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# SCIENCE and MECHANICS

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# How and Where

## Part 1

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FIRING rockets is not for fun. In untrained hands, these zooming tubes which have captured the fancy of young and old can be more deadly than dynamite, more far-reaching than a pistol and more unpredictable than a stalking tiger.

Already, children, young people and even teachers have been injured and killed in the name of "studying rocket science."

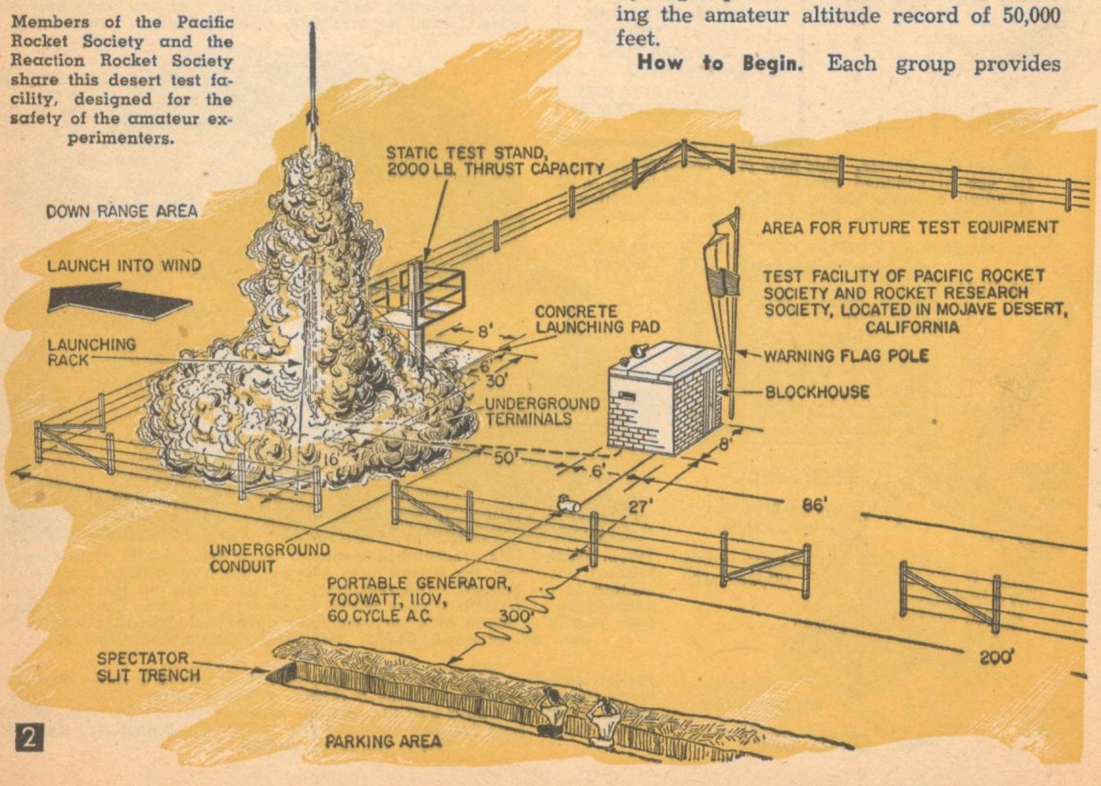
Conversely, amateurs can fire rockets safely, and some are doing so regularly.

To find out how, SCIENCE AND MECHANICS has found at least three amateur rocketry groups with good safety records and studied their methods.

They are the Southwestern Rocket Society, made up of 31 science students at the University of Texas in Austin; the Pacific Rocket Society, founded by eleven engineers and now including 120 members in three chapters in southern California, and the Reaction Rocket Society in the same area, credited with firing the first hydrogen peroxide rocket and with reaching the amateur altitude record of 50,000 feet.

**How to Begin.** Each group provides

**Members of the Pacific Rocket Society and the Reaction Rocket Society share this desert test facility, designed for the safety of the amateur experimenters.**

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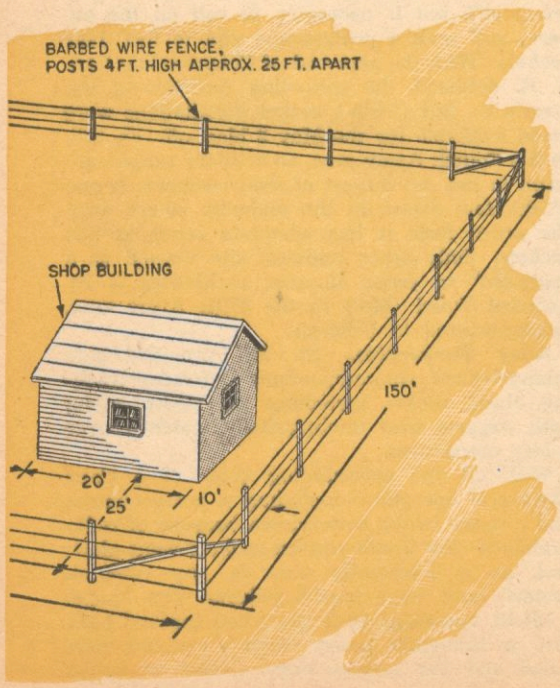
# to Fire Rockets Safely . . .

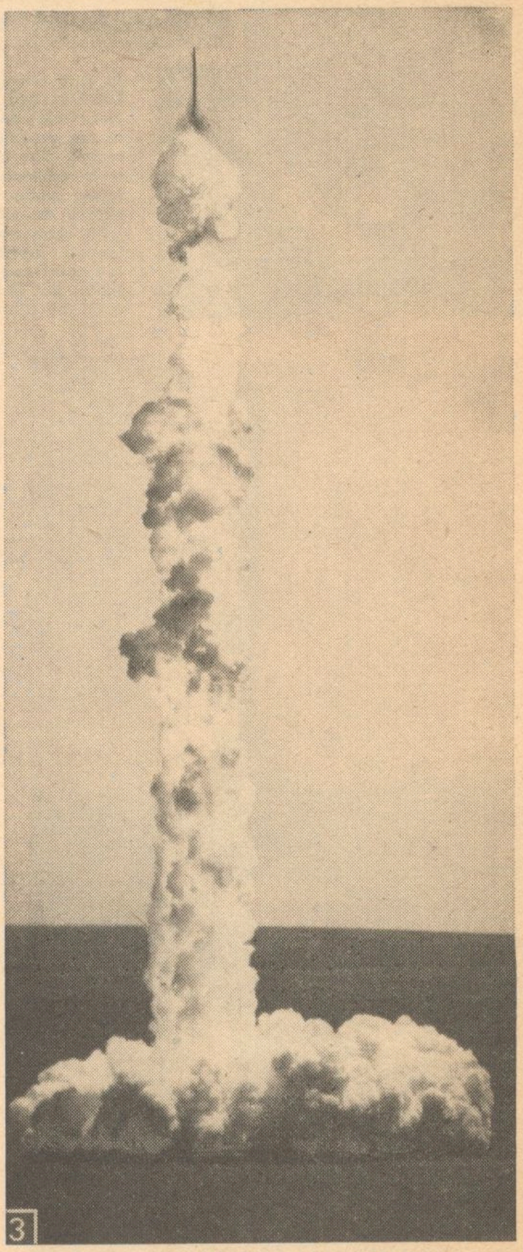
## *Building Amateur Cape Canaverals*

a fine illustration of the first rule of rocketry: Begin with expert guidance followed by research, and neither can be too good.

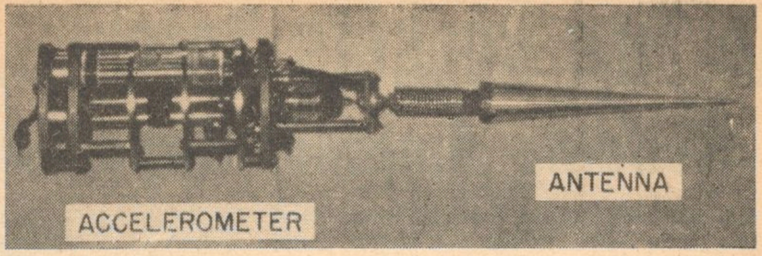
Take the case of the Southwestern society, as reported by Don Bott. According to one of the founders, Fred Beckner, now a senior physics student at Texas, almost four years of study and research, plus no little hard labor, went into the firing May 3 of two rockets by the group. With the shop and research facilities of the university available to them, members of the group gained permission to use a portion of the Balcones Research Center which had formerly been used to manufacture magnesium. Here three-foot-thick concrete walls were ready at hand, and the group spent almost a year laying brick and pushing shovels—not to build a firing site, but rather a suitable place to mix high-energy fuels and to test rocket engines.

The society's test stand, designed by John Swoboda, a senior mechanical engineer, measures the thrust of the engines by calibrating stress against an I-beam to which it is fastened. More than 150 such static tests of fuels were made by the group before beginning actual rocket firing. Jim Infante, a Phi Beta Kappa in aeronautical engineering and the club's safety officer, was recently requested to give a paper




This tower of smoke leaped into the sky May 3 at Ft. Sill, Okla., when Southwestern Rocket Society members fired their two-stage Iwapa rocket (See Fig. 5). Unfortunately, the second stage failed to ignite and tumbled to the ground soon after this point, although the first stage reached 4,471 feet.




Jo Ann Hamilton of the Southwestern Rocket Society holds the nose cone of the group's Shorthorn rocket. The cone houses a transistorized telemetering radio transmitter, shewn at right, above, with cone removed. Although drop-tested, the transmitter failed in flight, but the rocket set a Ft. Sill altitude record.

before the Institute of Aeronautical Sciences on this research.

**Some of the Dangers.** "Explosions on the test stand are common," Infante admits. "But it's better for a blow-up to happen there than on the firing range. We've learned what to avoid—like mixing chemicals of unknown composition and characteristics, not following instructions and safety precautions for commercial fuels and trying to use stuff like gunpowder, nitrates or nitroglycerin, chlorates and perchlorates.

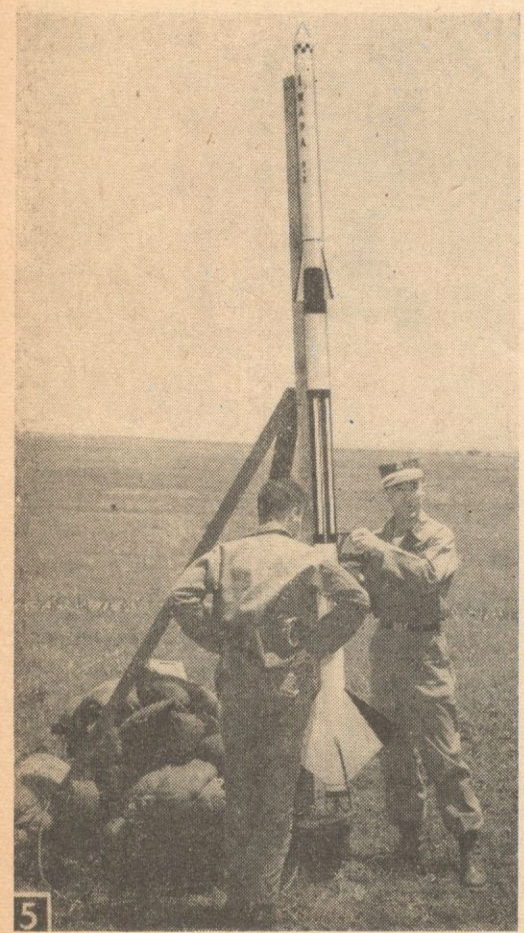
"We're pretty careful, too, about handling the common amateur rocket fuels such as zinc and sulfur or aluminum and sulfur. We do our mixing and packing in the open air. Both operations are done with club members protected. Concrete gives a fine, comfortable feeling when it's between you and something that might blow up."

To aid in tracking the group's rockets, Beckner designed, built and drop-tested a tiny transistorized radio transmitter (Fig. 4) to fit the nose cone of the Shorthorn, a six-foot version.

Even with such preparations, the Southwestern group still felt it necessary to call on the experts and seek a professional site to fire their rockets. With the approval of Commanding Gen. T. E. deShazo, the sprawling facilities of the army's Ft. Sill (Okla.) rocket installations were made available for the May 3 blast-off. Ft. Sill, in the Fourth Army area, an artillery range with room to fire the largest of field weapons, is one of the few places in the midwest where even the army feels it has adequate room to test rockets. Only other midwest site viewed as a "possible" to assist amateur rocketeers is Ft. Leonard Wood (Mo.) in the Fifth Army area, headquartered in Chicago.

**Army Cooperates.** Ft. Sill provided safe bunkerhouses, communications and radar tracking—three rocket launching necessities—along with experts who unobtrusively watched over safety procedures.

With all the surrounding color of a Cape Canaveral operation—including a postponement and a delay in the count-down because of radio problems—the Southwestern rockets went aloft; and, as is frequently true in any research project, both were partial failures. The Iwapa, a 161-lb. two-stage, 10-ft. giant had reached 4,471 feet on first-stage power when a coupling unit failed and the second stage, failing to ignite,



A Ft. Sill Army officer checked the launching angle of the Iwapa rocket for Southwestern Rocket Society members before its launching. The Army provides the test site and unobtrusively supervises this University of Texas group.

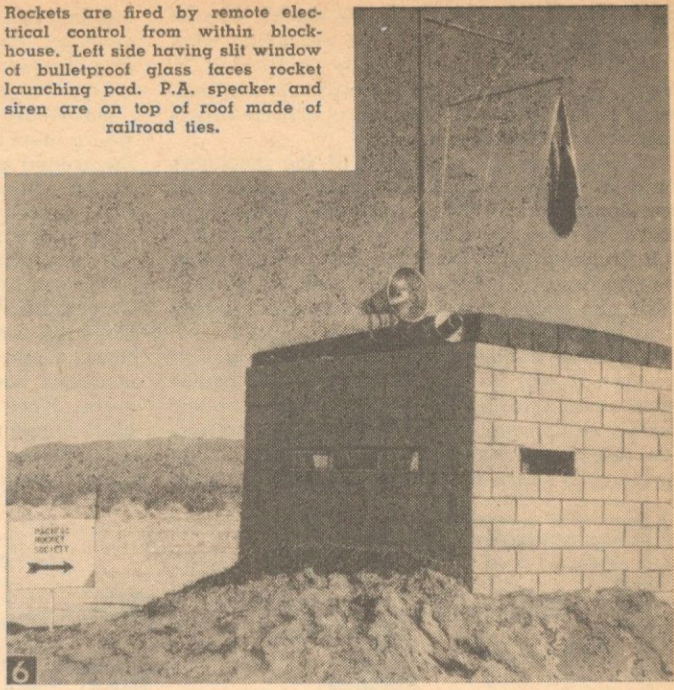
tumbled to earth. The 103-lb., 6-ft. Shorthorn, functioning smoothly, reached 8,871 feet (an amateur record at Ft. Sill) and a maximum of almost 370 mi./hr. —but its radio failed part-way in flight.

Yet, these budding scientists feel they have gone far and learned much. The Army thinks so too, and is strongly encouraging their work.

Similarly, the Pacific Rocket Society and the Reaction Rocket Society, both 15 years old, according to a study by Dick Ealy, have dug deeply and long to provide the facilities and know-how for safe and effective rocket study.

Pacific, headed by John Porter, chairman of the physics and electronics department at Northrop Aeronautical Institute, and Reaction have banded together to build their own test and launching site deep in the Mojave desert a hundred-odd miles from Los Angeles. (Details of construction of such a near-ideal amateur facility begin in the next column.)

Rockets are fired by remote electrical control from within blockhouse. Left side having slit window of bulletproof glass faces rocket launching pad. P.A. speaker and siren are on top of roof made of railroad ties.




Here, without danger to residents or passers-by—there are none—and without danger to experimenters, who are protected by a concrete blockhouse, more than 1,500 rockets have been fired in the manner described below.

**Records Are Set.** Among the successful firings of these groups have been several historic ones. In 1950, the Reaction group achieved what is claimed to be the first successful firing of a hydrogen peroxide rocket by anyone in the U. S., civilian or military. This 4-ft., 6-in. missile, developed largely by Lee Rosenthal of the society, rose to 30,000 ft. Later, what is said to be the pioneer work, by Jim Nuding of the Pacific Society, in the use of liquid oxygen and thiokol fuel resulted in an altitude record of 50,000 feet. This two-stage rocket used the LOX-thiokol mixture in the second stage and micrograin in the booster.

While the safer micrograin (it will not ignite accidentally) has been most frequently used by these groups, much work has been done with other combinations of solid, solid-liquid and bi-liquid fuels.

Such work as has been achieved by these groups can be achieved elsewhere, given the necessary people, the facilities and a willingness to work. For safety, you must have:

1) Adequate technical advisers. This means more than an interested teacher. While *some* teachers might be adequate, you want men who understand explosives and their chemistry and use; ballistics; metallurgy (the ability of a metal casing to withstand explosive forces), and organization (your test facility has to run with military precision to be safe). This is a minimum.

2) An adequate location. This means:

a) Good ground clearance—at least a three-acre launching site plus an adjacent strip of land at least 500 ft. wide and 2 miles long, parallel to the prevailing wind so that rockets can be fired into the wind. All should be at least 2 miles from the nearest habitation or roadway.

b) Good air clearance. Buy a sectional aeronautical chart of your area, which will show you the charted airways (25¢, U. S. Coast and Geodetic Survey, Washington 25, D. C., or at your local airport). Your site must be well away from any airway, airport or air installation. To be sure, contact any of the 89 Civil Areonautics Administration offices. You must contact them again before each firing.

3) Official local clearance. Before you start, be sure your state and local fire and police authorities understand your purposes and methods and exactly what you plan to do. You will *have* to have their cooperation.

Granted these things, and assuming you are ready to put in the elbow grease, thought and planning, you might be ready to—

**Build Your Own Cape Canaveral.**

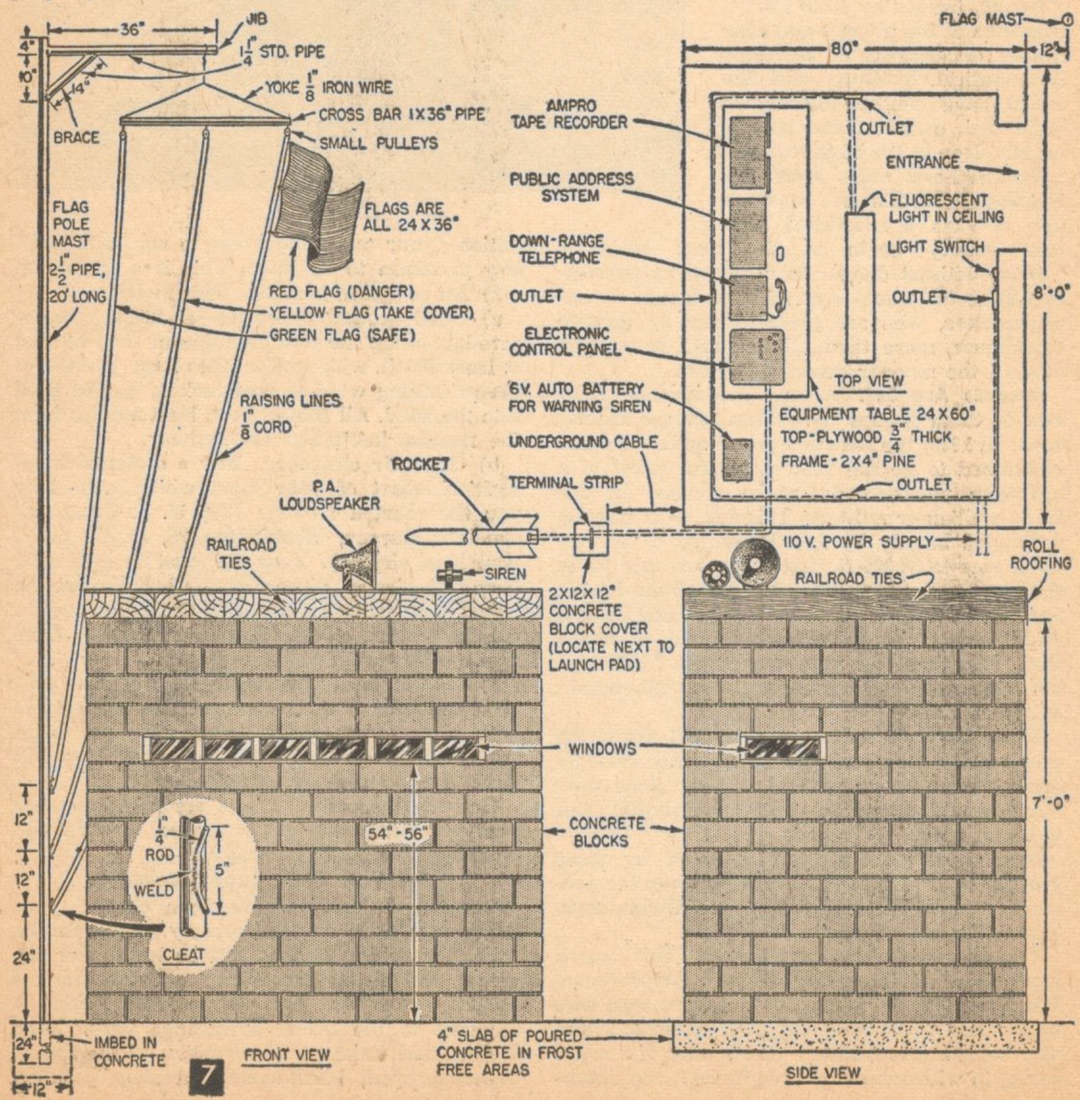
Once legal hurdles have been cleared your next move is to secure property on which the rocket launching facility will be built. For the actual test firing site, stake out an area of 150x200 ft. so that one of the 150 ft. sides is adjacent to the 2-mile downrange strip. Then lay out and stake out the location of the rocket launching pad, blockhouse and shop building as in Fig. 2. Be sure to locate the blockhouse so the front of it faces into the prevailing wind with the launching pad directly in front of it. Fence in this area to keep trespassers out and, even more important, help control expected spectators on a firing day.

At this time the placement of the spectators must be determined. A slit trench parallel with and approximately 300 ft. from one of the 200 ft. test area sides has been used by the P.R.S. and R.R.S. in the past. However, this method could be improved by building a stout roof of old railroad ties over the trench. Locate the parking area in back of the slit trench as in Fig. 2.

**Workshop Building.** Erect this building first because it will be needed for tool and equipment storage during the installation of the other facility equipment. Later, it serves as the rocket-fuel mixing and loading room. If your test range property is some distance from home, the shop building can also be used for overnight sleeping quarters. The building should be about the size of a one-car garage or larger. No special design or type of construction need be followed.

**Blockhouse Construction.** In southern states where there is no danger of winter frost heaving the ground and cracking the cement block walls, the blockhouse can be built on a poured concrete slab. In northern states dig a trench deep enough to be a few inches below the frost line in your area and pour a concrete footing as in Fig. 8.

We used 6x6x16 in. concrete blocks, which were available locally, for the blockhouse walls. However, the more common 8x8x16 in. concrete blocks could be used as well. The outside dimensions could also be changed to suit your needs. Keep the dimensions in multiples of the block length you are using to avoid having to cut some of the blocks to fit. Half-blocks for use around doors and windows are available. Lay



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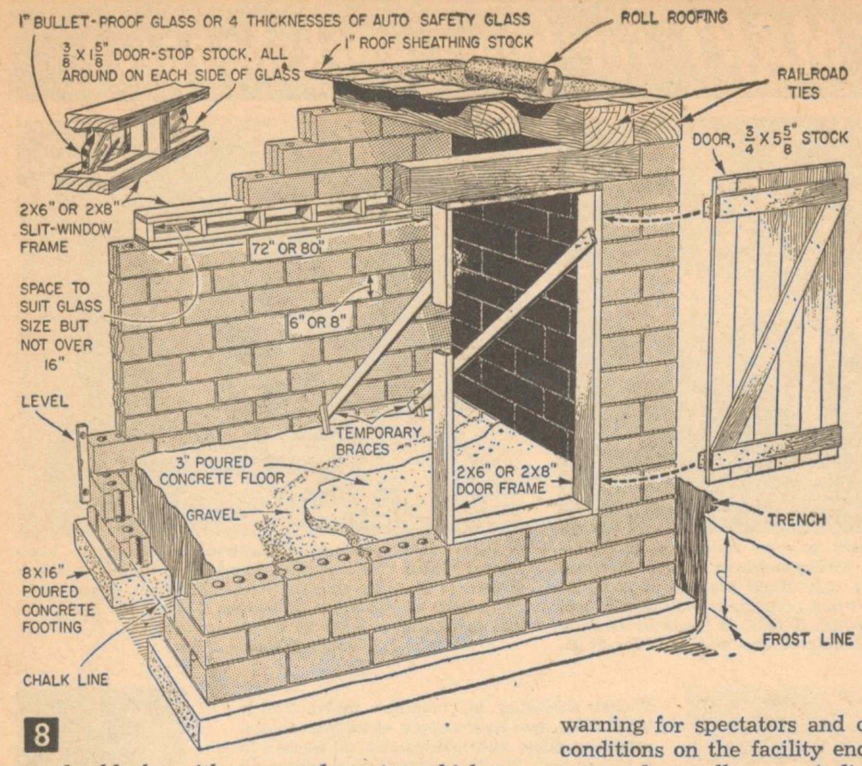


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up the blocks with prepared mortar which requires only the addition of water for mixing. Build up the corners two or three courses high first, then fill in between the corners using a chalk line (Fig. 8) to keep the courses of blocks straight and level. Use a level to set the corner blocks plumb.

Make the windows and door frames as in Fig. 8 from 2x6 or 8 in. stock depending upon the size of concrete block you are using. Locate and set up the door frame with temporary braces (Fig. 8) before laying up concrete blocks. Insert the window frames during wall construction.

When you have the walls up to a height of 7 ft. or a little over, insert ½ in. concrete reinforcing rods or lengths of old iron pipe down through the cored openings of the blocks. Space these rods about 2 ft. apart and pour concrete into the openings around the rods. This will tie the entire structure together so it will withstand an explosion or a direct hit from a rocket in the event one goes haywire.

You must have overhead protection too. Probably the best material to use for a roof is old (but not rotted) railroad ties. Hoist these up, placing them across the width of the blockhouse. Then nail down a layer of 1 in. roof sheathing boards to tie the railroad ties together, and cover with rolled roofing.

Use 1 in. thick, bulletproof glass for the slit window facing the launching pad if available; otherwise use four thicknesses of automobile safety glass. Install the electrical wiring for the 110 volt, 60 cycle A.C. current as in Fig. 7, in accordance with the local electrical code. Unless you can obtain power from a nearby utility line you will need a 700 watt, gasoline-engine driven portable generator. The 6 volt, D.C. current for the warning siren is supplied by a regular car storage battery.

For the equipment table inside of the blockhouse you can vary the size to suit your needs. We used 2x4 in. stock for legs and frame and ¾x24x60 in. plywood for the table top.

**Flagpole.** This provides a visual warning for spectators and club members as to conditions on the facility enclosure. Three flags are used: a yellow one indicating the enclosure is to be cleared of all unauthorized persons; a red one indicating rocket is about to be fired, and a green one signifying all clear or safe. The siren and public address loudspeaker provide necessary audio warning.

Use a 20 ft. length of 2½ in. black iron pipe for the flagpole mast. To this, at right angles and at one end (Fig. 7) weld a 36 in. length of 1¼ in. black iron pipe for a jib. Fasten three single awning pulleys to a 36 in. length of 1 in. pipe with 8-32 eyebolts for a crossbar as in Fig. 7. Attach the crossbar to the jib with a yoke made of #12 gage iron wire. Make up three cleats from ¼ in. rod and weld them to the mast 5 ft. from the lower end.

For the flag raising lines, run loops of ⅛ in. cord from the pulleys to the cleats. Tie three dog-leash snaps to each cord 1 ft. apart to fasten the flags. The 24x36 in. flags can be made of colored or white cotton and dyed red, yellow and green. Hem the edges and have your local awning shop put in three brass grommets for fastening to the cord snaps.

It will take several men to raise the flagpole. First dig a hole about 12 in. in diameter and 2 or 3 ft. deep. Erect the pole in the center of the hole and fill it with concrete. Brace the pole with three 8 or 10 ft. lengths of 2x4 in. stock until the concrete hardens.

Part 2, appearing in the next issue (on sale Aug. 28), will include more data on building and operating this test facility, and other sources of information for amateur rocket experimenters.