

# Predator-Deterrent Electric Fence for Rough Terrain

O.D. Knipe

Improved techniques of electric fencing have provided rangemen with an effective, nonlethal method of reducing predation losses. Electric fences have been used for many years for containing animals and have proven effective for various uses ranging from the fencing of "elephants out of tea plantations" to "rats out of rice paddies" (Anonymous 1979).

Constructing predator-deterrent electric fence in rugged and/or rocky terrain poses problems not encountered in level terrain. An electric fence has been designed that solves some of these problems and was proven effective in reducing or eliminating predation in the rough, rocky terrain of the Arizona chaparral. The configuration was used to fence in 240 angora goat weanlings and older wethers for 2 years near Payson, Ariz. Track and animal sightings and conversations with commercial trappers indicated that the predator population (mainly coyotes) in the area was considerable. During the 2 years many instances were observed where coyote, fox, bear, bobcat, and mountain lion encountered the fence and turned away without loss of contained animals (Knipe 1982).

This paper describes the electric fence configuration used and discusses problems associated with its construction in rough, rocky terrain. A quality deterrent electric fence has

requirements common to other fence types. These basic fence construction procedures, e.g., corner, end, and brace post assemblies, and instructions for clearing and laying out lines, will not be discussed. These are well covered in manuals available from state and federal land management agencies and from distributors of electric fence materials. Before installing electric fences, one should become familiar with current electric fencing principles—high power-low impedance energizers, reasons for alternating grounded and charged wires, the unique components and tools available, and safety considerations.

## Prerequisites of a Predator-Deterrent Electric Fence

The essential features of an effective predator-deterrent electric fence are: (1) wires tensioned to 175-200 pounds, (2) proper and precise wire spacings, and (3) current at or above 5,000 volts. The lower charged wire must be tight and 4 inches (or slightly less) above ground level. Subsequent wires must be tight and precisely spaced so that predators attempting to negotiate the fence touch both a charged and ground wire upon initial contact. For example, it was observed that if a coyote's head and neck passed through the fence before full contact was made, the shock caused the coyote to lunge forward and through the fence. In rugged terrain the major problem lies in anchoring the fence so that the lower charged wire in a depression is close enough to the ground to form a barrier without being grounded out.

The author is a range scientist with the Rocky Mountain Forest and Range Experiment Station, Tempe, Ariz. Station headquarters is in Fort Collins, Colo., in cooperation with Colorado State University.

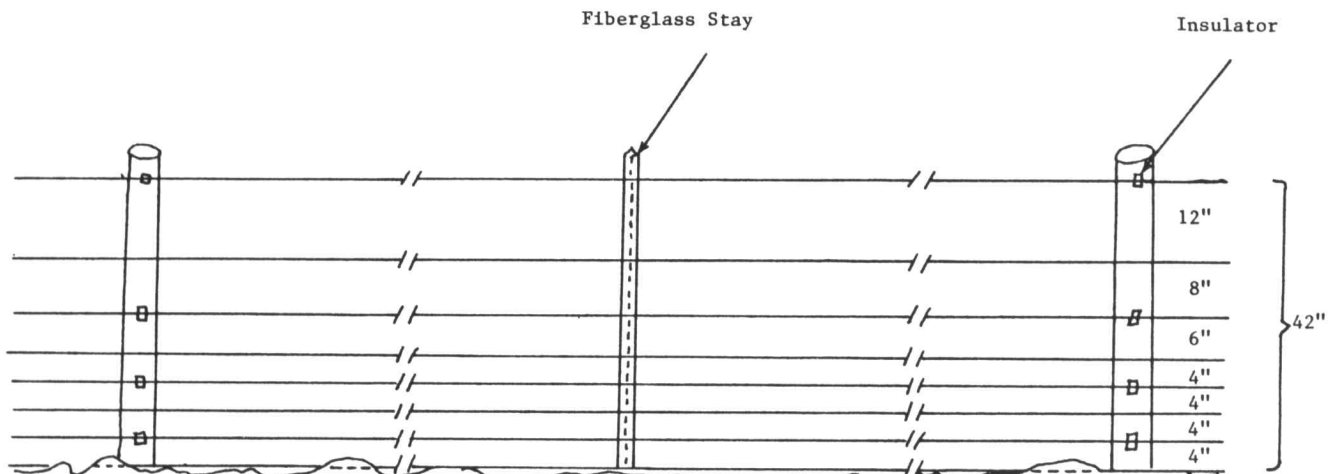
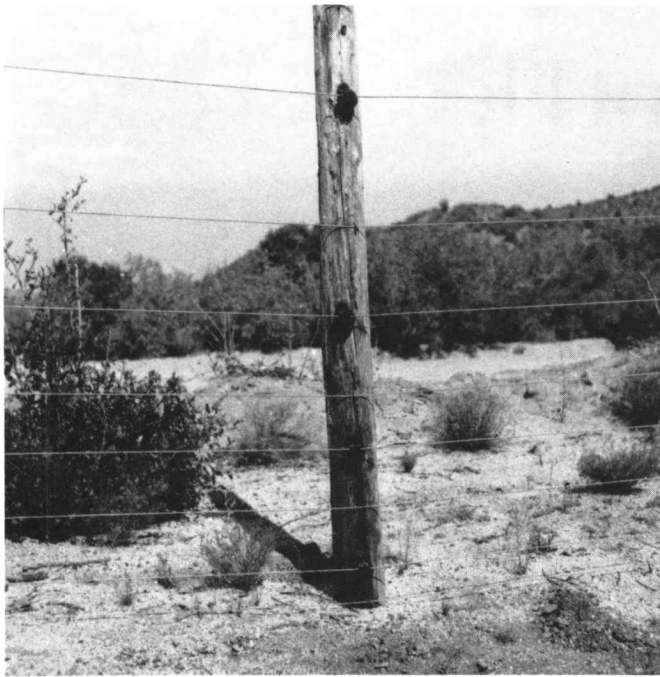


Fig. 1. Configuration of predator-deterrent electric fence: (+) charged wire; (-) grounded wire.



**Fig. 2.** Fence that prevented predation losses of angora goat wethers for a period of two years.

### Basic Fence Design

The fence consists of 8 alternating grounded and charged wires, with a bottom grounded wire at or very near the soil surface. The lower 4 wires are spaced at 4-inch intervals with the fifth wire 6 inches above the fourth. The lower 16 inches is the area that coyotes attempt to pass through. These spacings provide a barrier and assure that any coyote attempting to pass through the fence must contact both a charged and grounded wire upon initial contact. The eighth or top wire is spaced 12 inches above the seventh wire to lessen the probability of jumping deer and elk entrapping their hind legs between the top two wires.

No predator problems have been encountered with this fence design. Fences with 5- and 6-inch spacings on the first 4 wires, with bottom wire both charged and grounded, and bottom hot-wire configurations with 4-inch spacings of the lower 4 wires resulted in loss of goats to predation.

A common recommendation is that the bottom wire be charged or a charged trip wire be placed a few inches out from the fence. These designs are not suitable for uneven terrain because it is not possible to prevent grounding of a charged wire low enough to the ground to exclude predators. There are several reasons for this: this terrain may rise and fall above and below level several times over a distance of a few feet. Therefore, an insulated post or some other means of holding the wire up on rises and down in depressions is needed. Because this installation may become unduly expensive and be extremely troublesome in view of difficulties in setting posts and/or anchoring the fence in low places, several methods of solving these problems were tested. In one (Fig. 3A) the bottom wire was too close to rocks and arced, especially during wet weather, causing loss

of current. Also, upward tension on the wire pulled the post out during the first rainstorm. An arrangement (Fig. 3B) where stones were laid below the bottom wire in the depression worked well but was time-consuming. Depressions of this nature are best fenced predator-proof if the bottom wire is a ground and is connected to the posts at ground level on either side of the depression. Thus, the bottom wire (grounded) is a maximum of 2 inches above ground level in the swale and provides an effective barrier. Where there is a downward tension on the wire, it cuts into the ground on the rises, making it still closer to the ground in the depressions (Fig. 1). When there is a post on either side of the depressions and tension is downward, the bottom ground wire should be tied loosely to the post so it can slide down freely and cut into the soil. In terrain such as shown in Figure 3A and 3B, a bottom ground wire may eliminate the need for considerable effort over several hundred feet per mile of fence. In Figure 3C spacer fiberglass stays were placed in the fence and tied to logs with wire passed through holes drilled near the bases of the stays; again, this was time-consuming and expensive. Were the bottom wire grounded, it could be tied directly to the log or rocks as shown in Figure 3D.

The insulator-wire-rock anchor is a neat, effective, and easily installed means of anchoring a fence in depressions. Insulators are threaded onto the fence line wires at depressions when the wire is strung; as the fence is stretched, the insulators are spaced and tied with wire attached to a rock anchor buried beneath the fence. The insulator-wire-rock anchor cannot be used on a boundary fence where the bottom wire must be near the ground unless a hole can be dug for the rock.

During storm periods bottom-charged wires across rills and small cuts are susceptible to grounding by water-carried soil and debris. A bottom ground wire usually eliminates this problem and, as soil and debris accumulates on the wire, the fence actually becomes a more effective barrier.

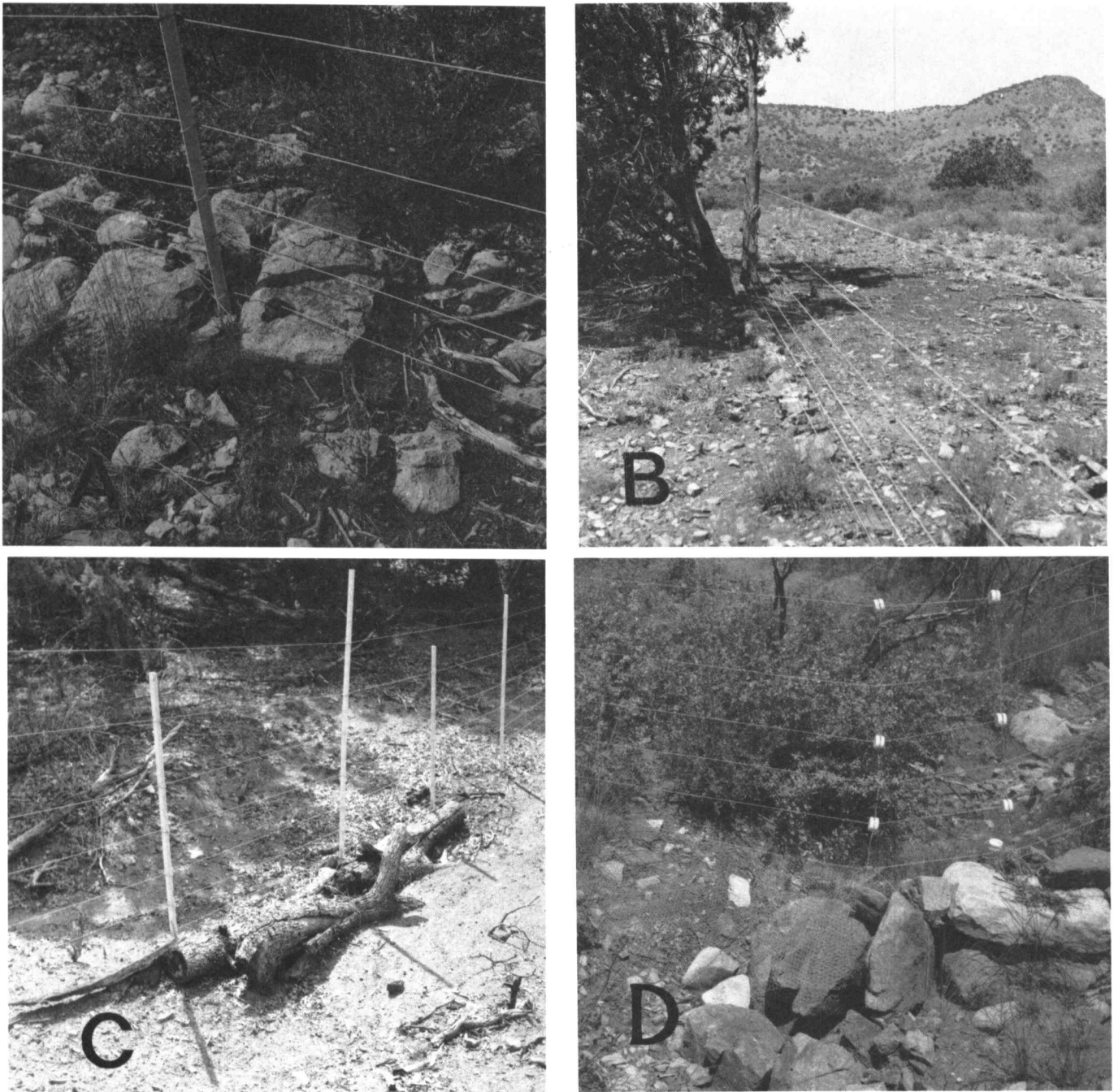
High flow from summer storm flash flow may wash out and/or ground out fences across the larger channels unless special precautions are taken. One-inch poultry netting was the most economical and effective means found for predator-proofing large channel crossings. With a bottom ground wire arrangement, the netting can be attached directly to the wire, eliminating the need for stringing an extra wire.

### Construction Considerations

#### Posts

Trees in the area should be used for posts where possible, even if it means deviating from a straight line. They provide a solid anchor and eliminate the need for digging holes—an extremely difficult task in rocky terrain. Trees that can serve as a corner, gate, stretch, or turn post should be included in the design when the fence line is being laid out.

Treated wooden or decay-resistant hardwood posts are suitable where holes can be readily dug. Wooden posts are the best alternative for corner, gate, and H-brace posts if a tree is not available. Posts cut from juniper that taper from a relatively large base to a smaller top are excellent because the large base helps prevent pull-out in depressions. Wooden posts with uniform diameters will hold very well in depression if a 2 × 4 × 8-inch long block is nailed to the base; blunt



**Fig. 3.** Methods of predator-proofing depressions: A, using insulators to prevent grounding of charged wire; B, rocks placed under charged bottom wire to create barrier; C, logs attached to spacer fiberglass stays to anchor fence down and create a barrier. Methods A, B, and C all had disadvantages. D, poultry netting attached to bottom ground wire and anchored with stones. This type channel crossing is easily constructed and when completed will be 100% effective. It is easily replaced when displaced by high stream flow.

the points of the nails before driving to prevent splitting the blocks.

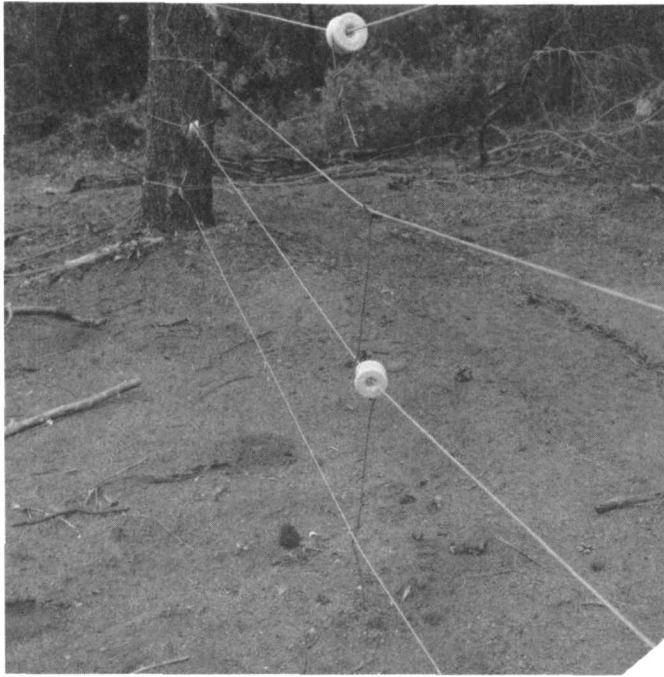
Fiberglass and insul timber are the best choice in locations where they can be used as posts because they do not require insulators and are light and easy to transport. However, their use is limited in rough terrain. The upward force on wires tensioned to 175-200 pounds will pull them up in depressions and in the case of fiberglass, bend them on rises.

Fiberglass and insul timber posts can be held down in

depressions by anchoring with rocks. This method works well but is time-consuming and not esthetically pleasing. Fiberglass and insul timber posts are best used for stays and for posts along relatively level stretches.

Standard steel T posts have more application in rough terrain than any other type post because they (1) are not easily pulled out in depressions (2) are not easily bent under tension, and (3) can be driven where fiberglass and insul-

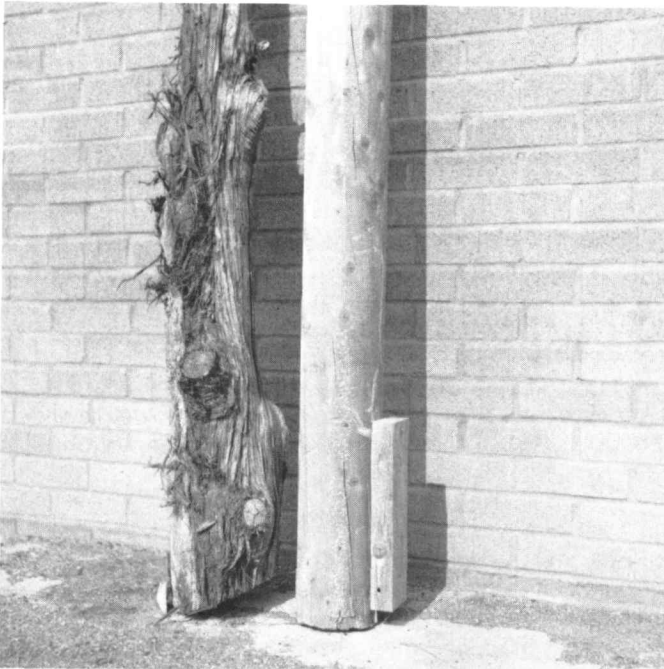




**Fig. 4.** Trees make excellent corner, turn, and line brace posts and the insulator-wire-stone arrangement makes an excellent anchor in depressions.



**Fig. 6.** Fiberglass posts can be anchored down where wire tension is upward as shown here; the anchor wire must be tied above ground wires to prevent grounding of charged wires.



**Fig. 5.** Juniper posts (left) with relatively large bases and even diameter posts (right) and 2×4×8-inch blocks nailed near their bases hold well in depressions where wire tension is upward.

timber stays cannot and where holes for wooden posts are difficult to dig.

#### Fencing Slopes

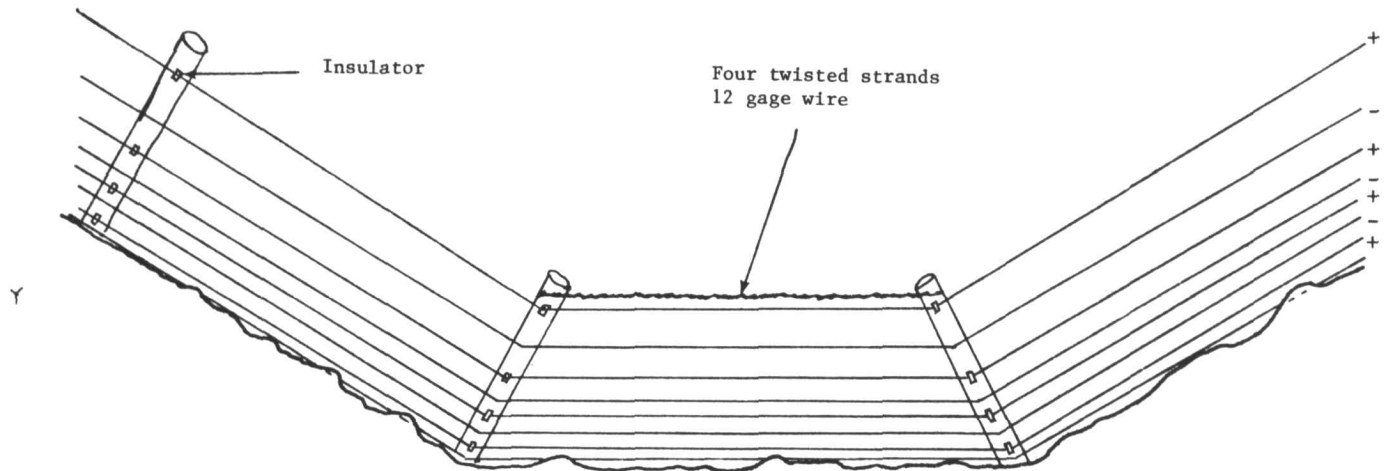
Setting posts on slopes poses special problems. Posts set on slopes should be set perpendicular to the slope, not perpendicular to level. Setting posts perpendicular to level

on slopes significantly reduces the height of the fence. On a 40-degree slope the height of the top wire of a 42-inch-high fence is reduced by 10 inches. Posts set perpendicular to level are also more susceptible to being pulled out by upward tension on the wires than those set perpendicular to the slope.

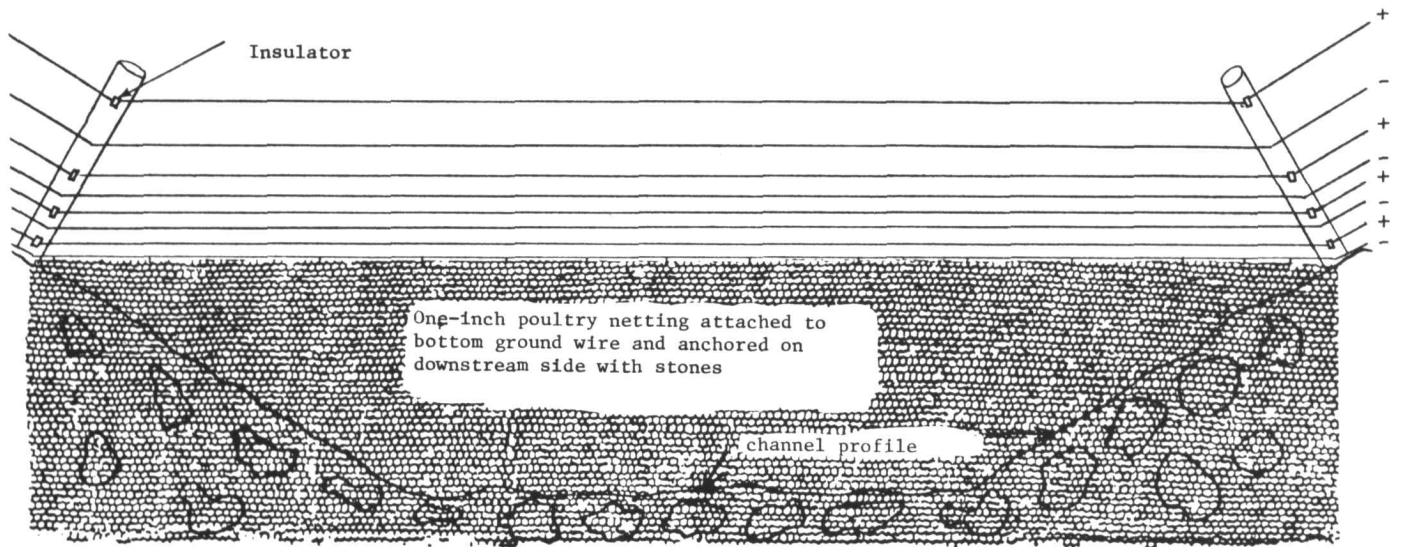
#### Crossing Channels

Crossing channels is the most troublesome task of erecting a predator-deterrent fence in rough terrain. It is usually not possible to tension wires across steep-banked or relatively deep channels in conjunction with the adjoining fence. The fence across the channel usually must be constructed as a separate segment. Solid anchors can be established in the channel bottom by setting a post at the toe of each slope in the channel and tying their tops together with twisted strands of 12 gage wire. Set the posts perpendicular to the slope so that the fence remains at the proper height and to provide a firm anchor. If channels are not particularly subject to flooding, the arrangement shown in Figure 7 is suitable.

To cross very unevenly sloped channels, relatively large channels, or ones subject to high or flash flow during the rainy season, it is usually not practical to build electric fences with wires spaced precisely from the ground. Because fences across such channels are subject to washing out or, at best, grounding out, the use of 1-inch poultry netting is recommended. The poultry netting may also become displaced by high flow, but it is easily replaced and the fence is less likely to be grounded out. The best procedure is to run the entire electric fence wires some height above normal and fill the gap below with poultry netting attached to the bottom ground wire—the poultry netting must be wide enough to



**Fig. 7.** Channels not subject to flash flooding and high flow may be fenced as shown here. Note that posts should be set perpendicular to the slope; this keeps the fence at the proper height and lessens the chances of posts pulling out from upward wire tension.



**Fig. 8.** The best means of crossing channels that are deep, have uneven profiles and are subject to flash flooding and high flows is by attaching 1-inch poultry netting to the bottom ground wire and anchoring it down to the channel floor with stones placed on the netting on the downstream side.

provide a barrier between the bottom wire of the fence and the ground and an apron on which rocks can be piled to hold it in place. The apron must be on the downstream side so that netting will swing out freely during high flow; this reduces the chances of the entire fence being torn out.

**Gates**

The best and most economical means of predator-proofing gateways is with frames constructed of light tubing or pipe covered with any durable woven wire netting, e.g., chain link or V-mesh. In the angora goat trial, no problems were encountered with predators digging under gates or fences; however, in friable soil areas it may be necessary to provide a sill under gates.

**Other Considerations**

If only sheep and goats are being fenced in, the top wire does not need to be charged unless there is outside pressure from larger livestock. Not charging the top wire during the early stages of an operation results in higher voltage in the lower charged wires and quickly teaches livestock and predators to respect the fence.

When carrying charged wires around corners, brace posts, and across gates always use a separate jumper for each charged wire. Connecting two or more charged wires with a single wire results in a loss of current. In rugged terrain where this may be necessary several times per mile of fence, the loss in current can easily amount to 1,000 or more volts.

There are several makes and models of energizers of solid-state design that release high voltages and have low impe-



**Fig. 9.** Used 1-inch galvanized pipe frames covered with hog, chain link, v-mesh, etc. fabric is suitable for predator-proofing gateways. It may be necessary to provide a sill under the gate in friable soil areas to prevent predators from digging under.

dance (good resistance to shorting out). These include 110-volt plug-in models and models powered by solar-charged wet cell 12-volt batteries. If mainline power is available, the 110-volt plug in models are more practical as they have higher rated outputs, can energize more fence, and are best for overcoming leakage due to contact with vegetation. The 12-volt solar-powered energizers are quite satisfactory and will charge several miles of fence; 130-ampere hour deep-discharge batteries should be used. Most manufacturers' claims about battery life and output of energizers are somewhat optimistic and are probably based on ideal fencing conditions which cannot be duplicated in rough terrain. The output of energizers can be checked by connecting a house circuit socket to the output terminals—the better energizers will momentarily light a 200-watt bulb.

#### Construction and Maintenance Costs

The cost of constructing the fence varies considerably with local labor costs, availability of materials, and terrain. Often, wooden posts can be obtained locally at considerable savings. The number of posts required, labor required to anchor the fence in depressions, and amount of net wire required across channels depends on terrain. Costs, including labor, gates, energizers, batteries, and solar panels range from \$2,500 to \$4,000 per mile. Four miles of fence were constructed for \$3,500 per mile in a typical Arizona chaparral area. Time required for construction by a three-man crew varies from 1/4 to 3/4 mile per day.

Maintenance may be a full time job for one man for one to several days following the first major storm as water-borne soil and debris may cause grounding out of lower wires.

Maintenance is directly related to ruggedness of terrain (primarily the number of channels crossed). Most of the trouble spots will be eliminated after the first major storm. Thereafter maintenance consists of checking the fence periodically to determine if the proper voltage is being maintained.

To state that the fence described is predator-proof would not be realistic because any electric fence is subject to grounding by virtue of occurrences such as fallen trees, post pull-out, broken wires, and failed energizers. However, it is a fence that is relatively easy and economical to construct in rough terrain and it should reduce predation to an insignificant amount.

#### Literature Cited

- Anonymous. 1979.** Better fence for less money. *Dairymens' Digest*. February 1979.
- Knipe, O.D. 1982.** The use of angora goats in converting Arizona chaparral to grass. *Proc. Intern. Conf. on Goat Prod. and Disease* [(Tucson, Ariz., January 10-15, 1982). Proceedings published by (and available form): Dairy Goat Journal Publ. Co., P.O. Box 1808, Scottsdale, Ariz. 85252]

## High School Youth Forum- Orlando, Florida 1986

High school students with interests in range should plan now to attend the Forum at the SRM meeting in Orlando, Florida, next February.

An exciting agenda has been outlined, including a day at Deseret Ranch, a trip to Florida beaches, student-professional interaction, and time to see Disneyworld, Sea World, or Epcot Center. High school and college students will participate together in some meetings and activities.

Back to business—each student must present a 6-8 minute illustrated talk on any range related topic. Four judges will ask questions and evaluate the presentations. The speeches will be scored on knowledge of the topic, speaking ability, and use of visual aids. Illustrations may be slides, charts, overhead projections, or other appropriate aids visible from 25 feet or more. Speeches should address current issues in range management. They may describe range practices on a ranch or in an area, or range research.

It is very important for interested students to prepare *now!* Practice in speech competitions before the SRM meeting is recommended. Some Sections have speech contests at summer meetings, or they may rely on 4-H and FFA contests for qualified participants. Sections are strongly urged to develop formats for selecting delegates to the High School Youth Forum before November 1. Many Sections sponsor their delegate's registration and travel expenses.

Several of the goals of the Forum Committee are to have at least one delegate from each Section, to have speeches prepared and polished before arriving at the annual meeting, and for everyone to have a great time in Orlando!

For more information, write or call Jan Wright, SCS Office, Box 917, Baker, MT 59313 (406) 778-2217.