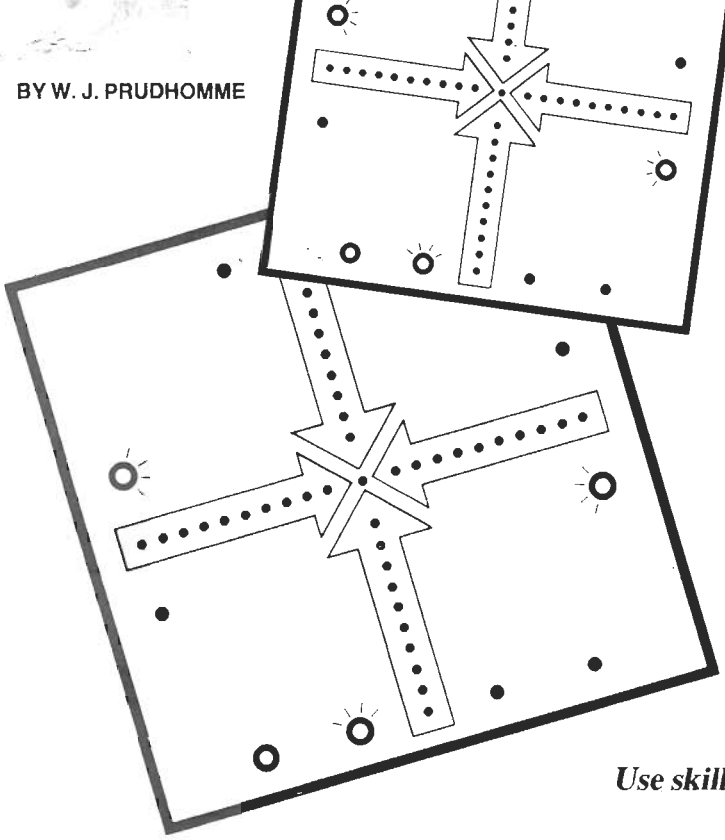
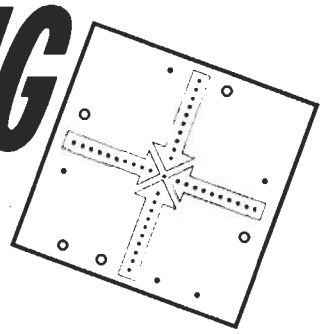
BY W. J. PRUDHOMME

MULTIPLAYER LED RACING GAME





Use skill as well as chance to win the game of "Strategy."

MOST electronic games, like dice and roulette, depend purely on luck. The "Strategy" game presented here, however, depends on the player's skill and the strategic maneuvers one exercises to win. Each of up to four players tries to get "home" before the others. A player can move directly toward home, a step at a time, or use strategy to move an opponent backward, while sacrificing a chance to move forward. In either case, a relative degree of skill is required, the amount of skill determined by a variable-rate blinking LED.

Directly in front of each player's position on an 18" (45.7-cm) square playing field is a set of 10 LED's arranged inside a colored arrow that points toward the center of the field. At the center of the field is a master LED that blinks at an adjustable rate. As each player's turn comes up, he tries to score and move one step closer to the point of his arrow by pressing his SCORE pushbutton switch. Here is where the skill comes in because the SCORE button must be pressed at the exact instant the master LED flashes on. If the SCORE button is pressed too soon or too late, the player fails to score. Since the SCORE button generates only a short pulse when it is operated, timing is very critical. Holding down a SCORE button will be ineffective because this pulse is generated only when the button is initially pressed. Changing the flash rate of the master LED determines the level of difficulty in playing the game.

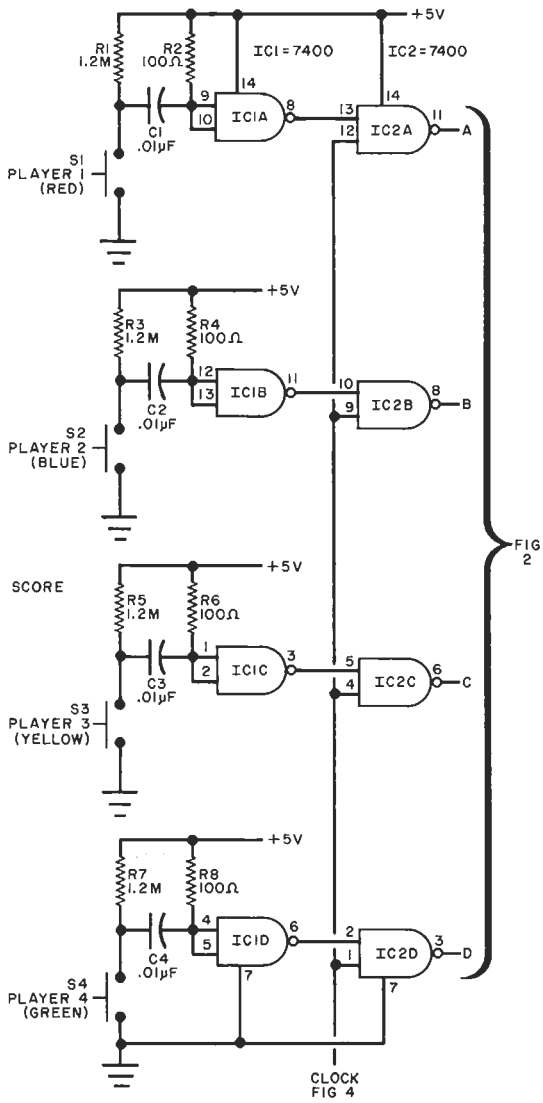


Fig. 1. Each time a player's pushbutton is operated, a single pulse is generated by its IC1.

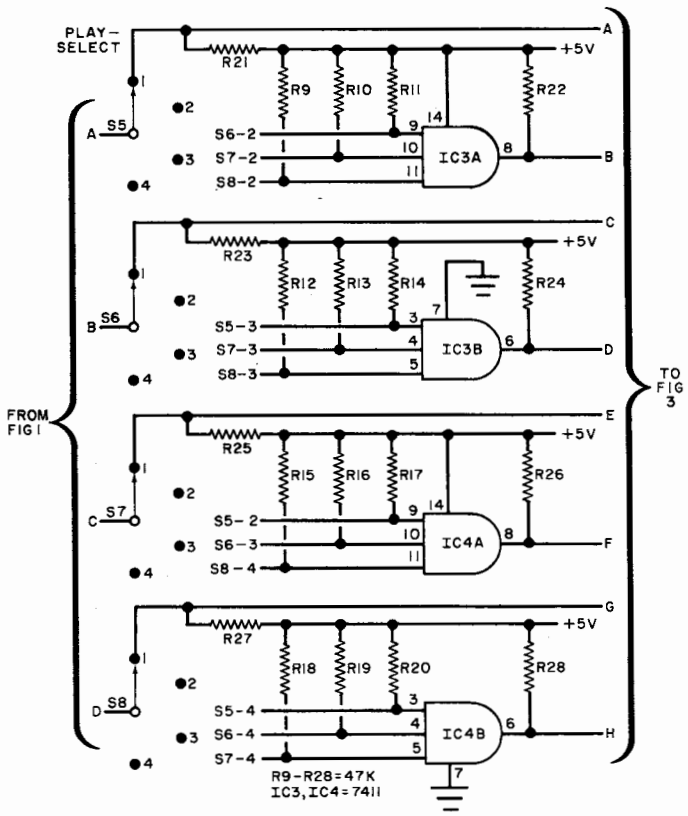


Fig. 2. Pulses are applied to player's LED or opponent's.

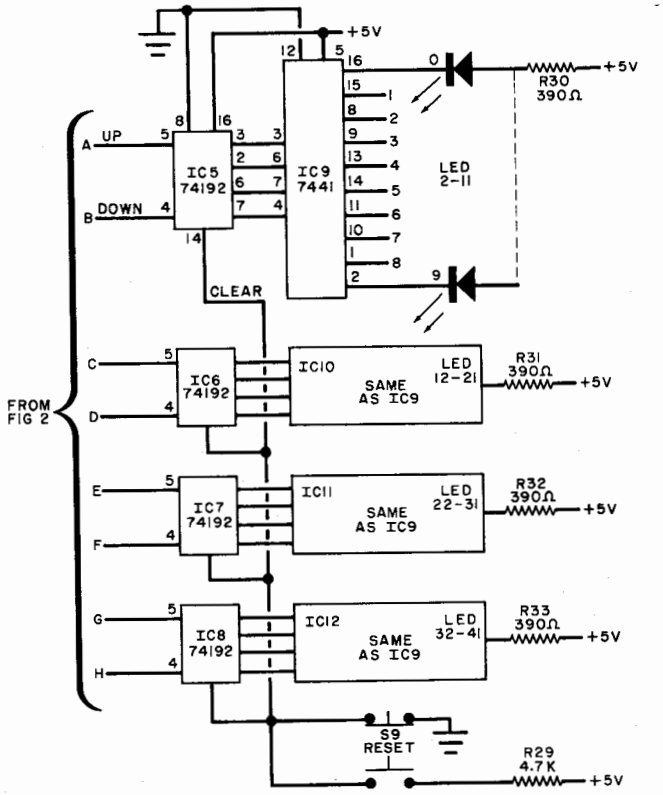


Fig. 3. Each counter drives its decoder to turn on LED's.

PARTS LIST

C1,C2,C3,C4,C6,C8—0.01-μF disc capacitor
C5—1-μF, 15-V electrolytic capacitor
C7—1000-μF, 25-V electrolytic capacitor
C9—1-μF, 15-V nonpolarized capacitor
D1 through D4—1N4002 rectifier diode
F1—½-ampere standard fuse
IC1,IC2—7400 quad 2-input NAND gate
IC3,IC4—7411 triple 3-input NAND gate
IC5 through IC8—74192 up/down decade counter
IC9 through IC12—7441 one-of-10 decoder/driver (see text)
IC13—555 timer
IC14—LM309K 5-volt regulator
Q1,Q2—2N2222 transistor
Q3—Programmable unijunction transistor (Radio Shack No. 276-119 or similar)
The following resistors ½-watt, 10%
R1,R3,R5,R7,R34—1.2 megohms
R2,R4,R6,R8—100 ohms
R9 through R29,R40—4700 ohms
R30 through R33—390 ohms
R35,R38—10,000 ohms
R37—220 ohms
R39—330 ohms
R41—22,000 ohms
R43—27,000 ohms
R44—56,000 ohms
R36—100,000-ohm potentiometer with spst switch
R42—10,000-ohm potentiometer
S1 through S4—Spst normally open pushbutton switch
S5 through S8—Single-pole, four-position nonshorting rotary switch
S9—Momentary-action pushbutton switch with one set each normally open and normally closed contacts
S10—Spst switch (part of R36)
SPKR—8-ohm miniature speaker
T1—6.3-volt, 1.5-ampere transformer
Misc.—Two 19½" lengths of 1" × 3" pine for frame sides; two 18" lengths of 1" × 3" pine for frame sides; two 18" lengths of 1" × 2" pine for cleats; two 16½" lengths of 1" × 2" pine for cleats; one 18"-square piece of ¼" plywood or Masonite for playing field; one 18"-square piece of ¼"-thick Masonite pegboard for bottom plate; fuse holder; printed circuit or perforated board; IC and transistor sockets (optional); paint; sandpaper; line cord; rubber feet (4); white glue; finishing nails; woodscrews (1" long); control knobs (4); hookup wire; solder; etc.

In addition to being able to adjust the difficulty of play with the TIMING control, each player has a PLAY/SELECT switch that he can use to attempt to prevent his opponents from scoring. With this switch, a player can elect to advance his own position on the board or cause an opponent to retreat one step. The latter strategy is useful when an opponent is getting too close to home and a player is willing to sacrifice his own advancement to send him back.

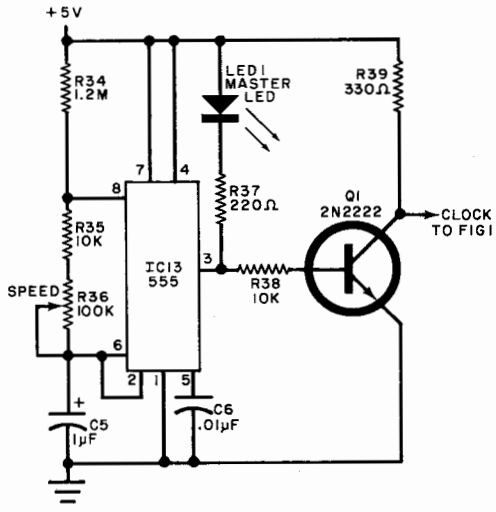


Fig. 4. The 555 operates at about 1 Hz, but its duty cycle can be varied by control R36.

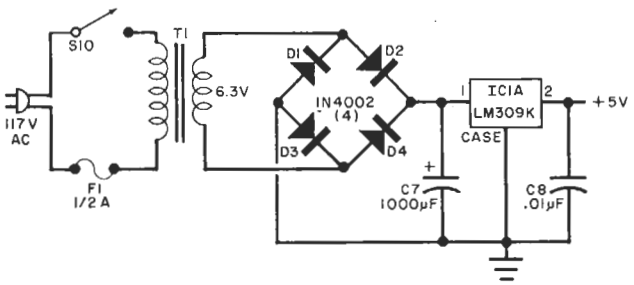
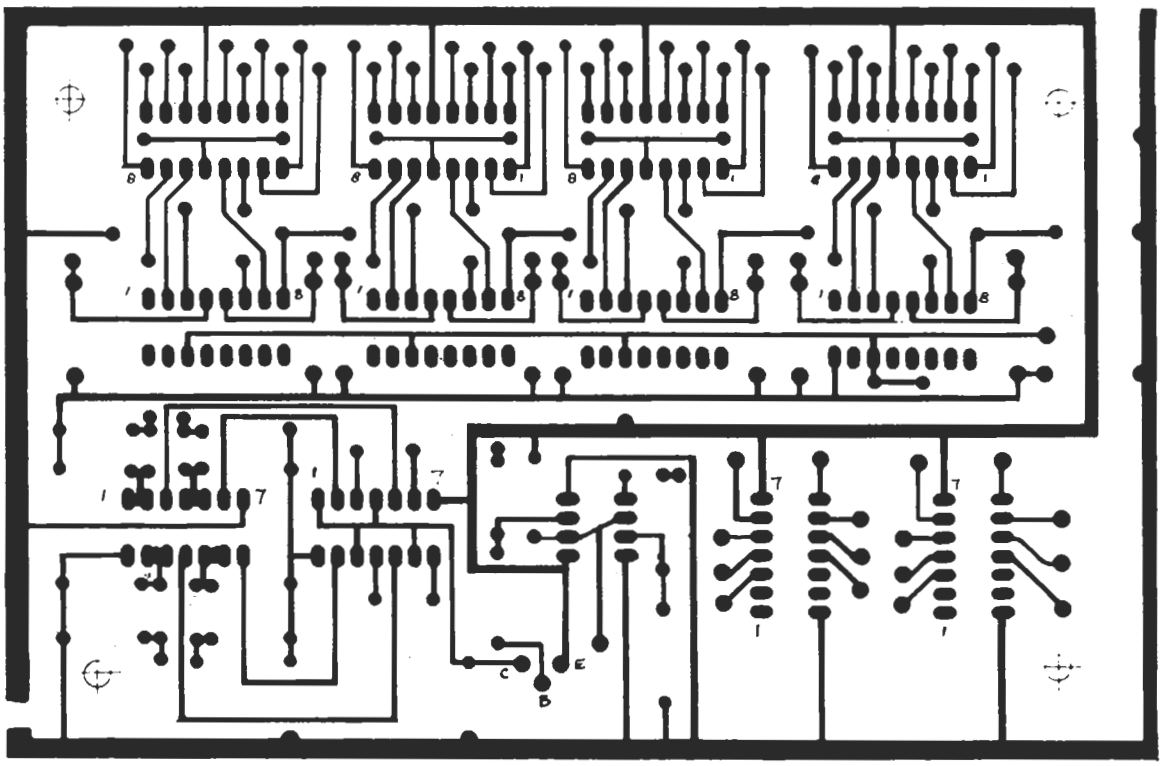


Fig. 5. Power supply is conventional regulated 5-volt system.

About the Circuit. The complete schematic diagram of this game is shown in Fig. 1 through Fig. 4, while the power supply common to all circuits is shown schematically in Fig. 5. Starting with Fig. 1, when a player presses his SCORE button (*S1, S2, S3,* or *S4*), the inputs of the appropriate NAND gate in *IC1* are grounded by the capacitor (*C1, C2, C3,* or *C4*). Since the inputs to the NAND gate are also connected to the common +5-volt line through separate 100-ohm resistors, the capacitor quickly charges, returning the output of the gate to its original low state. When the SCORE



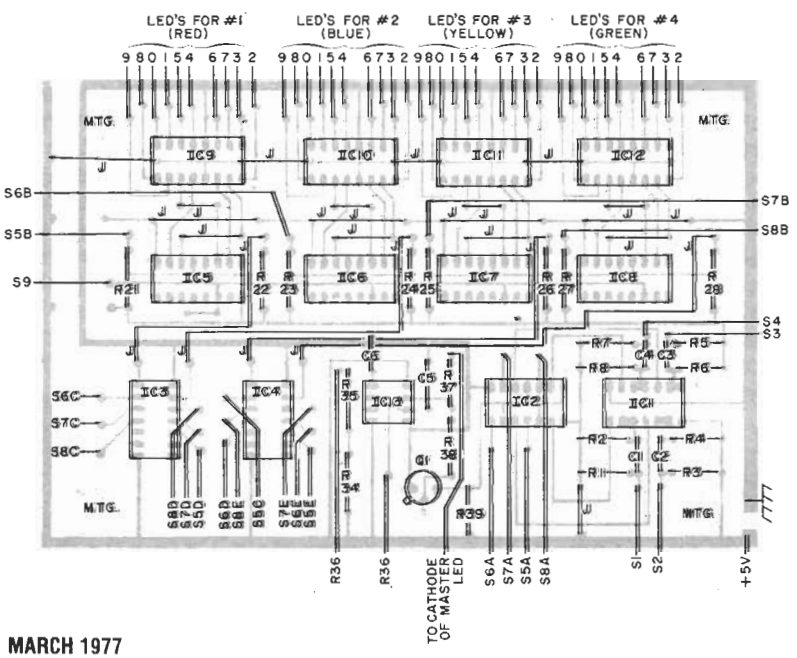


Fig. 6. Actual-size etching and drilling guide is shown above with component layout at left. External connections are also shown at left.

GAME RULES

1—Rotate SPEED control clockwise to turn on power and adjust level of game difficulty.
2—Press and release RESET switch.
3—Choose (by lot, with dice, or by cutting cards) starting player.
4—First player begins by setting his PLAY/SELECT switch to his own color and trying to press his SCORE button at exact instant master LED turns on.
5—If a player is successful in scoring a point, his LED will advance one step. Whether or not the first player scores, next play goes to the next player in a clockwise direction around the board.
6—When an opponent gets near the finish line, it is possible for any other player to move him back one step by setting his PLAY/SELECT switch to the other player's color and operating his SCORE button. The same odds apply whether a player wishes to advance his own score or send another player back one step. A player who elects to send an opponent back forfeits his chance to score.
7—First player to reach home is the winner. If desired, the game can be played to determine the second- and third-place winners.
8—Players can mutually agree to change the rules to add variety to the game. For example, instead of one play at a time, each player can be allowed to score as many points as possible in a given period of time. Another possibility is to allow each player two scoring attempts per turn. In this case, he can elect to score twice, move one or two opponents back, or move one player back and also score.

button is released, the output remains low and the capacitor discharges through the 1.2-megohm resistor until the circuit is again ready to generate a pulse. The RC charge/discharge time, consequently, becomes an effective debounce circuit.

The output from the *IC1* NAND gate is coupled to one input of NAND gate *IC2*, where it is combined with the output pulse from the clock generator (Fig. 4). These gates determine if the player "scores" by detecting simultaneous inputs to the *IC2* gate. The logic rules for a two-input NAND gate require that if either input is low, the output will be high. Also, if both inputs are high, the output will be low. Hence, if the positive-going pulse generated by operation of the SCORE button and the positive-going clock pulse are present at the same instant, the output of that particular gate in *IC2* will go low for the duration of the pulse-coincidence interval. If the two pulses do not occur simultaneously, the output of the *IC2* gate will remain high, as it does between plays, and the player will not score.

When each player has taken his turn, the next player has the option of either advancing his own position or sending his opponent's position back one step. He does this by setting his PLAY/SELECT switch (*S5* through *S8* in Fig. 2). This circuit routes the player's pulse to the up-count input of his own counter (*IC5, IC6, IC7,* or *IC8* in Fig. 3) or to the down-count input of the opponent's counter selected by the PLAY/SELECT switch.

The up/down counters shown in Fig. 3 will advance one count for each low-to-high transition of the up-count input when the down-count input is held high and the clear input is held low, the latter via *S9* in Fig. 3. Conversely, the counter will back up one count for each high-to-low transition at the down-count input when the up-count input is held high and the clear input is held low. At the end of each game, *S9* must be pressed momentarily to reset the system for a new game.

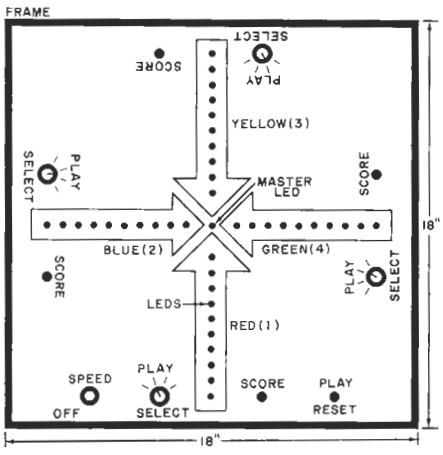


Fig. 7. Diagram shows layout of top of prototype game. Arrows are color-coded on 18" frame.

The BCD output of each up/down counter is decoded by a 1-of-10 decoder (*IC9* through *IC12* in Fig. 3), with each of the 10 outputs connected to its own LED. Hence, there are 10 LED's for each player, all of which are driven by their own decoder. Only one LED at a time is on at any given time for each player. The glowing LED determines the player's position during the game. As the player advances position, the next LED toward the point of his arrow comes on and the position vacated extinguishes. Needless to say, the player who reaches the point of his arrow first is the winner of the game. Because only one LED for each player is on at any given time, only one current-limiting resistor (*R30* through *R33*) is required for each player position. The absolute maximum current output of the decoder specified in the Parts List is 10 mA. If you choose LED's that require more current, substitute 7445 IC's in place of the 7441's specified. The 7445's are capable of delivering up to 80 mA per output.

The clock circuit shown in Fig. 4 contains a 555 timer-IC oscillator whose time constant is approximately one pulse/second. Adjustment of potentiometer *R36* determines the on time of master indicator *LED1*. With the component values specified, the on time of the LED can be varied from about 0.01 to 0.1 second. This particular time span was selected because most people have a reflex action time of 0.3 second or longer. The intent here is that a player will not be able to wait for *LED1* to flash and then try to score by operating his SCORE switch. To be successful in scoring, a player must anticipate the flash. For this

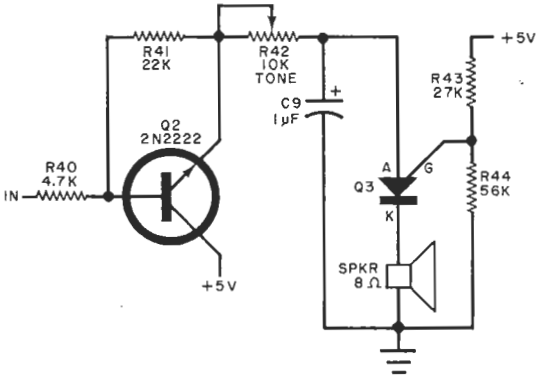


Fig. 8. Optional tone control can be connected to different portions of circuit (experimentally) to make the desired sound effect.

reason, the game challenges a person's timing skill, rather than his reflexes.

Transistor *Q1* is used as an inverter and TTL level converter. The power supply shown in Fig. 5 employs full-wave bridge rectification of the stepped-down ac and a 5-volt IC regulator.

Construction. Except for the LED's, switches, and power supply, the complete circuit can be assembled on a single printed circuit board. The etching and drilling and component-placement guides for the pc board are shown in Fig. 6. To conserve space on the pc board, pull-up resistors *R9* through *R20* mount directly on PLAY/SELECT switches *S5* through *S8*.

The playing field should be mounted in a frame that leaves enough depth under the field to accommodate the circuit board assembly and power supply. If you have a miter box, you can construct the frame with miter joints, in which case use four 19½" (49.5-cm) long pieces of 1" × 3" (25.4 × 76.2-mm) pine. Otherwise, simple butt joints will serve just as well. Fasten the joints together with finishing nails and white glue.

Glue and nail the 1" × 2" (25.4 × 50.8-mm) pine to the inner walls of the frame, spacing it ⅜" to ½" (9.5 to 12.7 mm) from the top edge of the frame. This will provide a convenient platform on which to mount the playing field board. Smoothly sand and paint or varnish the frame, making sure you do not paint or varnish the inside cleat.

Smoothly sand and paint the top surface of the playing field board white. When the paint has completely dried, drill the LED and control holes as illustrated in Fig. 7. Then paint on the color coded arrows. Apply a liberal bead of white glue to the upper surfaces of the cleats and lower the playing field board into place. Weight down the board with a few books until the glue has set.

Mount the LED's in the playing field's holes, using small dots of glue to hold them in place. Then mount the four SCORE, four PLAY/SELECT, and single SPEED controls in their respective locations. The main circuit board and power supply can be mounted on the peg board used as the bottom plate of the project. Route the line cord through one of the holes on the pegboard, after first enlarging it. Secure the bottom plate to the frame with eight woodscrews. Finally attach rubber feet to the frame.

Sound Effects. If you want sound effects with your game, you can use the experimental circuit shown in Fig. 8. This circuit employs driver transistor *Q2* to trigger programmable unijunction transistor *Q3*. It can be connected to various points in the main circuit, such as the master LED, to produce an audible "beep" when the LED flashes.

You can try wiring a 555 into the circuit to serve as an oscillator that produces various sounds. As an example, you can set the sound-effect system to produce a low-pitched tone for an unsuccessful scoring attempt and a high-pitched tone for a successful attempt. ◇