Special Fair of Science Projects—50 Pages

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-Firing Rockets
-Basement Ballistics
-Underwater Camera Case
-Metal Detector
—and many others

SCIENCE and MECHANICS

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OCTOBER

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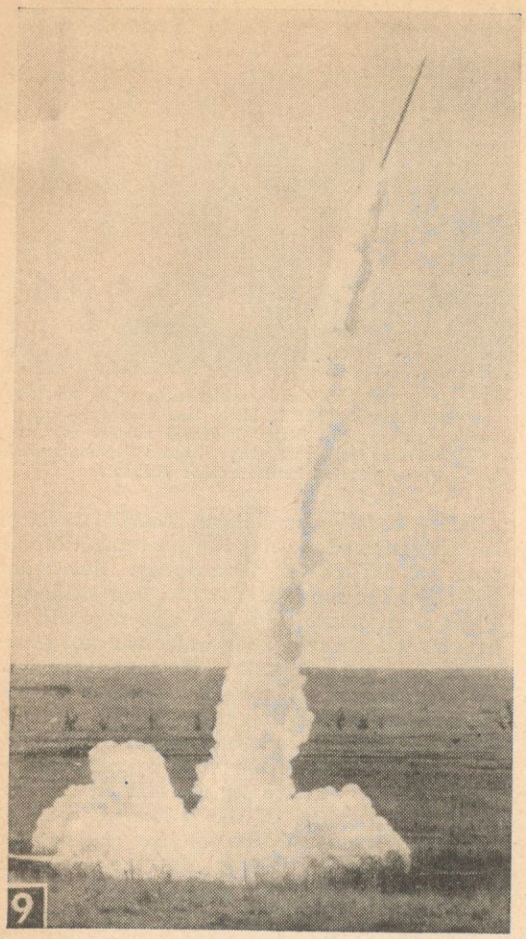

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This rocket, built by science club students at Oklahoma City and loaded and fired under the supervision of Army experts at Ft. Sill, reached an altitude of 5,200 ft. The basic device was 5 ft. 6 in. in length and 2 in. in diameter. Ft. Sill facilities have also been used by the Southwestern Rocket Society, students at the University of Texas.

How and Where

Part 2

YOUNG minds (of any age) today are reaching for outer space, and it takes rockets to get there.

But making and firing rockets is dangerous—so dangerous that it should never be attempted by anyone, young or old, without professional supervision and guidance and adequate facilities. Despite these odds, some groups—if only a few—have succeeded in setting up the necessary equipment, getting the necessary guidance and doing the necessary study to fire rockets with what appears to be safety.

In our last issue, we discussed the work of the Southwestern Rocket Society, the Pacific Rocket Society and the Reaction Rocket Society. And we began a physical description of the test facility built by the latter two groups.

Meanwhile, we have learned, others are going forward under good auspices. Oklahoma City high school students have succeeded in rocket firings under Army supervision at Ft. Sill (Fig. 9).

In Chicago, under sponsorship of the Chicago Rocket Society (an amateur group of adults), students are meeting in Saturday study groups with scientists at the Illinois Institute of Technology. Here they are learning such things as fuel chemistry, metallurgical problems arising from firing pressures and temperature, telemetry and allied subjects. It is hoped they will soon be able to witness a Nike firing by the Army.

And, while the American Rocket Society (made up of professional scientists and engineers in the field), has stated its official position as flatly opposed to amateur rocketry, individual members are volunteering their time to guide young people.

One outstanding example is that of Lt. Col. Charles M. Parkin, Jr., of the G-3 section of the Army Corps of Engineers at Ft. Belvoir, Va., and vice president of his home chapter of the Society. Under a directive from Secretary of Defense McElroy, Col. Parkin has designed a static test stand which is being built by high school students using public funds in Fairfax County, Va., and is working with teachers in the area toward safe study and experimentation. Rockets made under this program have been fired to heights of 4,000 feet from Army testing areas.

In addition, the American Rocket Society proposes soon to publish a book by member experts outlining potential fields of study and danger areas.

Another group which has developed an active program up to the point of actual firings is the Bristol chapter of the Rhode Island Rocket Society.

For those groups with adequate guidance, energy and space to construct their own test and firing facilities, we began in our last issue to tell you how to duplicate facilities of the Pacific and Reaction Rocket Societies. We described the workshop building and the construction of the necessary blockhouse and its flagpole. Other needed facilities are the static test stand, launching pad and rack and control panel.

Static Test Stand and Launching Pad. This 2000 lb. test stand will be used for preliminary rocket fuel testing before a firing, experimentation with various types of nozzles, thrust measurements, etc. Since it is located on the launching pad, measure and stake off the 8 x 30 ft. pad area as in Fig. 2 (Part 1). Centered across the 8 ft. side and 6 ft. from the right end of the pad dig a 3 ft. dia. hole 3 ft. deep (Fig. 14H).

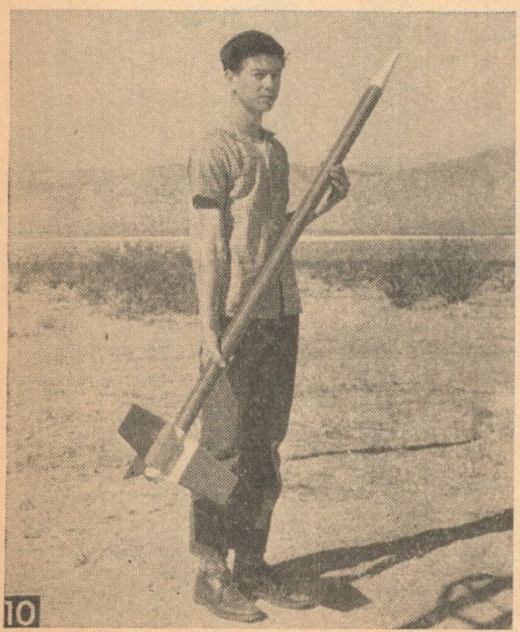
to Fire Rockets Safely...

Building Amateur Cape Canaverals

Set the test-stand upright, which is a 12 ft. length of 24 in. steel I-beam, in the hole and fill it with concrete. Use a level to set the upright plumb.

After the concrete has hardened, build the working platform and railing as detailed in Fig. 13. The rocket motor to be tested is bolted to the stand upright about 5 ft. above the ground. By using electrical instruments, now being developed by the P.R.S. and R.R.S., measurements of thrust and rocket chamber pressure will be recorded in the blockhouse.

The concrete launching pad is your next step. First construct a wooden form from 2 x 4 in. stock around the 8 x 30 ft. area. Nail the 2 x 4's to stakes so that the top edge is level and about 2 in. above the ground. Excavate the area for a tamped 4 in. fill of crushed stone or washed gravel and a 3 in. thick concrete pad. At the spot where the launching rack will be installed (Fig. 14H) make a depression about 2 or 3 ft. in dia. so the concrete will be 6 in. thick at this point. Then, while pouring the concrete, embed the four 5/16 x 5 in. bolts for the launching rack base (Fig. 14D). A 5 x 5 in. block of wood with 11/32 in. holes in it spaced as in the base plate will serve to locate placement of the bolts.



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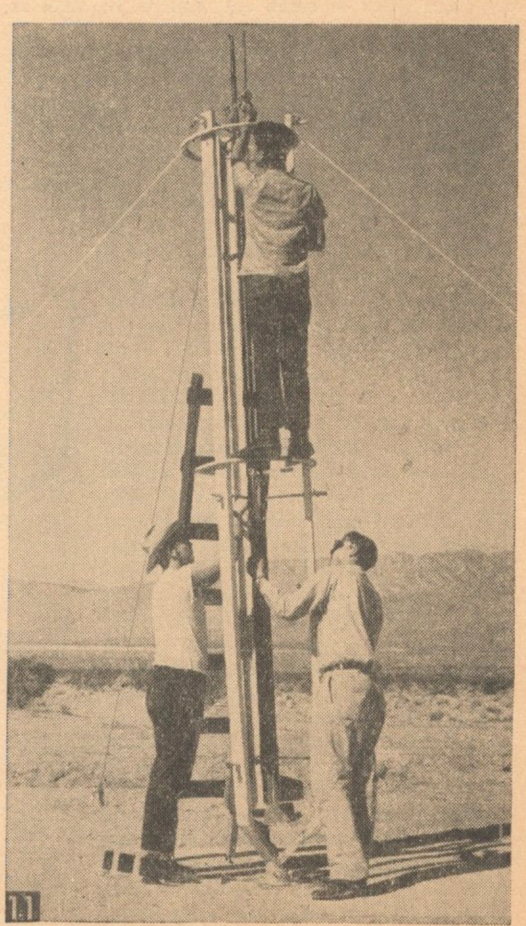
This typical micrograin rocket built by members of the Pacific Rocket Society is 4 feet long and weighs 21 pounds. It is in the class which has been fired to 4,000 to 7,000 feet.

Launching Rack. After experimenting with several types of fixed and portable rocket launching racks, the P.R.S. and R.R.S. designed and built the rack shown in Figs. 11 and 14. The launching guide rails are adjustable to take rockets of various diameters and the entire rack may be tilted from 0 to 15° into the wind.

Start by laying out and drilling the three 9/16 in. holes in the main beams (Fig. 14A) for the adjustment screws. Then cut the 45° notches at the lower ends of the beams (Fig. 14C) and bend the beams to a 45° angle. Weld the closed notches. Two 22 in. 1.0. steel rings made from 1 in. std. black iron pipe are needed. If your



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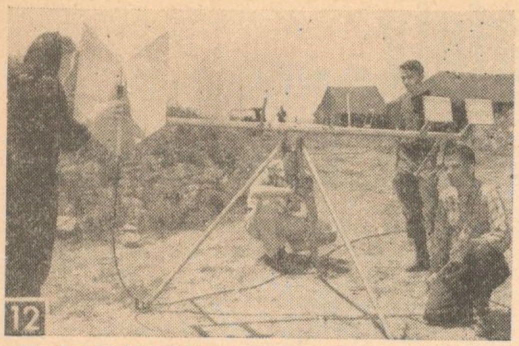
Members of the Pacific Rocket Society here ready a rocket on the launching rack for firing. The rack is tilted about 10° toward a dry lake bed visible in the background.



Members of the Southwestern Rocket Society are shown readying their own radio tracking antenna designed to pinpoint a telemetered signal from one of their rockets in flight. The system, perhaps the only amateur equipment of its kind, was designed and built by Fred Beckner (second from left), research director of the group.

local steel fabricating shop cannot bend pipe for you, the rings may be rolled from ⅜ x 1½ in. steel bar stock or torch cut from ⅜ in. steel as in Fig. 14E.

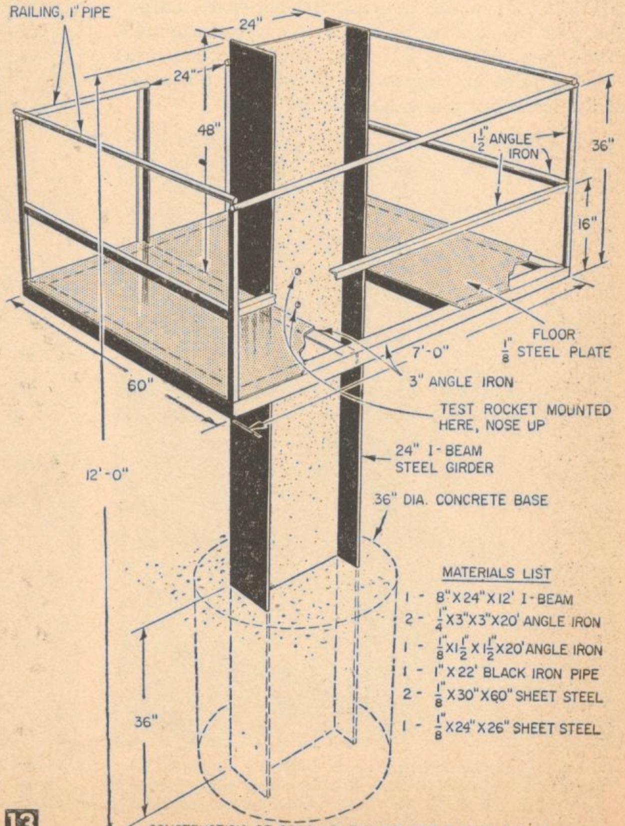
Slide the beams into the rings (Fig. 14), and fasten with C-clamps. Then, with a cutting torch fit a 5 in. length of 2½ in. pipe to the lower ends of the beams (Fig. 14D) and weld in place. Also weld the rings to the beams. To determine the exact size of the rocket rest plate (Fig. 14B), first cut and fit a cardboard template. Then cut the ¼ in. steel plate to template size and weld in place at lower end of beams. Cut nine 3 in. lengths of ½ in. std. pipe and weld them to the main beams centered on the $^{9}/_{16}$ in. drilled holes as in Fig. 14A. Five, 3 ft. lengths of ½ in. threaded rod, available at hardware stores, are cut in half and used for the adjustment screws.

To fasten the adjustment screws to the guide rails, saw-cut three lengths of ¾ in. pipe into three segments as in Fig. 14A and drill and file two $^{7}/_{32}$ in. slotted holes in each. Weld these segments to the ends of the adjustment screws. Run a nut and washer on the screws and insert them through the holes and spacers on the main beams. Fasten in place with another washer and nut. Now, fasten the ¾ in. steel guide rods to the segments with C-clamps and centerpunch the locations of the slotted holes in the segments on the guide rods. Remove the rods, drill #21 holes at center punch marks and tap 10-32. Then permanently assemble the guide rack to the adjustment screws with 10-32 x ¾ in. machine screws. Weld ⅜ in. eyebolts to the main beams as in Fig. 14F for attaching wire stay cables.

The rack base (Fig. 14D) acts as a socket for the rack so it may be tilted by adjusting turnbuckles on the wire stay cables. Fasten the base to the launching pad with the previously embedded bolts. Make up three guy wire stakes as in Fig. 14G and drive them into the ground 18 ft. from the rack base and 120° apart. Now, with the help of several men raise the launching rack, set it in the base socket and secure with the three guy wires.

Electrical Control Panel. Since all rockets are fired electrically and by remote control from the blockhouse, a control panel (Fig. 16) is needed. For the safety of the man who goes out to the launching pad to arm the rocket just before firing, a phono jack is incorporated in the rocket-firing circuit. He takes the jack out of the panel and puts it in his pocket before going out to arm the rocket. The rocket-firing circuit is then "dead" and no one in the blockhouse can inadvertently fire the rocket while the "arm'er" is on the launching pad. When the rocket is armed, he returns the jack to the panel himself.

Use a stock size 4 x 13 x 17 in. metal chassis with bottom plate (available at radio supply houses) for the control panel. Cut a 1 x 9 in. slot in one end (Fig. 16) and make the bakelite terminal strip. Lay out and drill the front of the chassis for lights and switches and wire them to the terminal strip as shown in the wiring diagram. To cover the exposed terminals, make up



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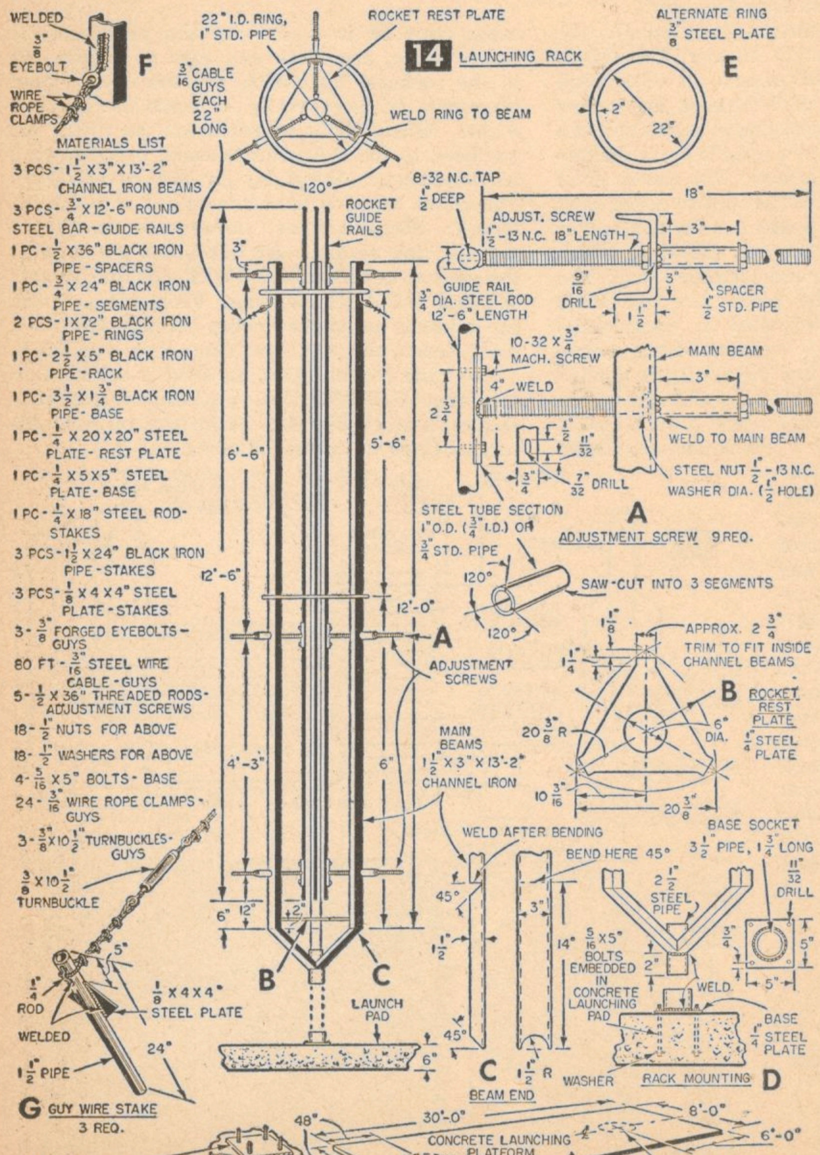
CONSTRUCTION OF 2000 LB. THRUST STATIC TEST STAND the cover (Fig. 16A) and fasten to the chassis side with four 8-32 *rh* screws.

Note that the siren operates off a 6 v. storage battery. All other equipment uses 110 v. 60 cy. A.C. from a 700-watt portable generator located outside the blockhouse. Bury a 2-wire, 12-gage underground cable about 18 in. deep extending from the blockhouse to an underground terminal box as in Fig. 2 (Part 1). Run two leads from the box to the launching pad. The wires from the commercial firecracker ignition squib in the rocket are connected to these leads by twisting the ends together and thus arming the rocket.

The public address system is also placed on the table in the blockhouse (Fig. 15). The P.A. loudspeaker is placed outside on the blockhouse roof. A downrange telephone system and tape recorder is useful for recording an on-the-spot, eyewitness report of a rocket's flight. However, these items can be added later.

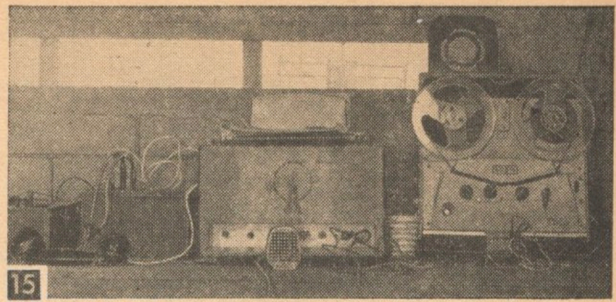
Field Operation. Now that all the equipment and facilities are ready, you can set up a date for your first rocket firing. The P.R.S. procedure is to inspect all rockets two weeks in advance of a firing date. An appointed committee looks over the rocketeer's filled-out data sheet and inspects the rocket for workmanship, materials, recovery feature, etc. If the committee suspects a so-called "secret" fuel within the rocket as being dangerous, they will open the rocket and inspect the fuel. The committee has the right to reject a rocket and prohibit firing it from the facility. While this is done primarily for safety, there is a secondary reason. In the past some of these "secret" rockets have caught fire in the rack and damaged the facility. This prevents the succeeding members from firing their rockets that day.

On the firing day the launching rack must be adjusted or tilted to compensate for speed and direction of the wind. On a calm day the rack is tilted 10° to 12° in the direction the rocket is to go. On a windy day it is tilted from 0° to 5°. The effect of the wind on the fins of a rocket cause it to tilt into the wind—thus less tilt is needed on a windy day. While the launching crew is busy with the rack, the electrical crew starts the generator and checks all electrical equipment. During this time the condition on the field is *GREEN* and spectators are allowed to visit and take pictures inside the fenced test area. The green flag is, of course, flying at this



time. The only place they cannot go into is the workshop building where the fueling committee is loading the rockets. After the first rocket is loaded and the radio transmitter, recovery device or other systems checked, it is brought out to the launching pad and installed in the rack (Fig. 11). When the rocket is free to move up and down without binding, the yellow flag is run up for condition *YELLOW*. The siren is sounded and the P.A. announces: *"The condition is YELLOW—all personnel return to protected areas."* At this time four men take their places in the blockhouse. (1) Operations Director (OD). (2) P.A. announcer (and timer). (3) Control panel operator. (4) Arm'er. The OD is like a ship's captain and directs all other club members. After a wait of 2 minutes the yellow flag is pulled down, the red flag is raised and the announcement made: *"The condition is RED—the rocket is now being armed."* The arm'er pulls the phono jack plug out of the control panel, puts it in his pocket—then walks out to the rocket and arms it by twisting together the wires which come out of the rocket and terminal strip. The wires coming out of the rocket are two leads from an igniting squib called a "commercial match." These squibs are obtained from a fireworks manufacturer. When electricity is applied to the rocket squib the glow-type element within it ignites the squib's powder which in turn ignites the rocket's fuel. (*Under no circumstances should dynamite caps be used for this purpose.*) The arm'er has been previously informed of the intricacies of the rocket and he sets any necessary switches for recovery, transmitter, vapor trail, etc. When his task is completed he returns to the blockhouse and replaces the phono jack into the control panel. At this time the following P.A. announcement is repeated twice: *The rocket is armed.* Then the Operations Director, who also serves as Range Safety Officer, takes a thorough look around to make sure all is ready—are the personnel all under cover, are there any cars or people out in the rocket's flight path, are the down range observers (if any) ready to track the rocket's flight? When all is in readiness, he gives the go-ahead to the P.A. man to make the following announcement: *Stand by for the count down.* The count down is then announced at these intervals: *Sixty seconds, thirty seconds, fifteen seconds, ten seconds.* At this point the man at the control panel turns POWER ON and throws #1 and #2 ARM switches. From ten seconds, the count is announced every second—*ten, nine, eight, seven, six, five, four, three, two, one, FIRE.*

After the rocket lands, the field is returned to condition *GREEN*. This professional-like procedure is much like that performed by the military at Cape Canaveral, Florida.



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Inside the P.R.S. and R.R.S. blockhouse, overlooking the firing pad, equipment includes (from left) firing control panel, downrange telephone, P.A. system and tape recorder.

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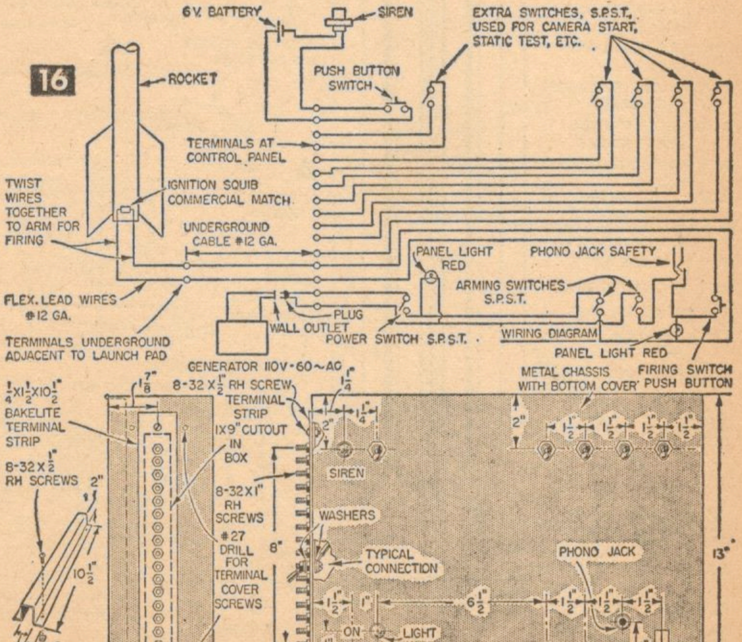

MATERIALS LIST—CONTROL PANEL

No. Req.	Description
1	4 x 13 x 17" metal chassis with cover
8	S.P.S.T. 110v toggle switches
2	110v push button switches
2	panel lights and sockets
1	1/4 x 1 1/2 x 10 1/2" Bakelite
17	8-32 x 1" brass screws
40	nuts and washers for above
6	8-32 x 1/2" brass screws
1	8 x 10 1/2" sheet metal
1	heavy duty phono plug and jack