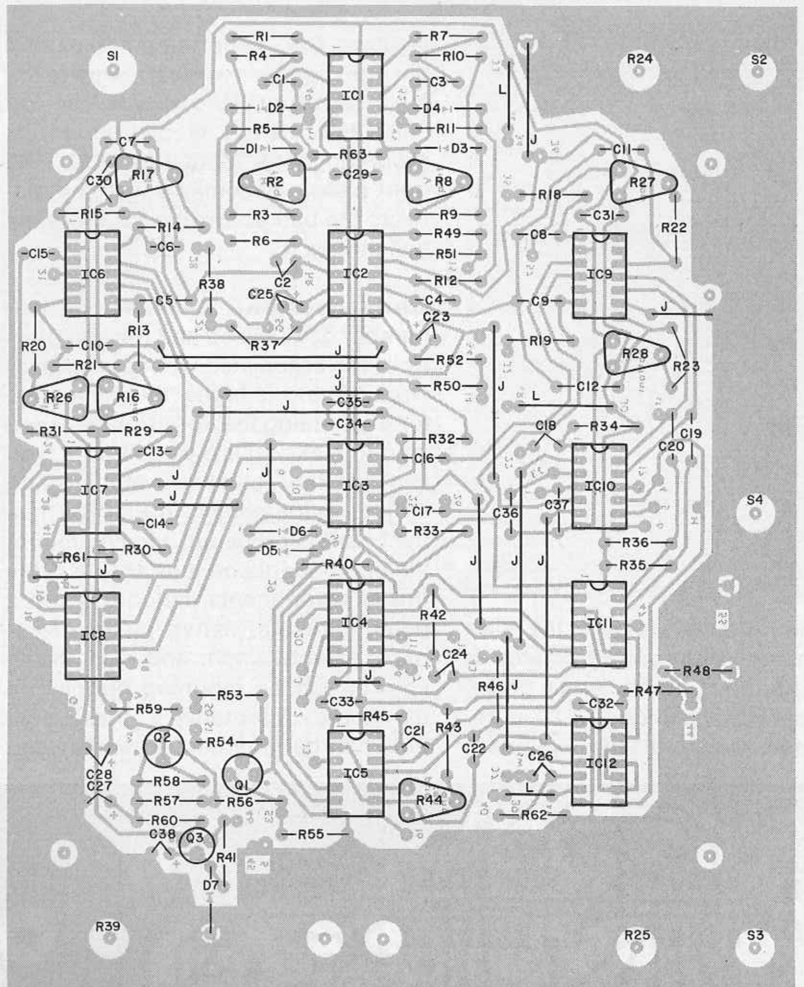


WIRING TABLE

From	To	From	To
1	2	33	SL (link)
3	4	34	R24, +V side
5	S1 lug 8	35	R24 wiper
6	7	36	R24,R25 GND
8	9	37	38
10	11	39	SS (link)
12	S1 lugs 6,7	40	41
13	14	42	S4 (serve)
15	16	43	S1 lug 2
17	18	44	S1 lug 4
19	20	45	B1-
21	22	46	S6 (on R39)
23	24	47	48
25	S1 lug 12	49	50
26	S1 lug 9	51	52
27	S2 & S3	53	Video output
28	R39	54	S5
29	R39,S2,S3	55	S4 GND
30	SR (link)	56	S2 & S3
31	R25, +V side	57	S1 lug 5
32	R25 wiper		

Note: Pads on the board with letter legends are for optional scoring/sound board.

Adjustments. There are two ways to have the Pongtronics fed to your TV receiver. One is an ac connection to the receiver's video amplifier input, the other is to use an FCC type-approved r-f modulator that permits you to feed the game into the antenna input of your receiver and operate on an unused channel in your area. If you elect video feed, you can install a through a chassis-mounted connector for the Pongtronics' output.

Assuming your receiver's horizontal and vertical controls have been set for a stable picture, connect the Pongtronics to the receiver through the desired input. Turn on the power to the receiver and Pongtronics, in the latter case rotating the BALL SPEED control clockwise. If you notice that the picture is rolling, adjust trimmer potentiometer *R8* until the frame locks. If you notice horizontal "tearing," adjust *R2* for stable horizontal lock. You can now adjust the receiver's BRIGHTNESS and CONTRAST controls for a sharp picture with a black or dark gray background and white paddles, ball, and court walls.

Adjust trimmer potentiometer *R27* until the upper wall of the court is about 1" (2.54 cm) from the top of the screen. Then adjust *R28* so that the bottom wall is the same distance away from the bottom of the screen. Adjust *R16* to set the left paddle about 1" from the left side of the screen and *R17* to position the right paddle. One or both paddles may initially be off the screen, so you may have to start your paddle adjustments by first getting the paddles onscreen.

Hold down the SERVE button. A vertical white line with a small "hole" in the middle should appear on the screen. This hole corresponds to the ball. The line will rebound back and forth between the paddles. Adjust *R26* to center the hole on the screen.

The angle of rebound between ball and paddle is controlled by *R44*. Adjust this trimmer potentiometer until the ball rebounds in a straight line across the screen when the ball hits the center of the paddle. A simple way to do this is to temporarily bring the two paddles close together and narrowing the court to form a small rectangle with the paddles. When the ball is trapped inside the rectangle, *R44* is properly adjusted. Return the paddles and walls to their proper positions.

The Pongtronics is now ready to use. Bear in mind that each time you turn on the game it may be necessary to touch up your receiver's horizontal and vertical controls as the agc circuit locks up in the wrong direction. Momentarily changing channels may also break the sync lock. You can also hold down the SERVE button to initiate the game and allow the Pongtronics' flip-flops to get into synchronization.

After operating the SERVE button, you may have to wait for up to five seconds, depending on the setting of the BALL SPEED control, for the ball to appear on the screen. ◈

BY JOSEPH A. WEISBECKER

BUILD SPACE-WAR GAME

EACH PLAYER USES A "SPACE SHIP" TO FIRE "MISSILES" AT THE OPPONENT

Popular among people who use computers is a "war" game in which space ships are positioned on the screen of a computer terminal and simulated missiles or laser beams are fired at them by the opponent. Since most people don't have access to a computer for such games, the simple version described here has been devised to be used with any TV set.

Signals are generated to produce two space ships (small white squares), one on each side of the screen. Each player can move his ship up or down by means of a single control. When one player thinks he is within range, he operates a pushbutton switch to make it appear that a "laser beam" is being fired from his ship to the opponent's. If he scores a hit, the opponent's ship disappears from the screen and the game is over. It can be restarted by the operation of a reset switch.

However, once a player has fired his laser (and it can only be fired in a single burst), it takes several seconds for it to be "recharged." During this period of time, his ship is helpless against the opponent and all he can do

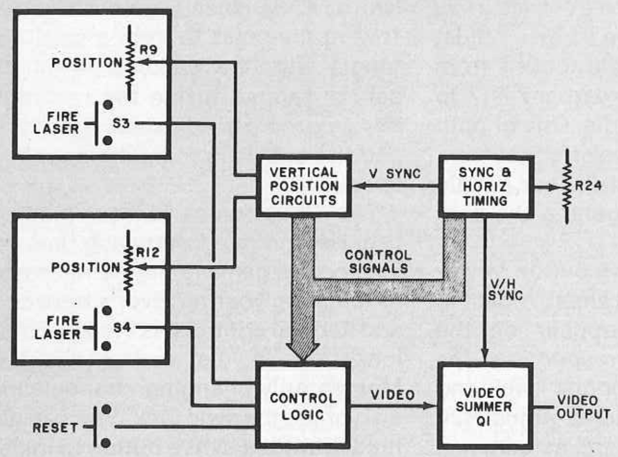


Fig. 1. Logic diagram shows how various stages are connected.

is try to keep out of the line of fire. Also, during this period, the ship of the player who fired is flashing on and off. When the flashing stops, his laser is recharged and ready to fire again. This feature discourages continuous firing and encourages the use of caution and strategy.

The block diagram (Fig. 1) shows how the system operates. Note that the output is a composite of sync and video signals. It can be applied directly to the video amplifier of a TV receiver or, through an FCC type-approved r-f device, to the TV receiver's antenna input using a locally unoccupied channel.

Circuit Operation. The sync and horizontal timing circuit is shown in Fig. 2. Basic timing is performed by two inverters in *IC1*, which is wired as an oscillator operating at a nominal 122.88-kHz frequency. Resistor *R1* increases the stability of the circuit, while *C1* and the combination of *R2* and *R24* are used to adjust the frequency. The output is a square wave with a period of 8.14 microseconds.

This signal drives a 14-stage binary counter formed by *IC2* and *IC3*. Diodes *D1, D2,* and *D3* decode the 000 output of *IC2* to form an 8.14-µs pulse occuring 16.28 µs after the beginning of each horizontal sync pulse. This pulse, if applied alone to the receiver, would produce a vertical bar on the left side of the screen. Diodes *D7, D8,* and *D9* decode the 110 output to provide an 8.14-µs pulse 48.8 µs after the horizontal sync pulse. This pulse alone would produce a vertical bar on the right side of the screen.

The differentiator formed by *C2* and *R6* provides a negative-going vertical sync pulse 60 times per second. This pulse in about 2 milliseconds with the component values shown.

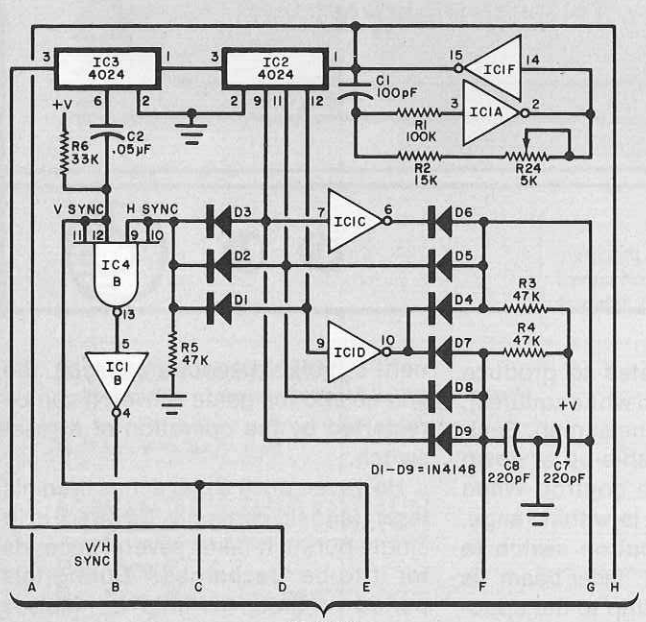


Fig. 2. Sync pulses and timing are generated by this circuit.

PARTS LIST

B1,B2—9-volt battery
C1—100-pF polystyrene capacitor
C2,C14,C15—0.05-µF disc capacitor
C3,C4—0.01-µF disc capacitor
C5,C6—4.7-µF, 6-V electrolytic capacitor
C7,C8—220-pF polystyrene capacitor
C9,C11—10-µF, 60-V electrolytic capacitor
C10,C16,C17—1-µF, 100-V electrolytic capacitor
C12—1000-µF, 16-V electrolytic capacitor
C13—0.1-µF Mylar capacitor
D1 to D9—1N4148 diode
IC1—4049 CMOS hex inverter
IC2,IC3—4024 CMOS 7-bit counter
IC4—4012CMOS dual 4-input NAND gate
IC5,IC6—555 timer
IC7,IC8—CMOS triple 3-input NAND gate
IC9,IC10—CMOS quad 2-input NOR gate
Q1—2N5129 transistor
The following are 5%, ¼-watt resistors unless otherwise noted:
R1,R7,R10,R14,R16—100,000 ohms
R2—15,000 ohms
R3,R4,R5,R21—47,000 ohms
R6—33,000 ohms
R8,R11—3900 ohms
R9,R12—250,000-ohm potentiometer
R13,R15—39,000 ohms
R17—22,000 ohms
R18—10,000 ohms
R19—47 ohms
R20—100 ohms
R22,R23—10,000-ohm potentiometer
R24—5000-ohm potentiometer
S1—Spst slide switch
S2 to S4—Spst normally open pushbutton switch
Misc.—Suitable chassis, extension cable, remote enclosure, knobs (2), battery holders, mounting hardware, etc.
Note—The following is available from Southwest Technical Products, 219 W. Rhapsody, San Antonio, TX 78216: complete kit (SW-1) including chassis at $39.50, postpaid. Texas residents, please add sales tax.

The horizontal and vertical sync pulses are combined in one section of *IC4*, a dual 4-input NAND gate. The composite positive-going sync is fed to the r-f circuit.

In this circuit, 256 horizontal sync pulses occur for each vertical sync pulse. However, once the oscillator is adjusted (by *R24*) for a good TV vertical sync lock, the small deviation from conventional TV line rate is easily tolerated by the receiver.

The vertical position circuits (Fig. 3) use two 555 timers in *IC5* and *IC6*. Both are connected as monostable (one-shot) multivibrators and are triggered (pin 2) by the negative-going sync pulse from *IC3*. The duration of the output waveform is determined by the value of the RC network connected to pins 6 and 7. The width of the output pulse is determined by the amount of dc voltage applied to pin 5. For example, the width of the output pulse from pin 3 of *IC5* is determined by the adjustment of *R9*. Since *IC5* is triggered by the vertical sync pulse, the rising edge of the output waveform coincides with the vertical sync pulse. Changing the value of *R9* varies the time at which the trailing edge of the pin-3 waveform occurs relative to the sync pulse. Capacitor *C3* and resistor *R7* provide a negative-going pulse from this trailing edge that can be positioned between the vertical sync pulses by *R9*. This signal alone would produce a horizontal line on the screen, moved up and down by *R9*.

Similarly, *IC6* and its associated components provide a horizontal line that can be moved by *R12*.

Note that each timer control pin (5) is connected to ground through a large capacitance (*C5* and *C6*). The charging and discharging of these capacitors produce a lag in the vertical movement of the displayed signals. The lag is deliberately introduced to improve the playing of the game.

The horizontal and vertical signals for each side of the screen are combined in the circuit shown in Figs. 3 and 4. Figure 3 also includes the laser firing circuit.

The horizontal pulse on line G is applied to pin 1 of *IC7B*. If laser switch *S3* is not depressed, pin 13 of *IC7C* will be low, causing its pin 10 to be high. This forms the signal for pin 8 of *IC7B*. If the reset switch has been operated, the two flip-flops (*IC9A, IC9B, IC10A, IC10B*) are in their reset states, providing a low signal at pin 13 of *IC9D*. The vertical signal from pin 3 of *IC5* is then inverted at pin 11 of *IC9D* and pin 2 of *IC7B*. Thus, the negative-going pulse at pin 9 of *IC7B* represents the intersection of the horizontal and vertical pulses and part of the video output of *IC4A*. The video output produces a small white rectangle on the left side of the screen for one of the space ships. The right-hand space ship is generated in a similar manner using the other gates.

When laser switch *S3* is depressed, a high level is applied to pin 13 of *IC7C*. A positive pulse is also applied to pin 3 of *IC7A*. The duration of this pulse is determined by the values of *C16* and *R14*. The pulse gates the inverted vertical signal at pin 4 of *IC7A* to the video output. The vertical signal would normally form a line across the TV screen at the same position as the left space ship. The line appears dotted because of the 8.14-µs square wave on pin 5 of *IC7A* and it forms the "laser beam" fired by that space ship.

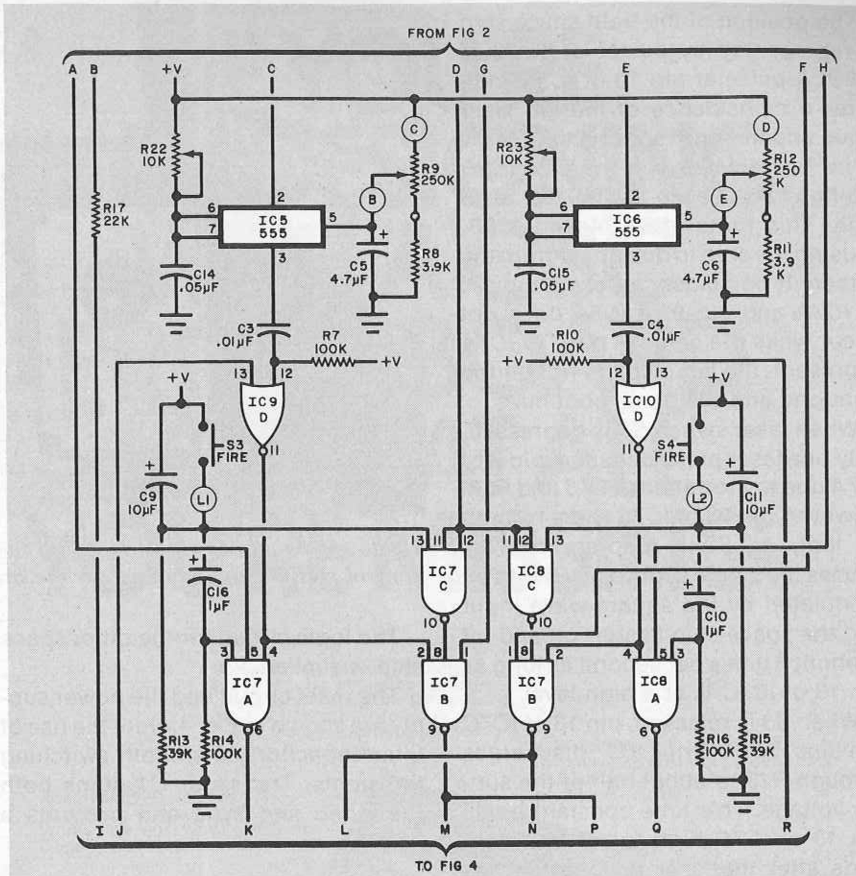


Fig. 3. One 555 timer is used for each spaceship. Though both are synced to the same vertical pulse, each has its own independent vertical position potentiometer. The high capacitance at each pin 5 makes vertical positioning "soft" to keep players on their toes. This circuit also produces "laser" effect and determines "helpless" time.

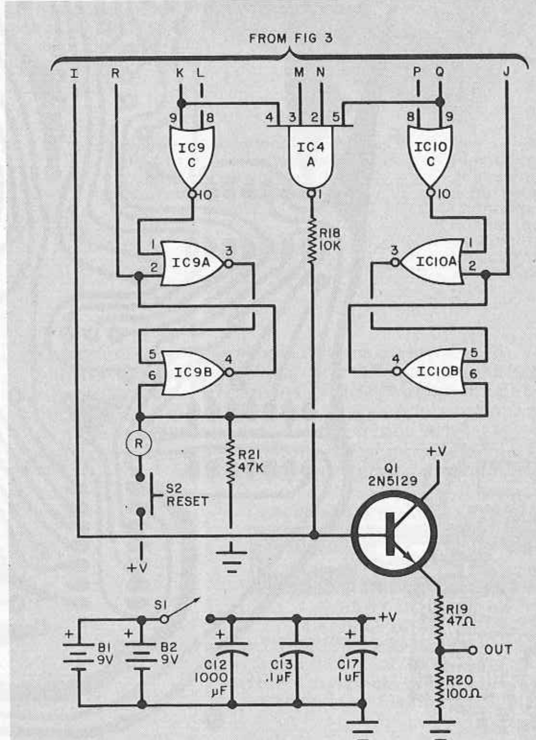


Fig. 4. Each set-reset flip-flop locks out the other space ship when it is "hit" by opposing laser. Power supply circuit is also shown here.

The position of the right space ship is represented by pulses at pin 9 of *IC8B*. A pulse at pin 10 of *IC9C* indicates a coincidence of the left laser beam and the right space ship. This is a "hit" pulse which sets the *IC9A-IC9B* flip-flop to cause pin 13 of *IC10D* to go high. This turns off *IC8A* and *IC8B*, causing the ship to disappear from the screen. If coincidence between pin 6 of *IC7A* and pin 9 of *IC8A* does not occur while the pulse at pin 3 of *IC7A* is present, the left ship did not hit the right one and the game continues.

When laser switch *S3* is depressed, only one laser pulse occurs at pin 3 of *IC7A* due to the action of *C16* and *R14*. However, pin 13 of *IC7C* remains high as long as *S3* is depressed. This causes the signal at pin 9 of *IC7B* to be modulated by the square-wave input and the space ship flashes on and off at about 8 times per second as long as pin 13 of *IC7C* is at a high level.

When *S3* is released, pin 13 of *IC7C* remains high until *C9* discharges through *R13* to about half of the supply voltage. This time constant holds pin 13 of *IC7C* high for several seconds after the laser pushbutton has been released. Pin 13 of *IC7C* must be low before *S3* is operated to provide a sufficient voltage swing to generate a laser pulse at pin 3 of *IC7A*. The time constant of *C9/R13* keeps the space ship flashing for a few seconds and also inhibits firing again for the same period of time. The values of *C9* and *R13* can be changed if desired.

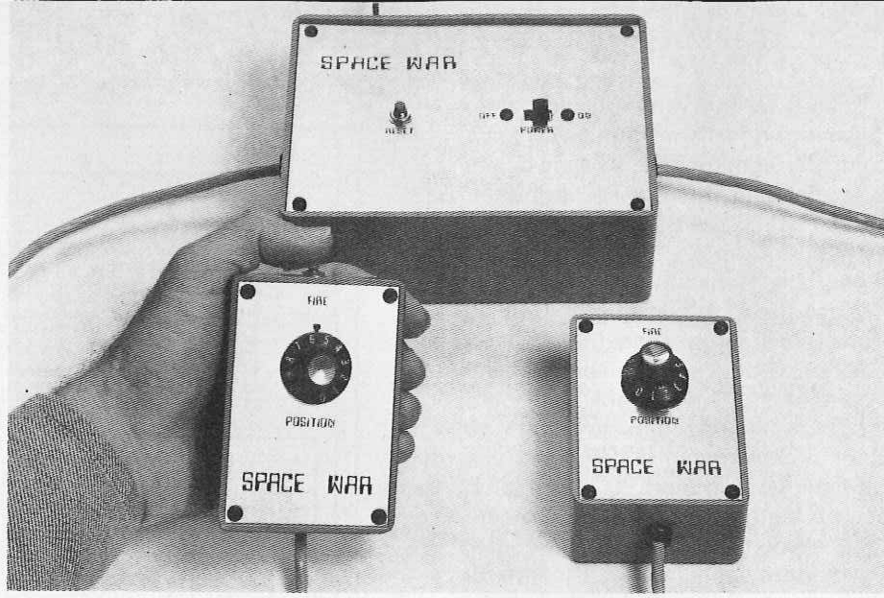


Photo shows main control box with two control stations as arranged for the prototype.

The logic circuit for the other space ship is similar.

The reset circuit and the power supply are shown in Fig. 4. Note the use of filter capacitors to smooth switching transients. Transistor *Q1* sums both the video and sync and presents a low-impedance composite video signal for use by the video amplifier of the TV receiver or an FCC-approved class-1 device.

Construction. The circuit is easily assembled on a pc board such as that shown in Fig. 5 (which also shows component installation). Position controls and laser firing switches can be mounted in separate small enclosures with cables connecting them to the main board. The latter (including battery holders) is mounted in its own enclosure. The power switch (*S1*) and reset switch (*S2*) should be on the front panel. The composite video/sync signal should be brought out through a phono connector.

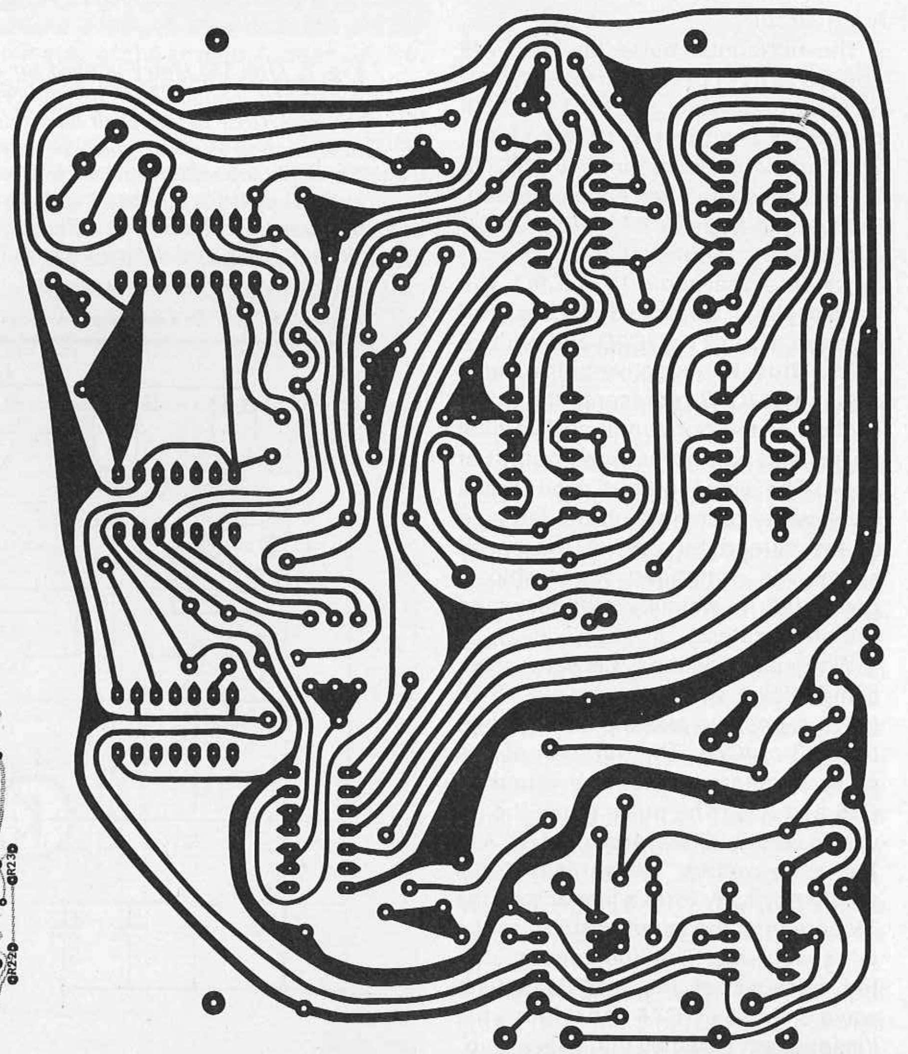
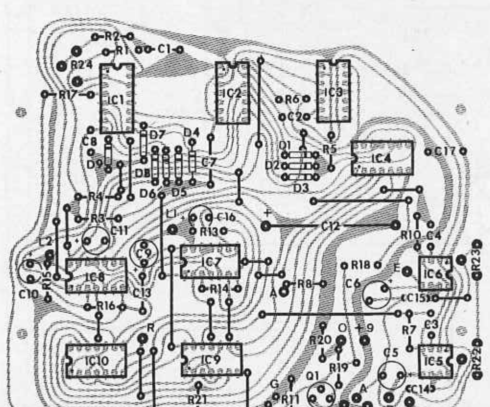


Fig. 5. Actual-size etching and drilling guide is at right. Component layout guide is below.



Testing. Check all wiring before turning on the power. Connect the game to the set's video amplifier. Turn on the space game (*S1*) and operate the reset switch (*S2*). Adjust *R24* (Fig. 2) for proper vertical sync. If necessary, trim *R2* for a stable vertical sync.

If the system is working properly, you will see two white squares (the space ships) on the edges of the screen. Turn up the contrast and turn down the brightness until the squares are clear white on a black background.

You should be able to move the space ships up and down using the appropriate controls. The width of the space ships can be altered by changing the values of *C7* and *C8* (Fig. 2). Their heights are determined by *R7* and *R10* (Fig. 3). The larger the spaceship, the easier the game is to play. About 8 to 10 TV lines is a good height.

Adjust both position potentiometers until the spaceships are at the lowest point on the screen. If they are not even, determine which is higher, and adjust the appropriate potentiometer (*R22* or *R23*) to get them even. Then position both at the top of the screen. If they are not even, adjust *R8* or *R11*.

Depress laser switch *S3* to check the firing. A streak of white dots should extend from the left ship to the other side of the screen. If the right ship is hit, it should disappear. Check the other side in a similar manner. If the firing or recover times differ appreciably from one side to the other, adjust *R13* and *R14* or *R15* and *R16*. ◈

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