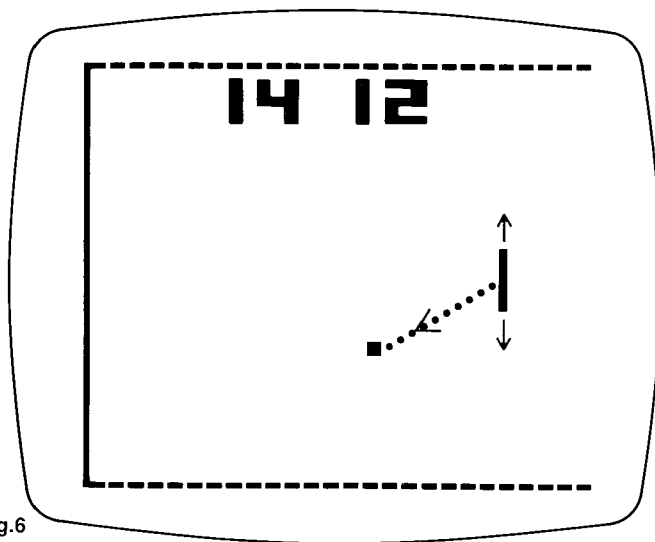


Fig.6

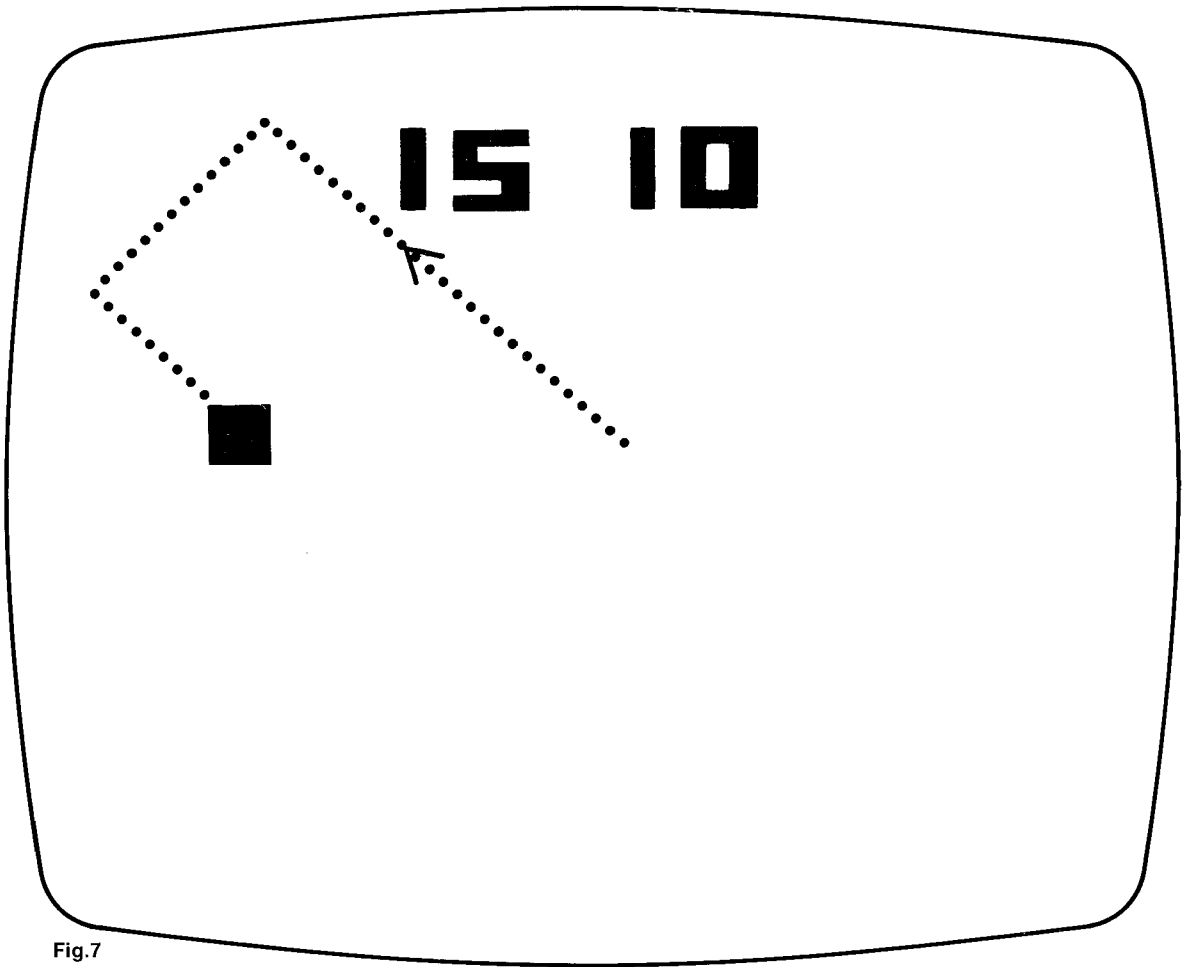


Fig.7

### Rifle Game No. 1

This game is illustrated in Fig. 7. It has a large target which bounces randomly about the screen. A photocell in the rifle is aimed at the target. When the trigger is pulled, the shot counter is incremented and, if the rifle is on target, the hit counter is incremented, a hit noise is generated and the target is blanked for a short period. After 15 shots the score appears but the game can still continue without additional scoring.

### Rifle Game No. 2

In this game illustrated in Fig. 8, the ball traverses the screen from left to right under control of the manual serve button. Otherwise the game is as described for Rifle Game No. 1.

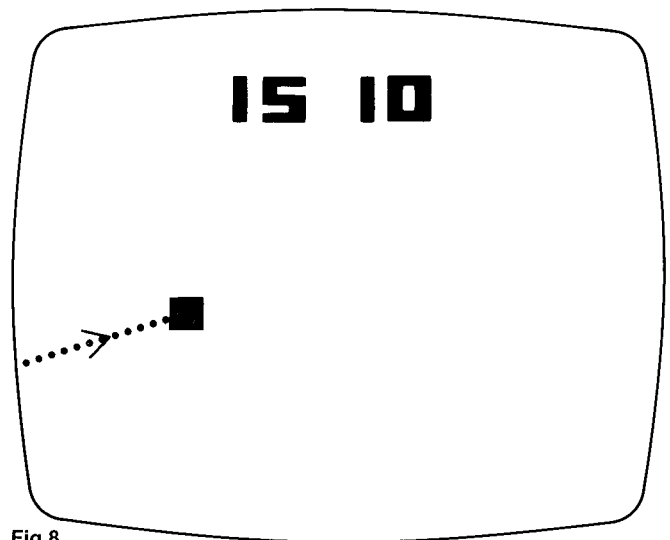
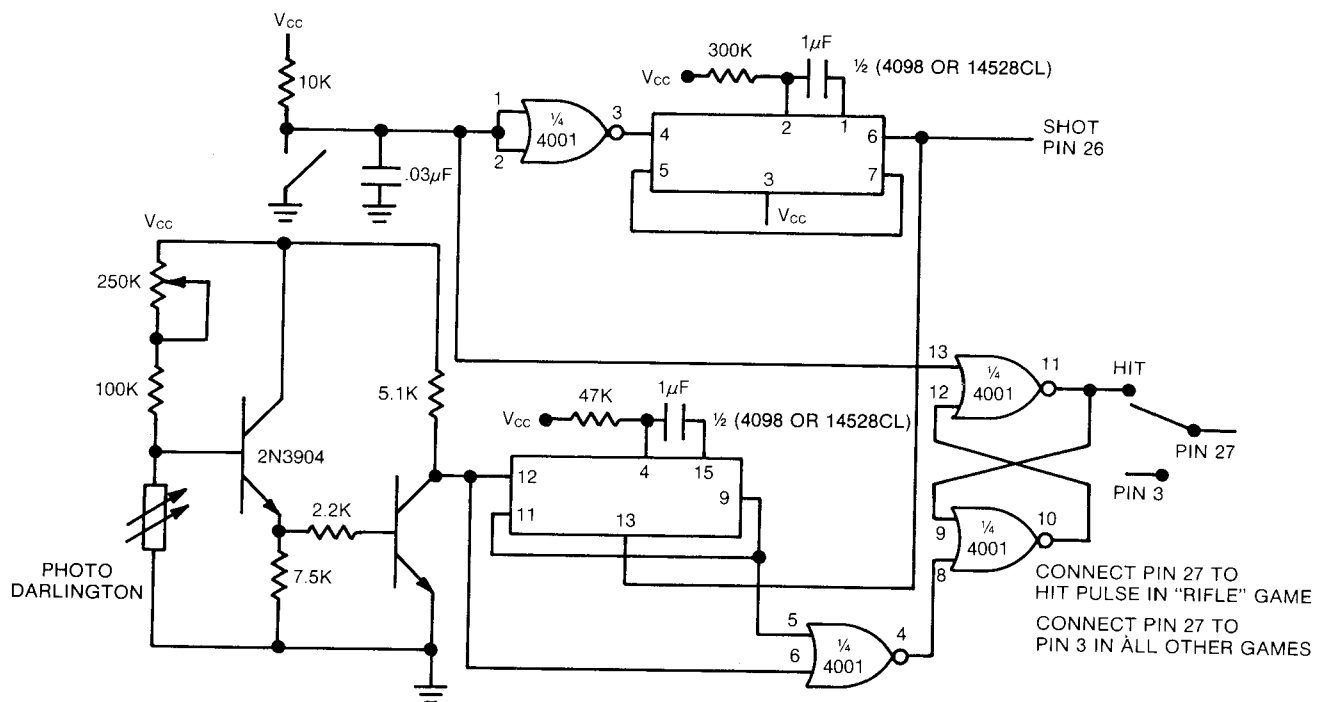
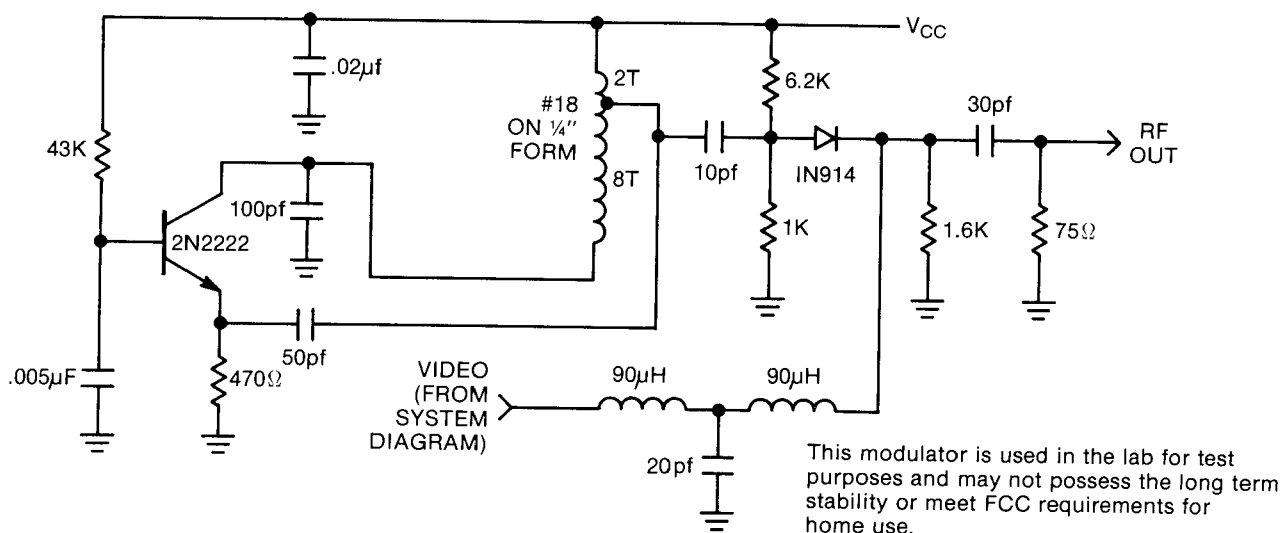


Fig.8





**Fig.9 RIFLE INTERFACE**



**Fig.10 VHF MODULATOR**

	Horizontal	Vertical
Slow	$\pm .5\mu s$	2 angles $\pm 1$ line 4 angles $\pm 3$ lines
Fast	$\pm 1\mu s$	2 angles $\pm 2$ lines 4 angles $\pm 5$ lines

**Fig.11 ANGULAR MOTION**



### RANDOM BALL SPEED/RANDOM ANGLES

To enhance the excitement and challenge of the various games, this option provides random variations of the ball speed and random changes in the ball rebound angle as the games are being played.

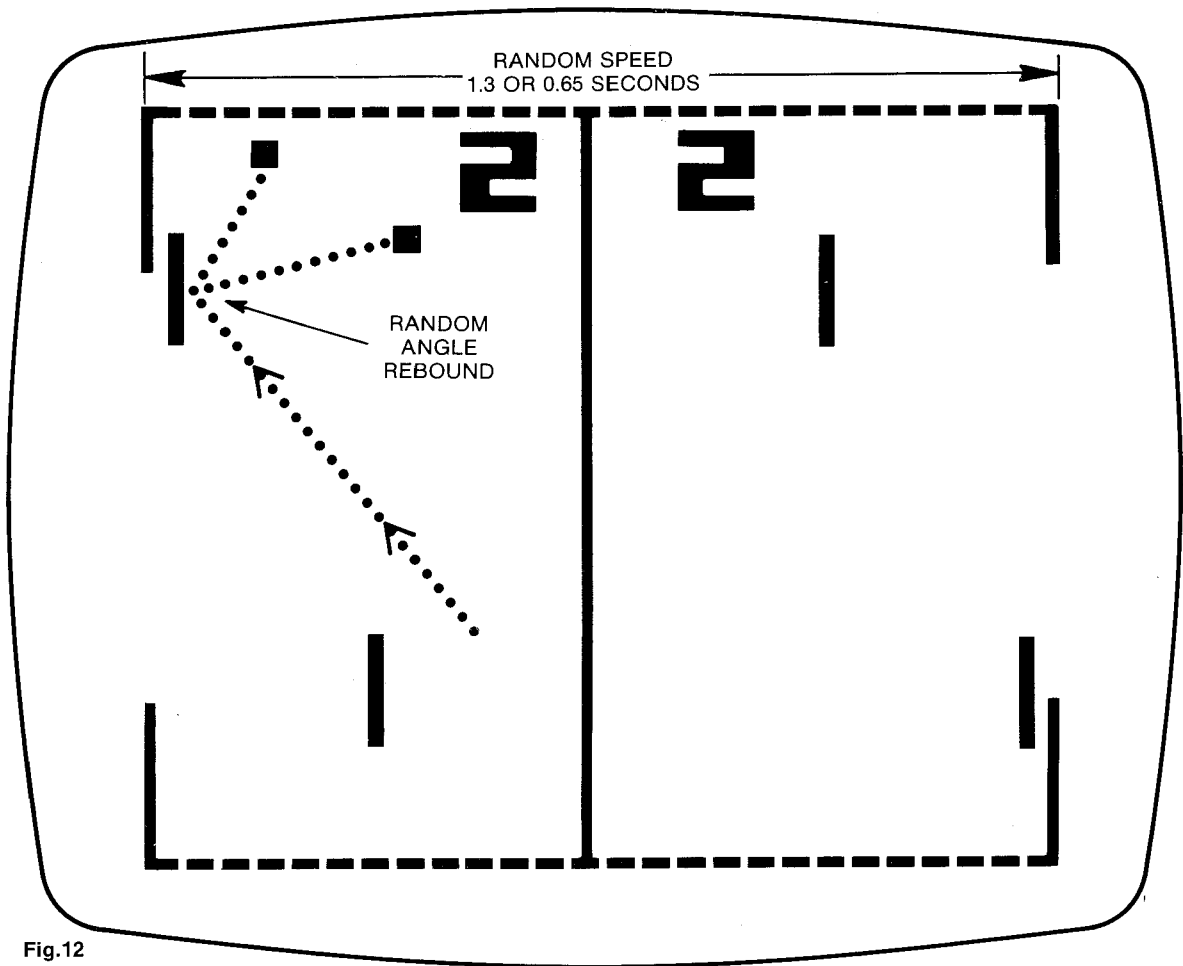


Fig.12

### Soccer

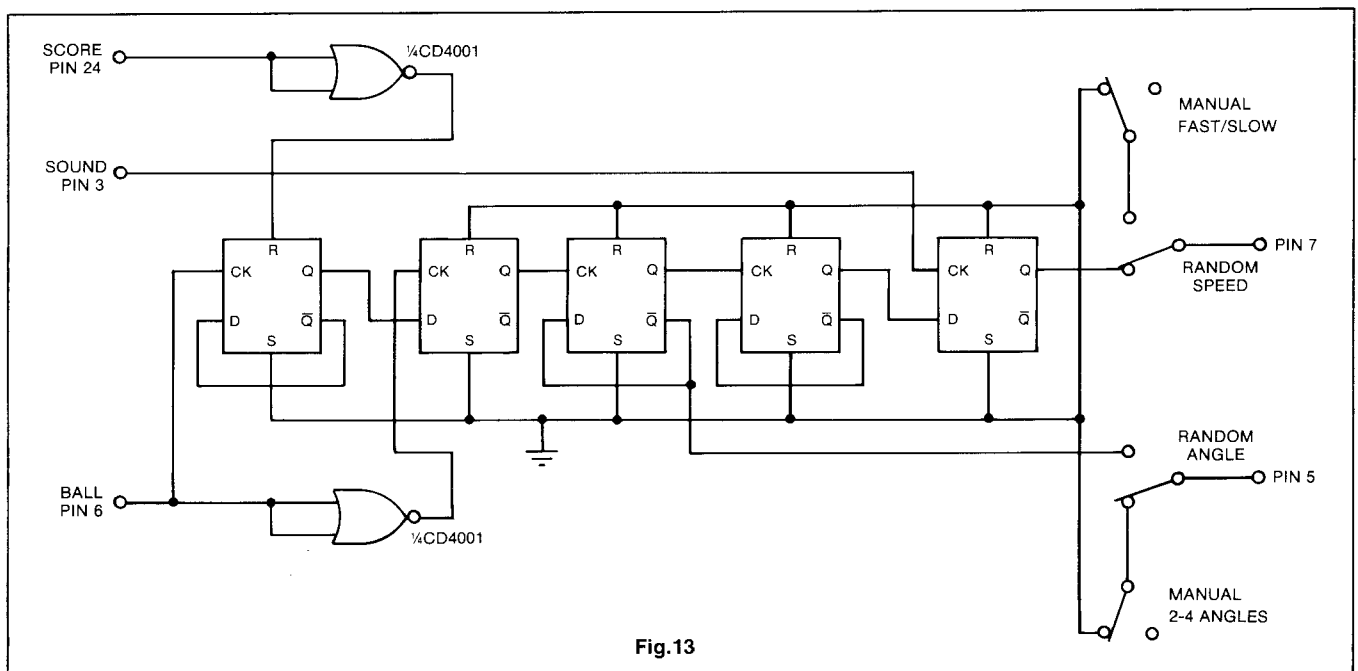
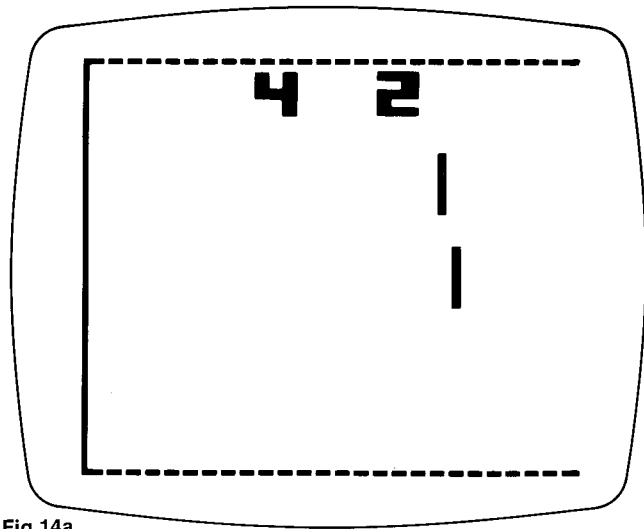


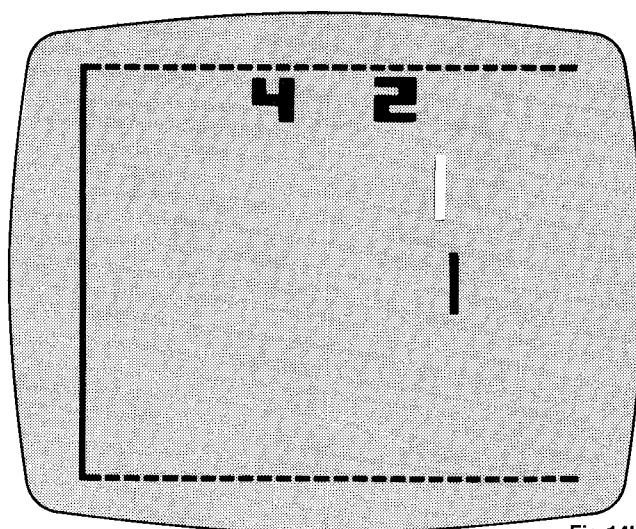
Fig.13

### BLACK AND WHITE BATS/GRAY BACKGROUND

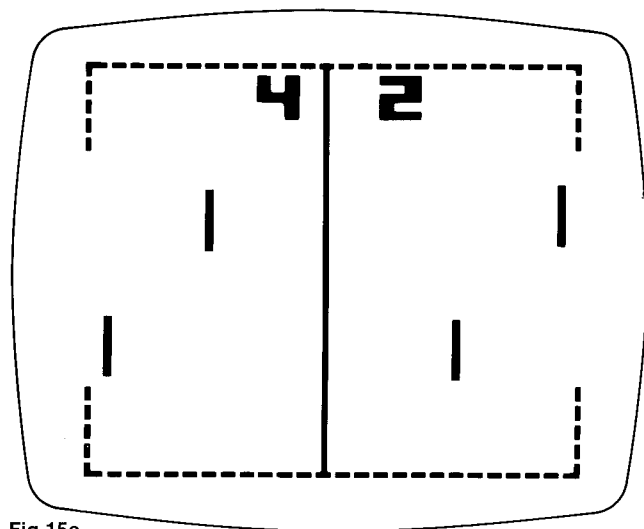
This option provides an added factor for player team recognition. The field or court is produced as a gray background with the bats in black and white. This option is particularly helpful for the squash game where the players are positioned close together.



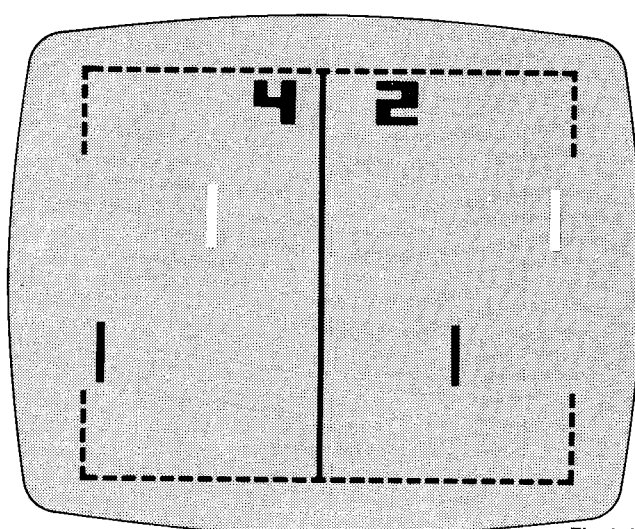
**Fig.14a**



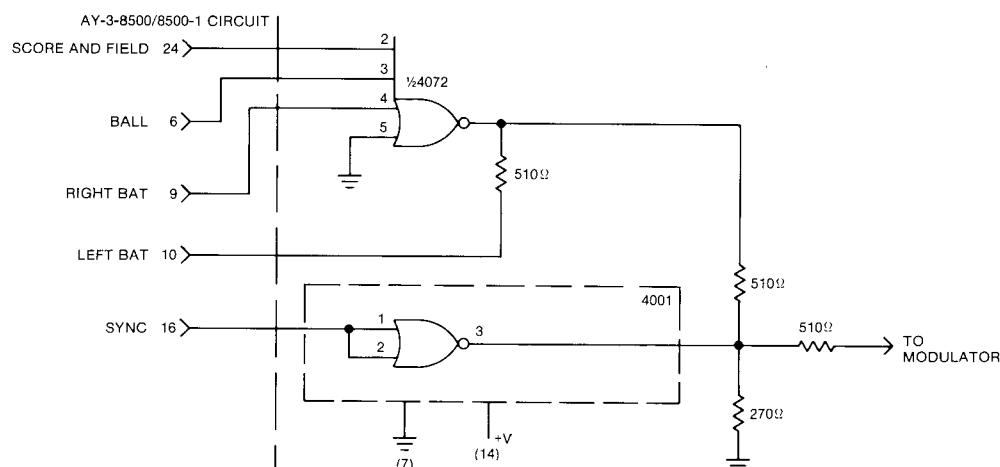
**Fig.14b**



**Fig.15a**



**Fig.15b**



THE ABOVE CIRCUIT IS USED AS AN ALTERNATIVE TO THAT SHOWN ON THE SYSTEM DIAGRAM.

**Fig.16 GRAY BACKGROUND**



### FOUR PLAYER CONFIGURATION

With this option, the basic two player tennis game can be expanded to true four player doubles. Each player is capable of playing the full width of the court.

A variation of this option allows for a three player handicap game with two players against one.

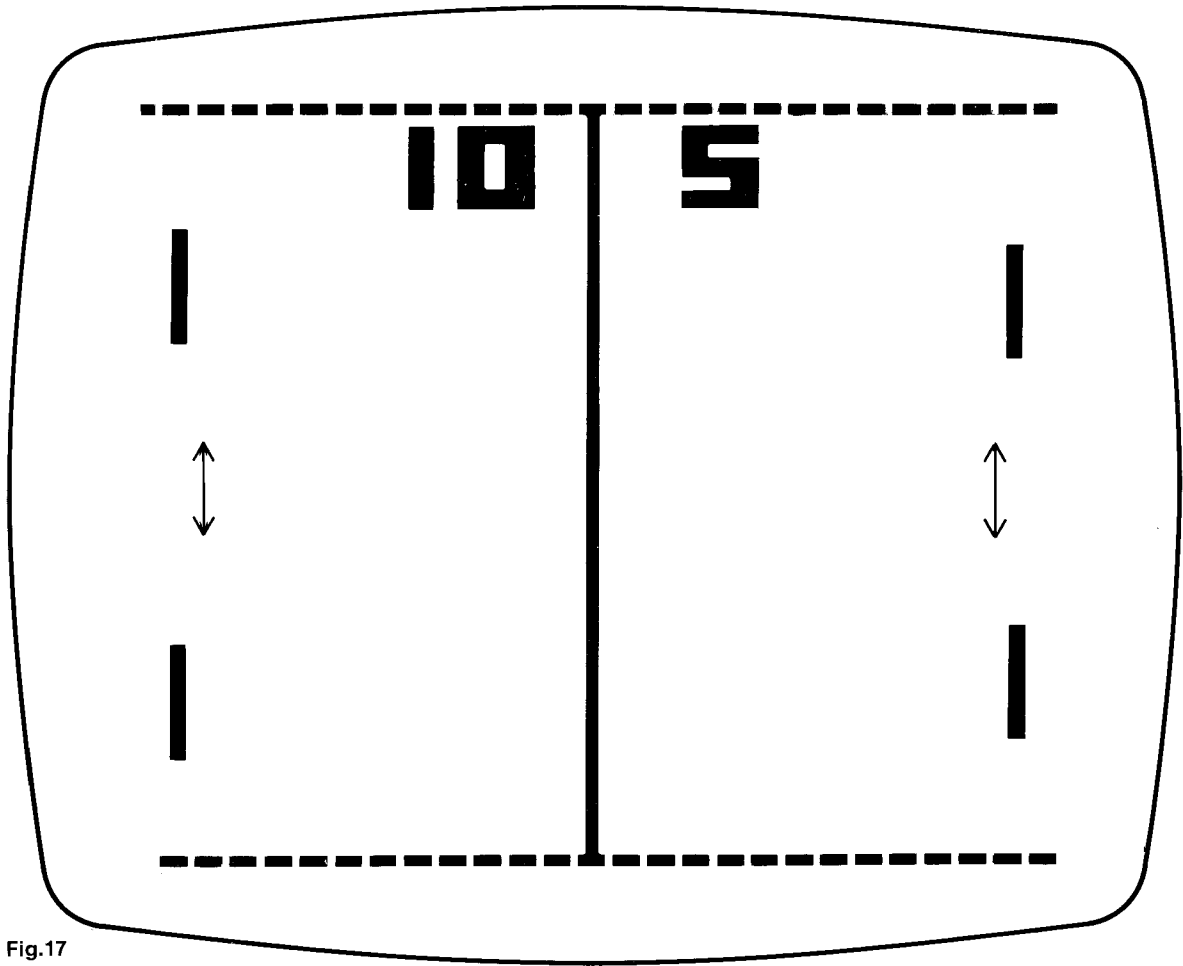


Fig.17

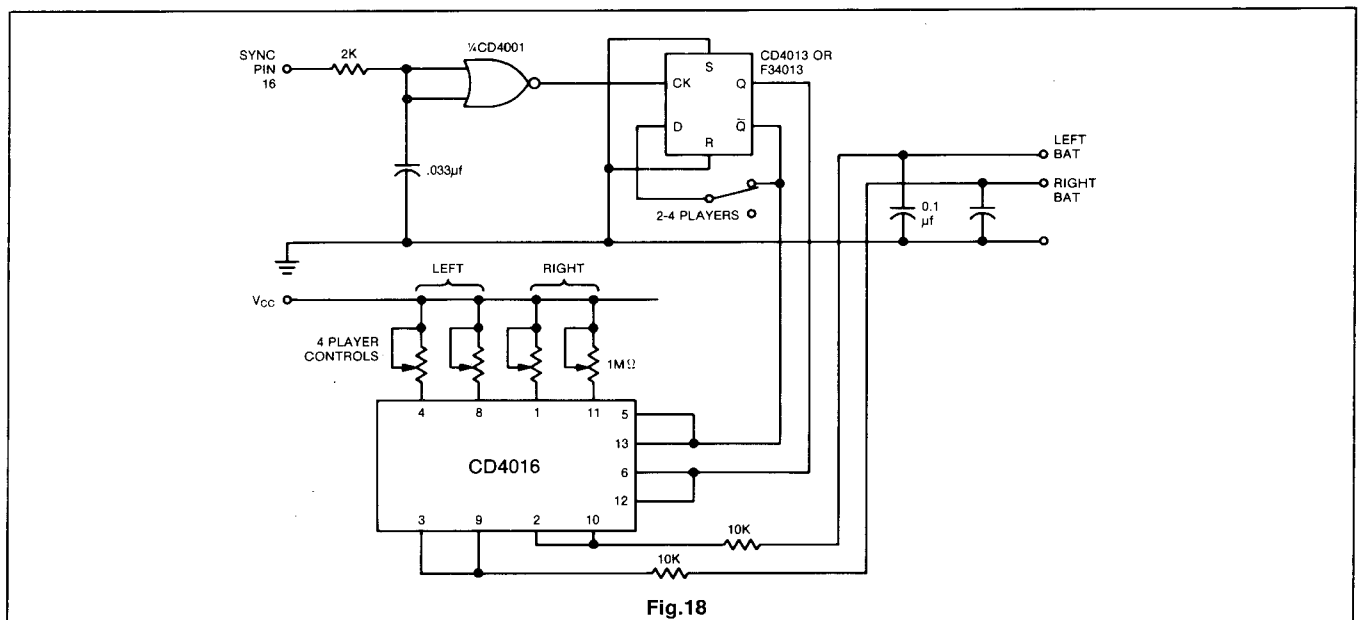


Fig.18