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Technology & Development Program
Society for Range Management

Fences

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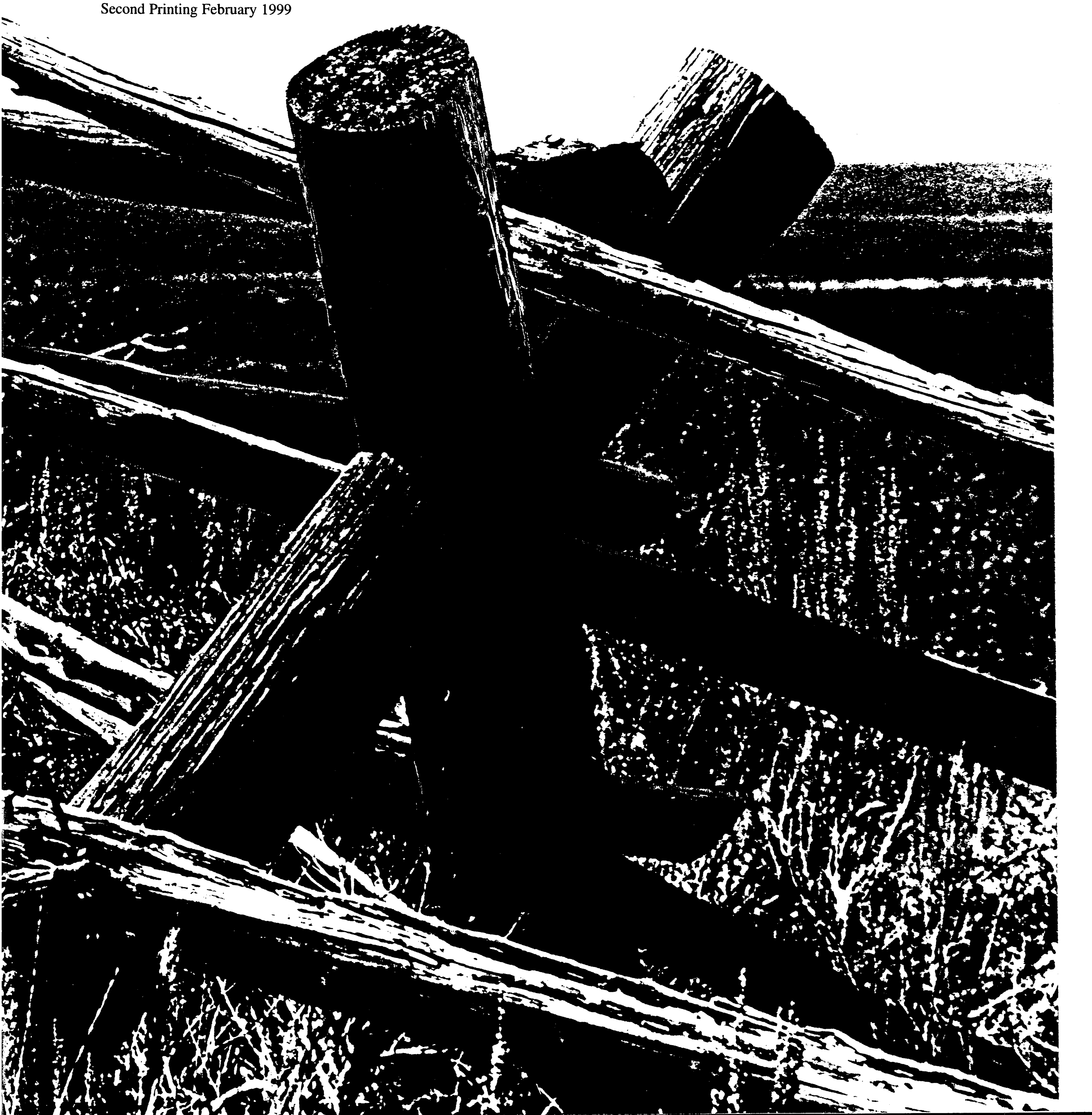
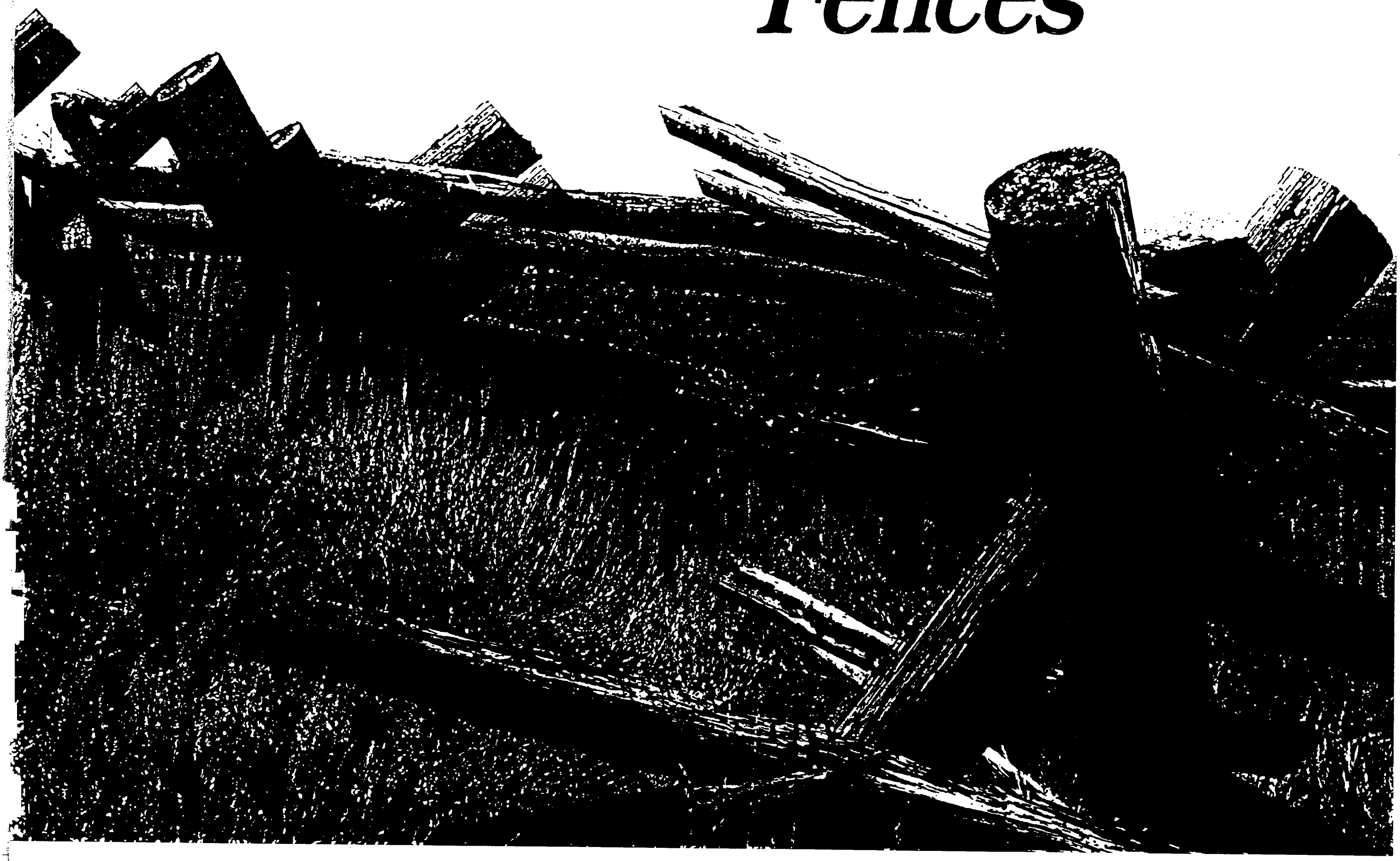


Fences



Sponsored by
Vegetative Rehabilitation and Equipment Workshop

Prepared by
Missoula Technology & Development Center

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Project Leader

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Acknowledgments

The Vegetative Rehabilitation and Equipment Workshop (VREW) is an informal group of Federal and State agencies, universities, professional organizations, and private citizens concerned with effective land management practices.

This handbook was prepared at their request by the USDA Forest Service Technology and Development Center at Missoula, Montana. Bill Duffy, MTDC Equipment Specialist, was the primary author; Brad McBratney, MTDC Equipment Specialist, Brenda Holland and DeLynn Colvert completed the text and illustrations. Questions should be directed to Richard Karsky, Project Leader, Missoula Technology and Development Center, Bldg. 1, Fort Missoula, Missoula, MT 59801.

Disclaimer

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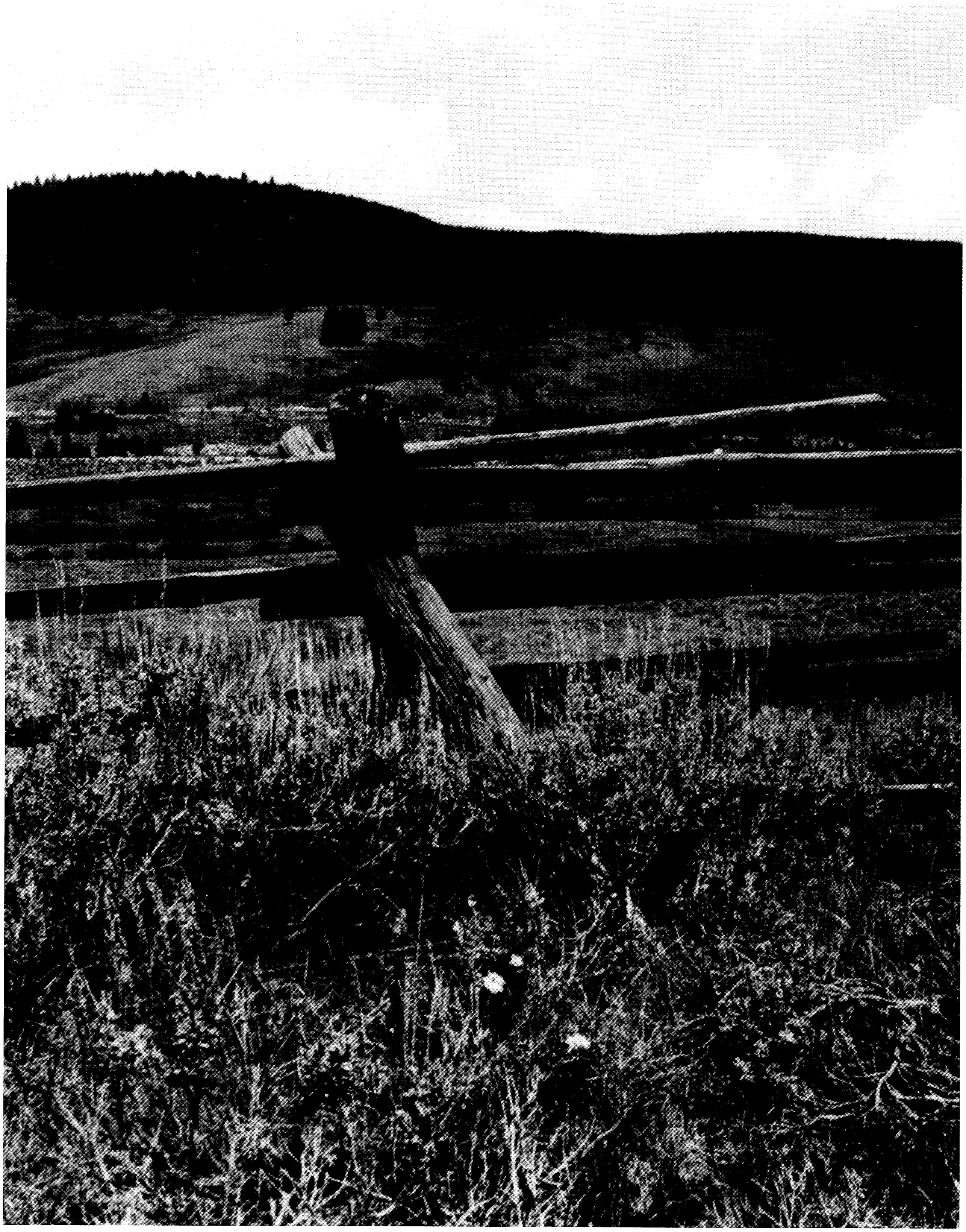


Introduction

As part of the continuing effort to develop and test revegetation equipment and provide information about suitable equipment to land managers, the Vegetative Rehabilitation and Equipment Workshop (VREW) has consolidated structural improvement handbooks now scattered through every agency into three volumes:

Fences
Facilities for Handling, Sheltering, and Trailing Livestock
Water—Pumping, Piping, Damming, and Storing

This volume describes components and uses of fences and gates and their advantages and disadvantages; costs; and safety, environmental and construction features. Pertinent books and articles are included in the Bibliography. The handbook is intended for use by private, federal, and state range land managers.

Fencing controls the movement of livestock, other animals, and people. Fences help manage grazing and they protect animals, people, and vegetation.

Costs and potential environmental impacts of any fence dictate careful planning. New materials, designs, and construction practices have reduced the cost of some fences, but considerations for wild animal movement, esthetics, recreation, and the environment may increase costs. Timing is also important. Post hole diggers and post drivers operate better in the spring when the ground is moist but not muddy. The availability of labor and material may also affect timing. Therefore, objectives must be carefully studied before a fencing operation begins. Careful planning will insure maximum benefits.

Costs cited in this handbook are general and intended to provide a basis for comparing various fence designs. Costs in your area may be somewhat different than those we have cited.

The following procedures are presented in the order most fencing operations would follow:

1. Coordinate planning with all appropriate land owners and managers
2. Gather site information and choose an appropriate fence design
3. Secure easements and clear right-of-way
4. Survey and mark land lines
5. Locate fence line
6. Choose fence design
7. Layout fence
8. Plan spacing and location of braces, posts, gates, and cattleguards
9. Set corner, gate, and line braces
10. Set line posts
11. Stretch wire
12. Place stays
13. Ground all wire fences
14. Set gates and cattleguards

(Photo courtesy University of Montana Mansfield Library.)

Planning

The first objective when building a fence is to plan its construction carefully. Analyze the site; consider its topography, its soil, its vegetation; the materials available and their costs. Consider the users of the area to be fenced—both people and animals. Choose an appropriate design. Secure easements, clear right-of-way, locate the fence, and lay it out.

It is essential that you coordinate planning with anyone who will be affected by the fence. Even when constructing a fence on your own land for example, wildlife migration routes may be disturbed, so wildlife managers should be consulted. Consult people who may have permits or leases on or near the area to be fenced. You may want to consult conservation organizations; federal, state, and local government agencies that adjoin the area; state highway departments; authorized public land users; people who use public access sites; adjacent land owners. Cooperation with all those affected will help avoid possible conflicts and, more importantly, make the fence an effective resource tool.

Gathering Site Information

A variety of fence designs are available to fit the needs of a site. Consider topography, soil type, visual impacts, recreation use, moisture conditions, wild animal use, and run-off before you chose a design. No single fence design will fit all conditions and if appropriate choices are not made, fences will fail.

Proposed fences must not be constructed in areas planned for future energy, minerals, and road development unless:

a. The fence will not be affected by development or is a required part of the development;

b. The principal features or components of the fence can economically be salvaged and used again;

c. The benefits yielded before the fence is destroyed or abandoned exceed the cost of installing and maintaining the fence.

The analysis of the fencing site should include:

1. *Type of Soil*—Sandy soils will require more braces and closer spacing than firm soils. Rocky soils may require fences built of rock jacks with figure-four posts or straddle jacks. Marshy areas may require the construction of figure-four or straddle jack posts with long flotation boards that keep the fence on top of the marsh.

2. *Topography*—Do not fence into areas where animals are naturally obstructed. Fencing in a straight line up a hill may cause erosion. However, fences should be on as straight a line as possible to reduce the costs. Use the lay of the land to make the fence most efficient. Getting materials to steep sites adds expense.

3. *Snow Conditions*—Areas of light snow usually do not require special fencing designs. However, blown snow will approximate heavy snow conditions and may require special fence designs. Moderate snow requires stronger fence than light snow. Fences exposed to heavy snow require straddle jacks with wire or pole fencing, or worm, block and log, post and pole wood fences or let-down fences. Be sure to check the proposed fence line during late winter or early spring. This allows you to identify problem areas and design the most appropriate fence.

4. *Water*—Fences across gullies or streams may require special braces and designs. Seasonal runoff needs break-away fences or swinging water gaps. Swinging water gaps or floating water gaps should span running streams.

5. *Accessibility*—Fences should have easy access for construction and maintenance. Fences have to be constructed where they will accomplish planned objectives, but construct them in the most accessible area possible. Power fences must have access to a power supply—a main line, a solar power panel, or easily exchanged batteries.

6. *Boundaries*—External property boundaries should be located, surveyed, and marked before construction. Existing fences usually figure strongly in disputes, so accurate boundaries are essential. Fences along state or county highways may be governed by state or county laws. Coordinate your planning with appropriate officials and with adjacent land owners. This not only avoids disputes, but may open opportunities for cost-sharing.

7. *People Access*—Consider installing narrow walk-through gates, post pass-through openings, or other access structures to improve esthetics and

8. *Visual Impact*—Select a form, line, color, and texture that blends with the landscape. The most critical locations are along major travel routes and across openings. As much as possible, keep fences out of view. Where practical, fences should be placed slightly inside vegetation surrounding openings. Landforms may reduce visual impact. A fence across a slope, viewed against a landform and vegetative background, is less offensive than one silhouetted against the sky. Avoid bulldozer clearing or major soil disturbance.

9. *Vegetation*—Fences may protect natural wetlands, streambanks, woodlands, and plants. Keep fences away from heavy vegetation and areas of potential blowdown.

10. *Animals*—Various kinds of animals (horses, cattle, sheep, elk, and deer) and classes of animals (different ages and sexes) may require specific fence designs. Fences can be built to accommodate or exclude wildlife.

11. *Safety*—All wire fences must be grounded to protect man and animals from lightning. Grounding should be done at both ends of the fence line, at each brace panel, on both sides of a gate, on both sides of a power line crossing, and where there is excessive moisture. Drive galvanized pipe into the ground at these sites and attach a ground wire from this pipe to all the fencing wires. Precautions should be taken to insure the safety of construction and maintenance crews.

Locating The Fence

Fence lines should be carefully surveyed and clearly marked. Established fences are often the subject of court cases, so be particularly careful in surveying and marking boundary fences. Fence lines to be built inside property lines can be located wherever they meet the land manager's objectives. These objectives include managing vegetation, livestock, wildlife; controlling access to water, gullies, heavy snowbanks, marshes, wildlife migration routes, or areas of high visual impact. When fencing water, be sure to consider wildlife access. Consider the topography of the site in locating your fence and plan to keep construction and maintenance costs as low as possible.

Choosing A Fence Design

The fence design that you choose depends on a number of factors including the intended purpose, visual impact, soil types, vegetation, topography to be crossed, maintenance requirements, materials available, labor and material costs, weather, and expected life span. No single factor determines the design of fence. Weigh your priorities and choosé a fence based on your goals and needs. For example, a 2-strand smooth wire fence will not keep buffalo in, but can effectively direct people. Or, a high tensile wire fence with fiberglass posts is a good choice in areas of high snow. The following tables list common designs, their advantages and disadvantages, and a rough estimate of their costs. By considering all your needs and goals carefully, you can insure the most effective fence possible for the area to be fenced.

A Summary of Fence Designs

Fence Type	Advantages	Disadvantages	Maintenance Rating	Costs Material $/Mile	Labor $/Mile	Total $/Mile
Conventional 4-strand barbed wire	Skills & designs for construction readily available.	Labor & material costs high.	Medium	$2,100	$2,000	$4,100
Gancho 4-strand barbed wire	Longer life than conventional barbed wire. 20-30% less expensive than conventional barbed wire. Lighter weight, less strain.	Wire less workable than conventional barbed wire.	Unknown	2,000	2,000	4,000
Woven wire w/top 2-strand barbed wire	Skills and designs for construction readily, available. Good control of sheep & cattle.	Labor & material costs high.	Medium	2,800	2,000	4,800
Let-down fence 4-strand barbed wire	Prevents fence damage in high snow pack & high wildlife concentration.	Labor & material costs high. Life span short because of wire corrosion.	High	3,500	2,300	5,800
High-tensile 8-strand smooth wire	Durable. Less expensive to install & maintain than conventional barbed wire. Withstands more than other wire. No barbs.	Requires special equipment & techniques to install.	Low	1,700	900	2,600
High tensile 10-strand smooth wire	Very durable. Less expensive to install & maintain than conventional barbed wire. Withstands more than other wire. No barbs.	Requires special equipment & techniques to install.	Low	1,900	1,000	2,900
Conventional barbed wire suspension w/wood stays	Few posts. Low costs. Long life. Alternative for interior & cross-fencing.	Not appropriate in rough broken country or in areas of tall, dense vegetation. Won't detour cattle near water. Great down-fence distance w/post breakage.	Low	1,200	600	1,800
Conventional barbed wire suspension w/wire stays	Fewer posts. Low costs. Long life. Alternative for interior & cross-fencing.	Not appropriate in rough broken country or in areas of tall, dense vegetation. Won't detour cattle near water Great down-fence distance w/post breakage.	Low	900	500	1.400
High-tensile smooth wire suspension w/wood posts	Few posts. Low costs. Long life. Alternative for interior & cross-fencing.	Not appropriate in rough broken country or in areas of tall, dense vegetation. Won't detour cattle near water. Great down-fence distance w/post breakage.	Low	1,100	600	1,700

A Summary of Fence Designs (continued)

Fence Type	Advantages	Disadvantages	Maintenance Rating	Costs Material $/Mile	Costs Labor $/Mile	Costs Total $/Mile
High-tensile smooth wire suspension w/steel posts	Few posts. Low costs. Long life. Alternative for interior & cross-fencing.	Not appropriate in rough broken country or in areas of tall, dense vegetation. Won't detour cattle near water. Great down-fence distance w/post breakage.	Low	800	400	1,200
Permanent electric conventional, barbed wire	Lower costs than conventional barbed wire. Long life. Versatile.	Not appropriate in rough broken terrain.	Low	1,000	300	1,300
Portable twine & 3-strand electric	Lightweight portable easily adjustable.	Weathers poorly. Don't use in lengths over 1,000 feet.	High	1,000	40	1,040
Permanent electric high-tensile, smooth wire, post & stays.	Durable. Low cost. Good psychological barrier. Less maintenance.	Not a physical barrier.	Low	800	400	1,200
Jackleg - wire fence	Very durable. Withstands heavy snowfall. Useful in areas where it is hard to dig or drive posts or on marshy ground w/use of floation boards.		Low	—	—	—
Rock jack & figure "4"	Useful in areas where it is hard to dig or drive posts. Good in light to heavy snow.	High material & labor costs.	Low	—	—	—
Jack leg - pole	Durable. Withstands heavy snowfall. Used in areas where digging or driving is impossible.	High material & labor costs.	Low	—	—	—
Post & pole	Durable. Withstands heavy snowfall.	High material & labor costs.	Low	—	—	—
Worm	Durable. Withstands heavy snowfall.	If logs not available, high material costs. Labor intensive.	Low	—	—	—
Log & block	Durable. Withstands heavy snowfall.	If logs not available, high material costs. Labor intensive.	Low	—	—	—
Suspension fence	Few posts, less cost. Little maintenance. Long lasting. Low-cost alternative for interior and cross-fencing.	Not appropriate in rough, broken country. Not suitable in tall, dense vegetation. Not an effective cattle deterrent near watering points. Greater down-fence distance with post breakage.	Low	850	450	1,300
Seimisuspension fence	Few posts, low cost. An alternative for interior or cross-fencing.	Suitable only for flat or slightly undulating terrain. Not as good a cattle deterrent as suspension or convenional fences.	Low	—	—	—

Fence Design Based on Site Conditions

Site Condition	Fence Design
Sandy Soil	Double-end line and gate braces—spacing up to 80 rods (¼-mile). Single-line braces—spacing up to 40 rods (1/8-mile). Use of deadman on corner, end and gate braces. Use two diagonal braces or one horizontal brace with a diagonal brace on corner, end, or gate location. Need to strengthen ground-holding capacity.
Marshy Soil	Add mud sills (two long poles or boards) to the bottom of a jackleg, straddle jack, buck, or figure-four fence.
Rocky Soil	Use rock jacks or rock cribs for braces. Use buck or jacklegs or figure-fours for line posts. May want to install steel or fiberglass posts.
Loam or Clay Soil	Single-end line and gate braces, spacing up to 80 rods.
Steep Ground	Put line posts in perpendicular to the land.
Heavy Snow	Jackleg, straddle jack, or buck fence with wire or pole fencing; post and pole fence; worm fence; log and block fence.
Ridgeline	Often a good fence-line location. Easy to maintain and allows effective management. Consider a single-strand wire.
Water Discharge	Infrequent—Normal fence construction with fence held in depressions with weights attached to the posts. Seasonal or Frequent—Construct end braces on either side of depression. Construct independent braces for fence in depression. Build break-away fence in depression. Build swinging or floating water gap fence. Running Stream—Construct end braces on either side of stream. Construct separate braces for holding swinging or floating water gap fence.

Site Condition	Fence Design
Wildlife Exclusion Fences	Deer—Electric fence designs: double deer fence; 6 ft, 6 in high 10-strand high-tensile strength fence; 8 ft high 15-strand high-tensile strength fence. Antelope—Electric fence designs: 6 ft, 6 in high 10-strand high-tensile strength fence; 8 ft high 15-strand high-tensile strength fence. Woven wire fence 32 in high with one barbed wire strand on the top. Elk—Power fence designs: 8 ft high 15-strand high-tensile strength fence.
Visual Impact	Wood fences are generally more pleasing in areas of high visitor use. Use standard fence designs for low visual impact.
Difficult Accessibility	Use steel line posts for reduced weight and bulk, or consider fiberglass posts with a few wood posts for added strength.
Fences for Wildlife	Deer—Fence height: min. 38 in to max. 42 in. Spacing between top and second wire 12 in. Moveable top wire or two. Antelope—Cattle fence height: min. 38 in to max. 42 in. Bottom wire at least 18 in above the ground. Bottom wire should be a smooth wire. Sheep fence height: min. 38 in to max. 42 in. Bottom wire—smooth at least 10 in above the ground. Leave out fence stays in areas where antelope frequently cross. Provide small cattle guards at 1-mile intervals for antelope to jump over. Moveable bottom wire or two. Elk—Fence height: min. 38 in to max. 42 in. Attach wooden rail to top wire for visibility. Construct let-down fence. All fence posts should be wood.

Clearing The Right-Of-Way

Clearing is usually accomplished at the same time the fence line is layed out. Rights-of-way should be cleared at least wide enough to permit easy construction and maintenance. If the terrain permits vehicle access, clearing should all be on one side of the fence. Adjacent landowners may cooperate in constructing boundary fences and clearing on both side of the fence may be mutually beneficial.

Wire should be strung on the cleared side of the posts. All division or drift fences should be cleared at least 4 feet on each side of the fence line.

Avoid straight line swaths up mountain sides or hills that cause undesirable visual effects. Leave an occasional tree and shape the side of the right-of-way to have an undulating or ragged edge.

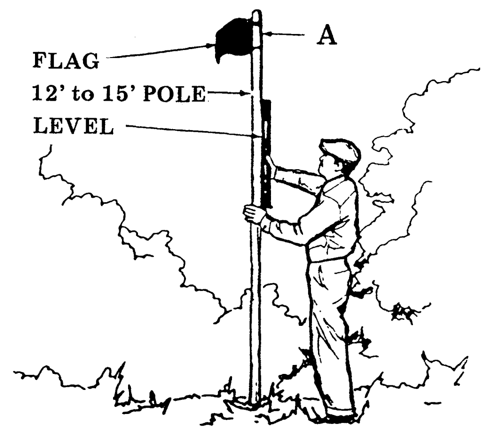
Slash from clearing along interior and exterior boundary fences should be used for erosion control or dispersed or burned. Slash should be lopped and scattered off the right-of-way. Dead or leaning trees on or near right-of-way lines should be removed. Down logs should be removed only if they will interfere with construction and maintenance or create a hazard. Logs can sometimes turn runoff on slopes away from the right-of-way. Bulldozers may effectively be used for clearing and providing access routes for crews, equipment, and material, but avoid unnecessary soil disturbance. Implements like the Klearway brush cutter, the Hydro-ax brush cutter, and horizontal shredders chop brush and leave it on the ground as a mulch and disturb very little soil.

Laying Out The Fence

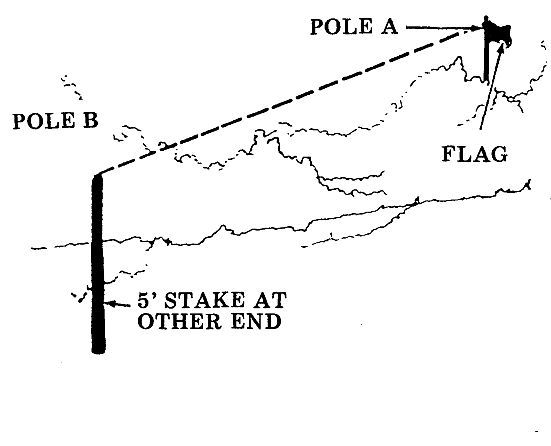
When the right-of-way has been cleared and the fence has been properly surveyed and marked, follow these procedures in laying out the fence:

To lay out fences in heavy undergrowth:

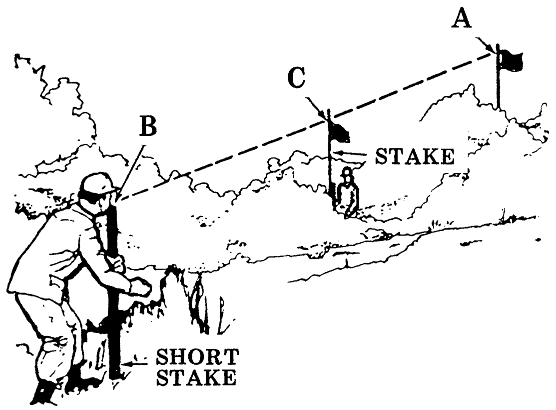
1 Hold a 12- to 15-foot flag at the end of the fence line with the heaviest growth. Check the pole with a level to make sure it is vertical.



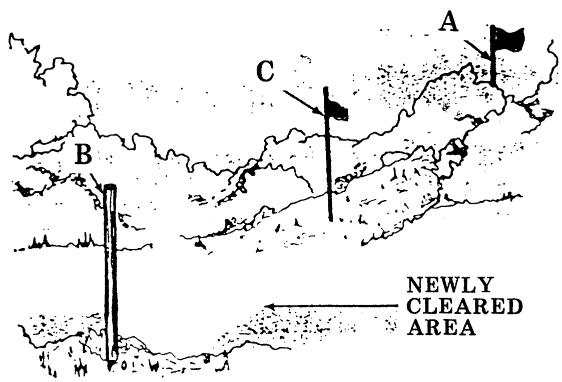
2 Place a 5-foot stake at the other end of the fence line.



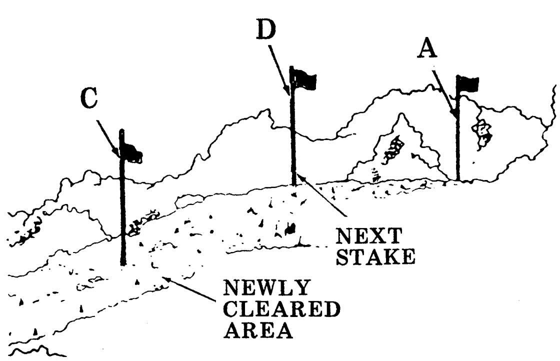
3 Sight from short stake, B, to pole. Align stake C as far into the thicket as it can be seen.



4 Clear area between stakes B and C for a distance beyond stake C.

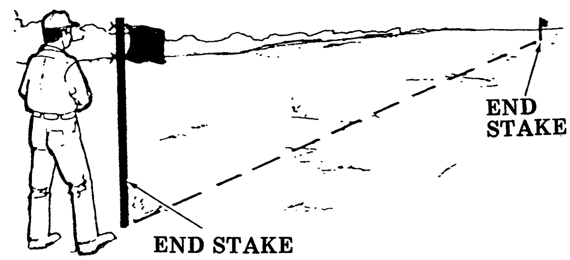


5 Continue to place stakes until line is completed.

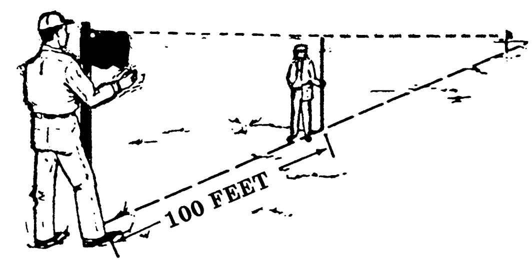


To lay fences across open, level areas:

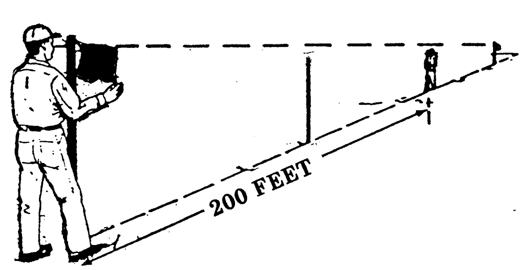
1 Set a stake at each end of the proposed fence line. Station someone at one of the end stakes to help align the remaining stakes.



2 Align and set a stake about 100 feet from the end stake.

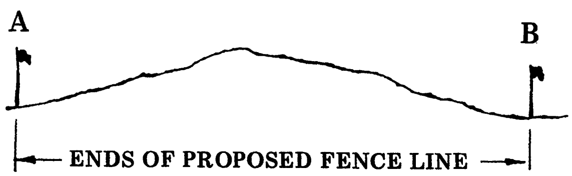


3 Continue setting additional stakes about every 100 feet until complete fence line is staked. Align each stake with the end stakes. This is easily done with the help of a person at the end stake sighting through to the other end stake.

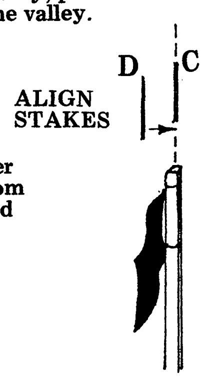


To lay out fences on open rolling areas:

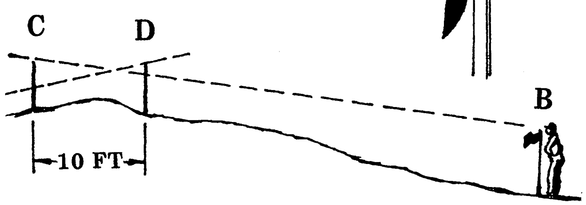
1 Set a stake at each end of proposed fence line, stakes A and B.



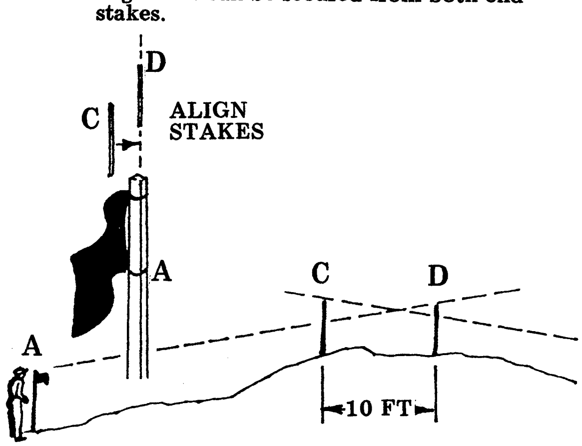
2 Place two stakes about 10 feet apart on top of the hill so both are visible from either end stake. In case of a valley, place stakes at the lowest position in the valley.



3 Align the two center stakes, C and D, from one of the other end stakes

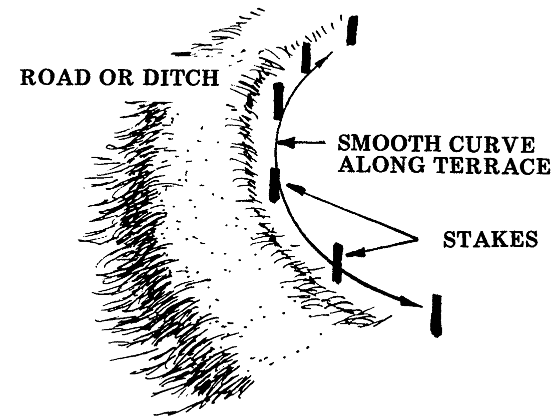


4 Check alignment of the center stakes from the other end stake. Center stakes may have to be moved several times before satisfactory alignment can be secured from both end stakes.



To lay out fence line on contour:

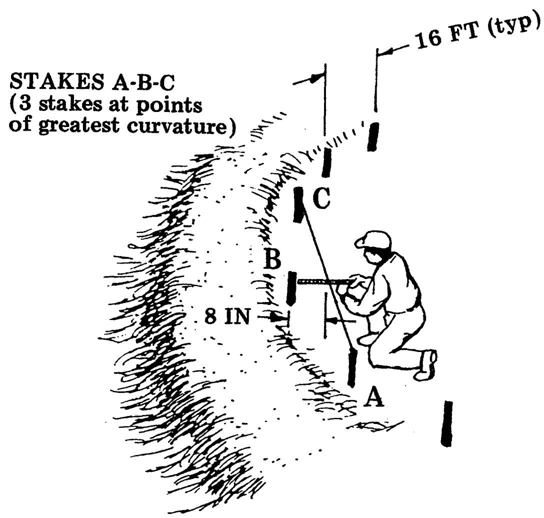
1 Stake out a smooth curve along a contour strip or terrace. Space stakes about 16 feet apart. If following a terrace ridge, place stakes below the ridge so the terrace can be maintained.



2 If there is much curve at any one point, select three stakes at the points of greatest curvature.

3 Stretch string between the first stake, A, and the third stake, C.

4 Measure distance from the center stake, B, to the string.



5 If the center stake is more than 4 inches from the string, decrease the spacing based on the following tabulation:

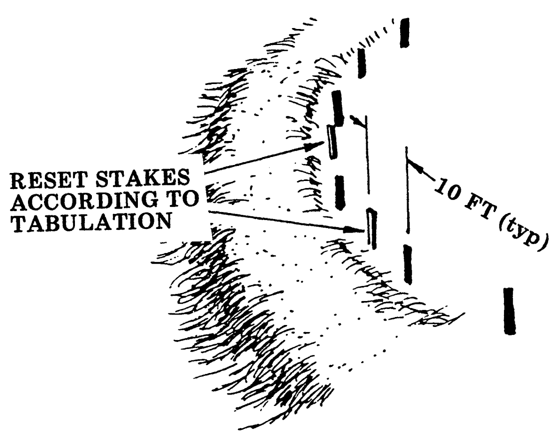
Post Spacing for Contour Fences

Distance from center stake to string	Recommended post spacing
inches	*feet*
4 or less	16
4 - 5	15
5 - 6	14
6 - 8	12
8 - 14	10
14 - 20	8

6 Set posts to the recommended spacing.

7 Repeat steps 3 to 6 wherever there is a curve.

8 Check by sight to see that no single post is out of line of the smooth curve. Keeping a smooth curve will insure that fence wire will pull equally against each post.



Safety

Precautions must be taken when constructing fences. Anyone building fences is subject to cuts and scratches as well as other accidents. Accidents and injuries can be prevented by always observing safety precautions:

1. Wear tightly woven, tough clothing.

2. Wear heavy-duty, gauntlet-type leather gloves that fit snugly.

3. Wear long pants and high work shoes with heavy soles.

4. Have the right tool for each job; keep it in good condition; and use it only according to manufacturer's directions.

5. Wear safety goggles or eye shields when cutting or tensioning wire, and when driving nails or staples.

6. Never carry nails or staples in pants pockets. Use a nail apron or tool bag.

7. Use proper shields on power equipment.

8. Wear a hard hat and ear plugs or ear muffs when operating power equipment.

9. Use driving caps on posts as recommended by the driver manufacturer.

10. Keep children and livestock away from all fencing operations.

11. When handling, driving, drilling, nailing, or stapling chemically-treated wood posts or lumber, wear face shields and rubber gloves. Cover unprotected skin. Some people are allergic to wood-preserving chemicals.

12. Never take shortcuts or eliminate such items as safety wires on twitch or twist sticks.

13. Pick up all cut ends of wire, dropped staples and nails. They can cause injury to humans, be eaten by grazing livestock, or damage mower blades.

14. Suspend all fencing operations during electrical storms.

15. Install proper ground wires to wire fences as soon as they are erected.

16. Remember that any wire is an excellent conductor. Be careful when stringing guide wires or line wires so they do not contact power lines. Do not install fences under power lines or near buried power lines.

When you have completed the site analysis, located the fence, chosen an appropriate design, cleared the right-of-way, laid out the fence, and analyzed safety needs, a review of the proposed fencing operation with all those affected will insure that all resource values and needs are met before construction begins.

Components

Braces, corner posts, and line posts are the most important components of a fence, since they determine its effectiveness and life expectancy. Gates, cattleguards and less common components like stiles, ladders, and walk-throughs may be included, depending on the needs at your site.

Braces and posts can be installed in a variety of ways and they are made from a variety of materials—wood, steel, fiberglass and plastic. Careful planning will help you determine the components appropriate for your fence.

Materials, tools, and construction techniques are described.

Braces And Posts

The first step in constructing a fence is to plan and place braces and corners. Braces determine the structural soundness and longevity of any fence line. Corners are braces that are located where there is a change in fence direction. If any brace or post fails, there is a loss of wire tension and fence effectiveness. Design and spacing are determined from such factors as the number of strands of wire used (3 to 15), the type of wire (barbed, woven, high tensile strength), soil type (sand, loam, clay), terrain (level, hilly), animals to be restrained, etc.

Braces may be constructed with either wood or steel posts and in a variety of designs. The following table summarizes the most common designs. Shaded posts in the drawings are the tie-off posts.

Corner, line, and gate or fence-end braces (strainers) are an important part of any fence. With the use of high tensile, smooth wire, these strainers are of even greater importance because of the necessity of maintaining the complete fence at the recommended tension. In recent years, the horizontal fence strainer has been accepted as the standard and strongest design. Because suspension fences are subjected to greater tension, double brace assemblies should be constructed every ¼-mile (1,320 feet). In sandy, loose soils, braces may have to be placed every 1,000 feet.

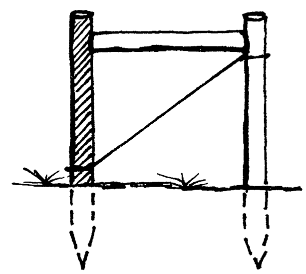
Fence braces fail because of: (1) structural failure; (2) soil movement or failure; (3) corner or end post pullout. Structural failure of an end brace is usually due to improper design, poorly selected materials, or over-stressed members. By carefully designing fence braces and properly proportioning and sizing the members, structural failures can be all but eliminated. Fence braces also fail when the soil is too weak to support the load, which allows the fence brace to move through the soil. Soil failures can usually be eliminated by using larger posts or by applying plates. Corner post pullout, when braces lift out of the ground, can be eliminated by using longer fence braces and placing cleats on the post.

Common Brace Designs

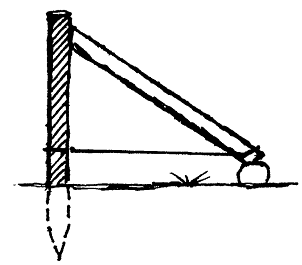
Braces

(Shaded Posts are the Tie-Off Posts)

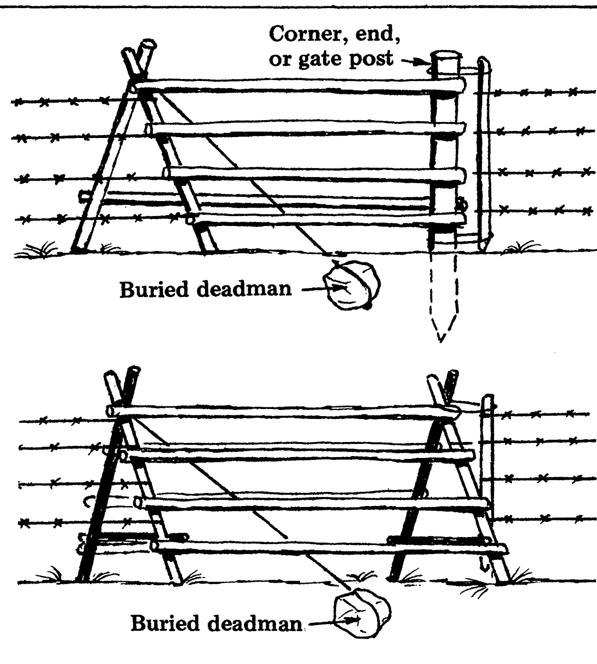
Horizontal	Structurally strong. Construction procedures well known.
Diagonal	Eight percent more resistant to overturn than standard horizontal brace; structurally equivalent to horizontal brace; twenty-five percent less expensive than horizontal brace.
Straddle Jack	Stable; transfer fence angle to a single post; used where it is difficult to dig or drive posts.
Square Rock Crib	Used where it is difficult to dig or drive in posts; very stable; used as corner, end, gate, or in-line braces.
Rock Jack	Used where it is difficult to dig or drive in posts; very stable; used on corner, end, gate, or in-line.
Wire Fence Cribs	Used where it is difficult to dig or drive posts; very stable; used at corner, end, gate or in-line.



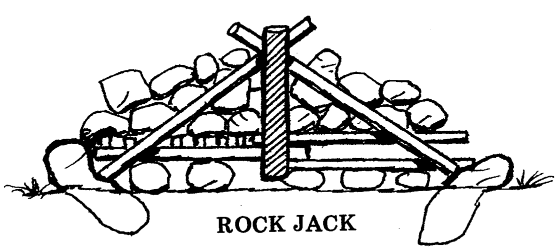
HORIZONTAL BRACES



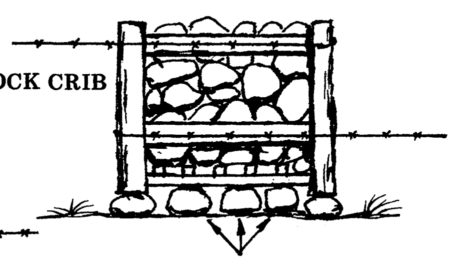
DIAGONAL BRACES



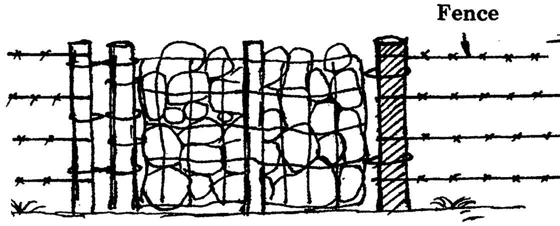
STRADDLE JACK BRACES (2 types)



ROCK JACK



SQUARE ROCK CRIB

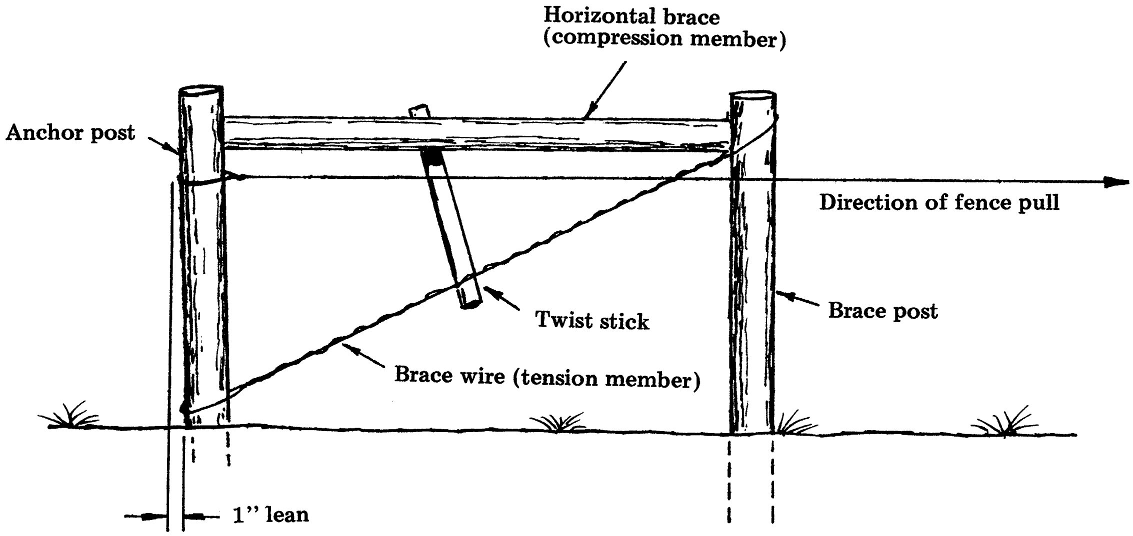


WIRE FENCE CRIBS

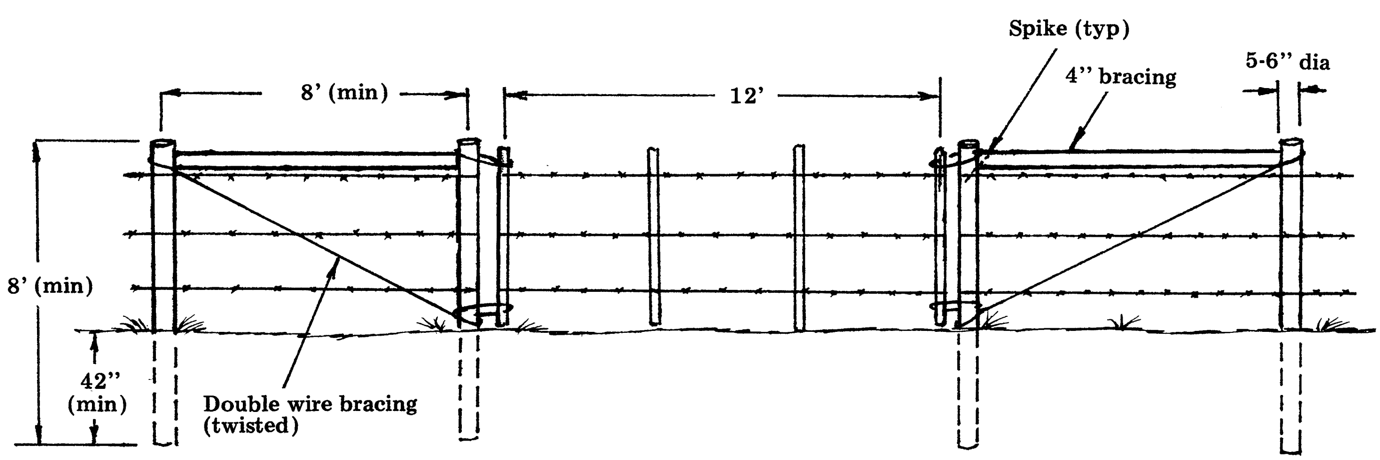
Brace Designs

Horizontal Braces

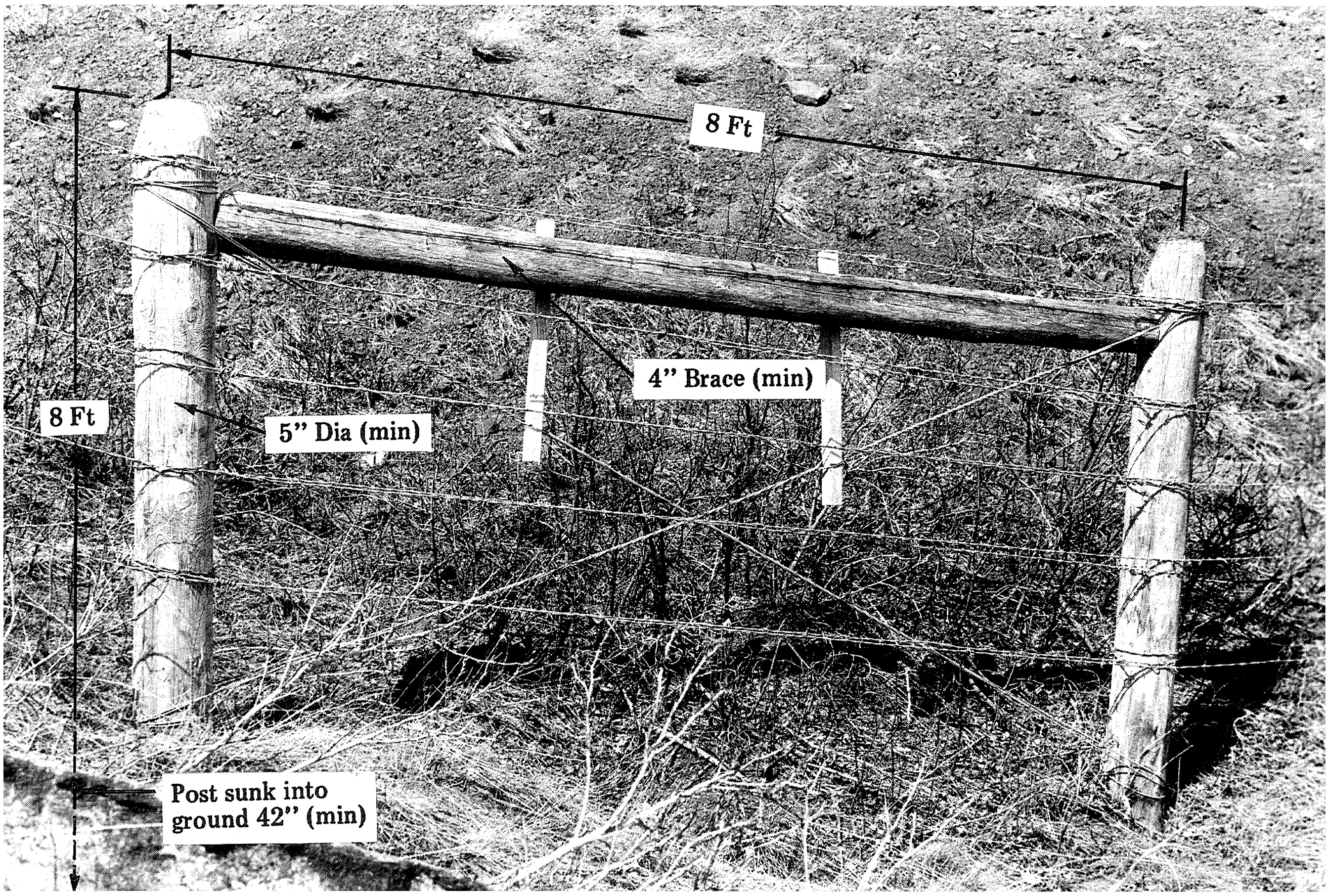
Horizontal braces are structurally sound and appropriate for most fences. They are the most common brace constructed.



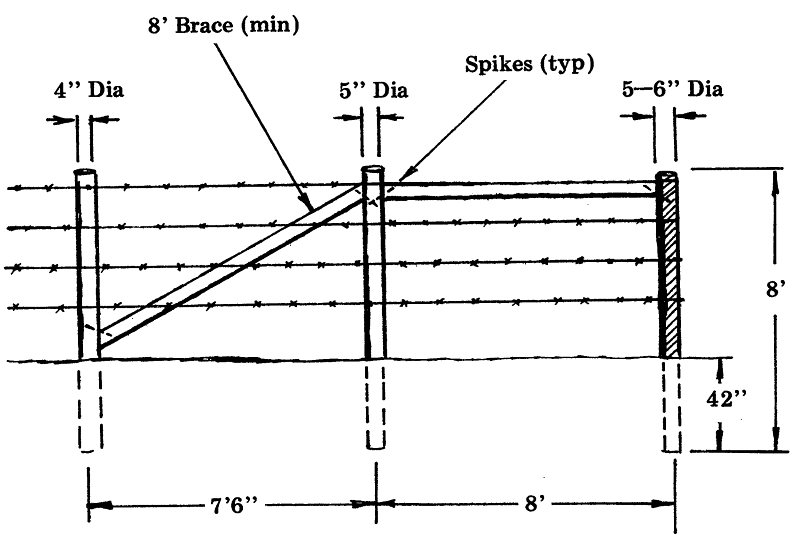
Parts of horizontal brace.



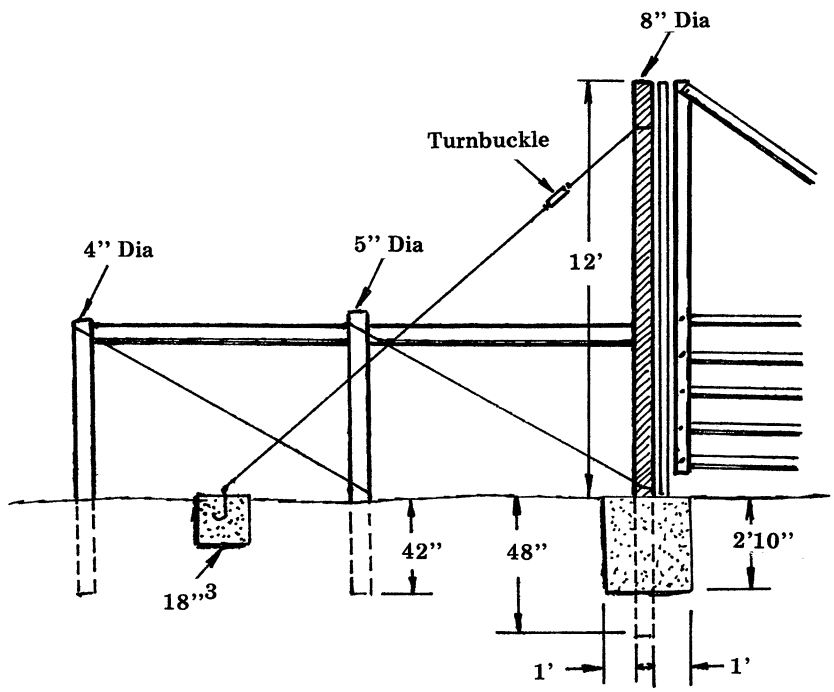
Single panel end and gate brace.



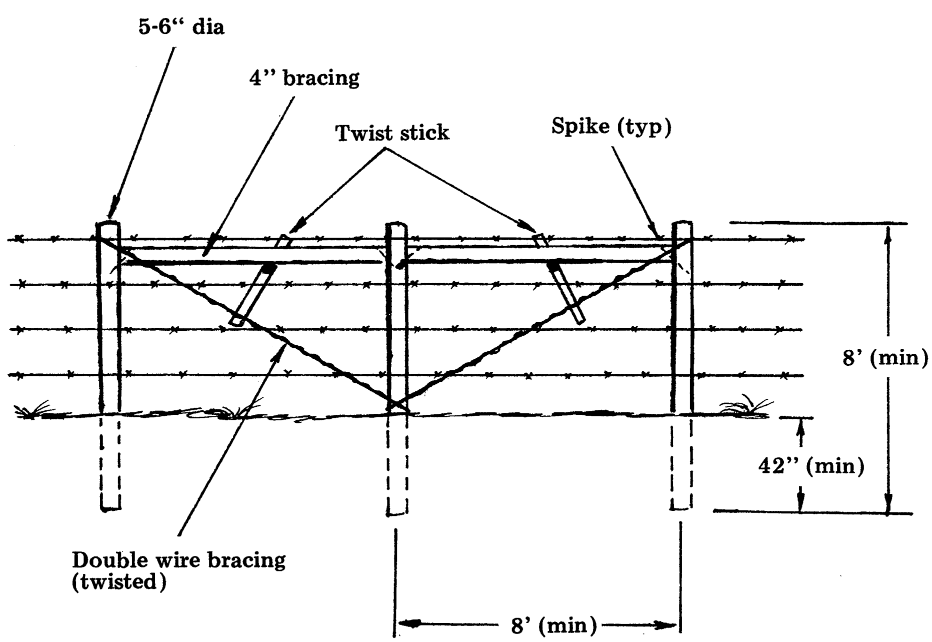
Single panel in-line braces.



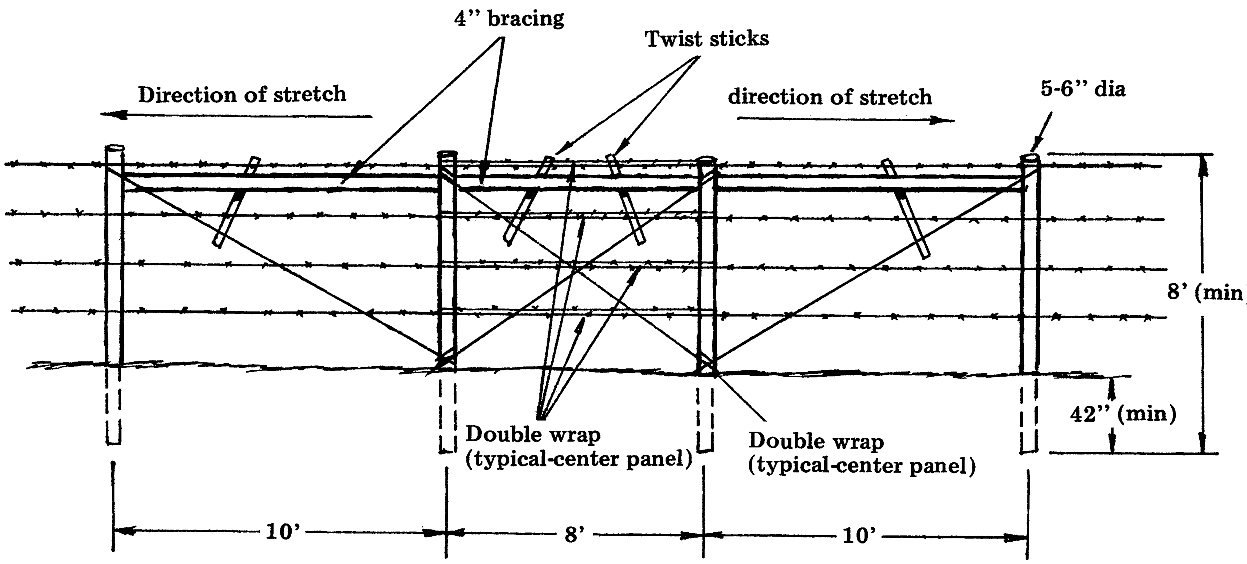
Double panel end brace.



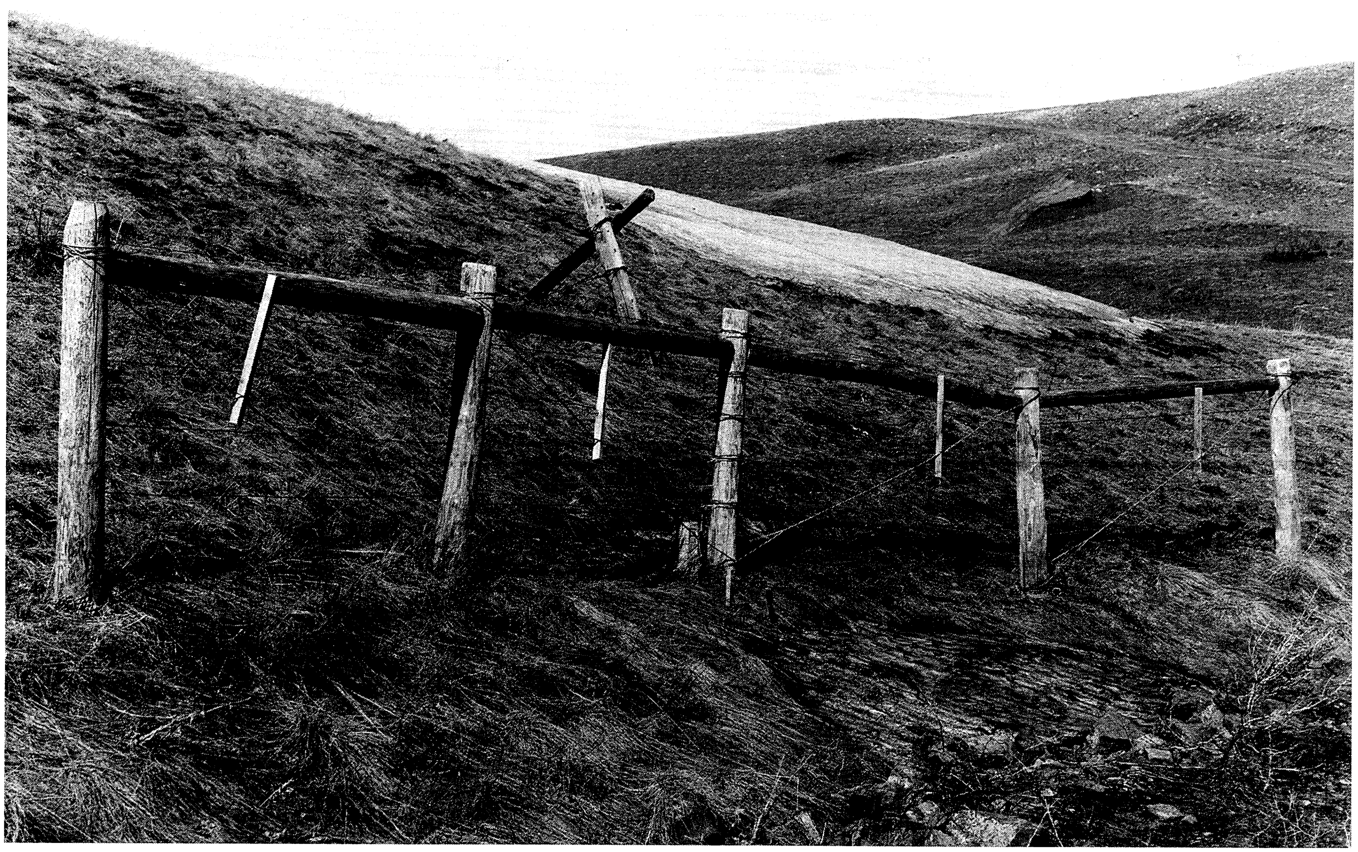
Double panel gate brace.



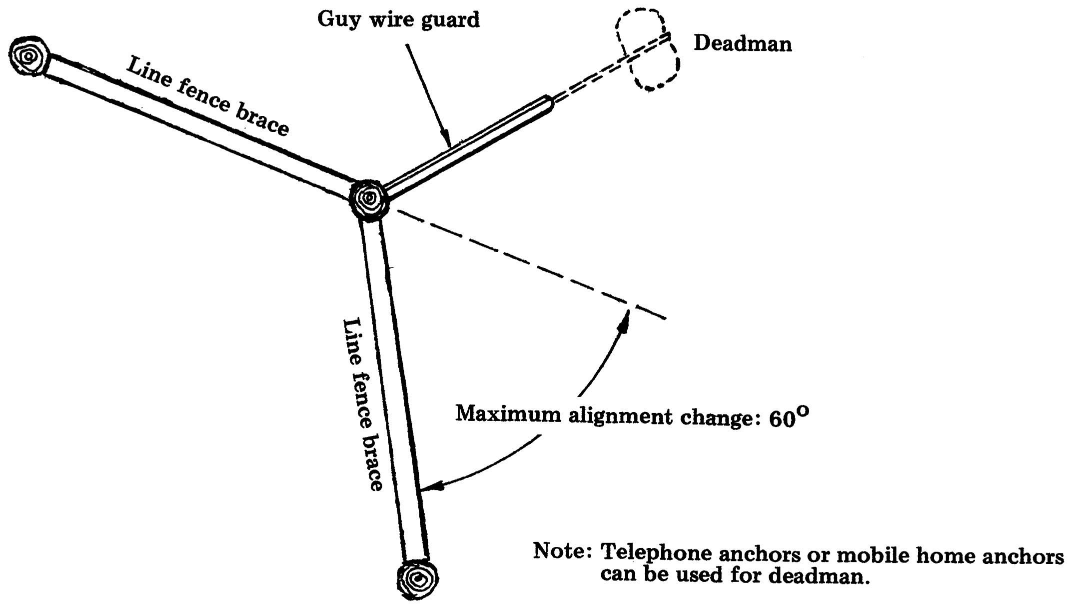
Three-post double panel brace.



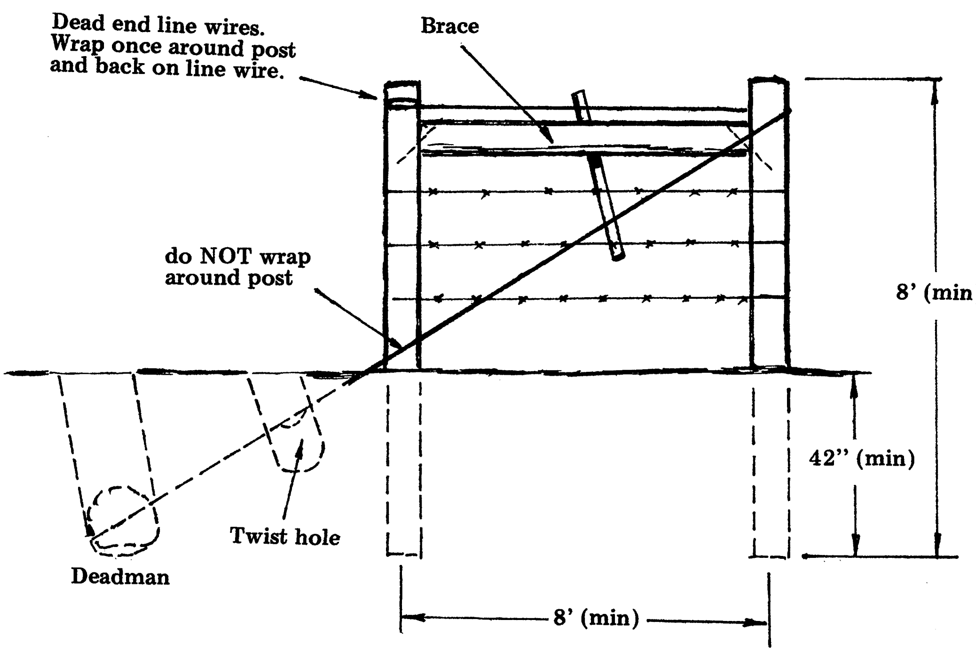
Four-post three-panel brace.



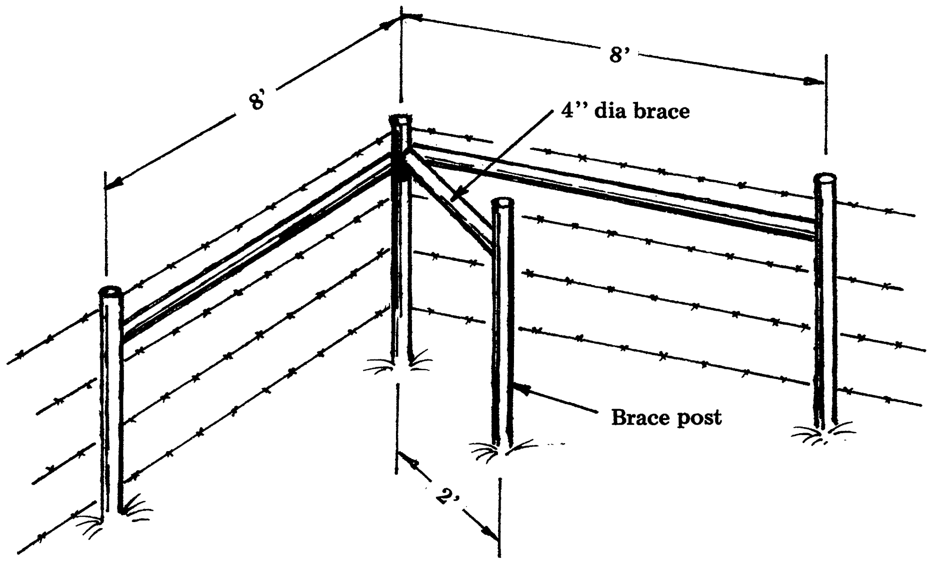
Five-post four-panel brace.



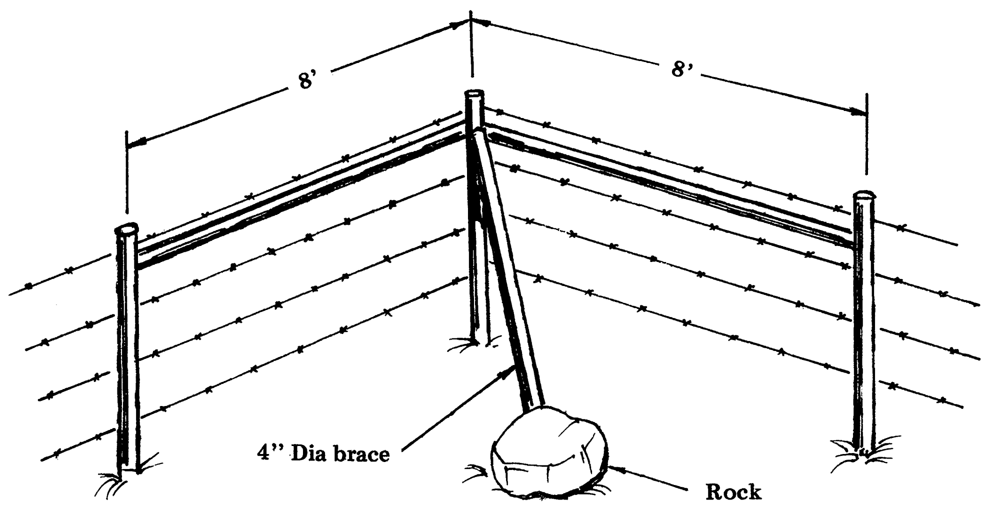
Angle guy with deadman.



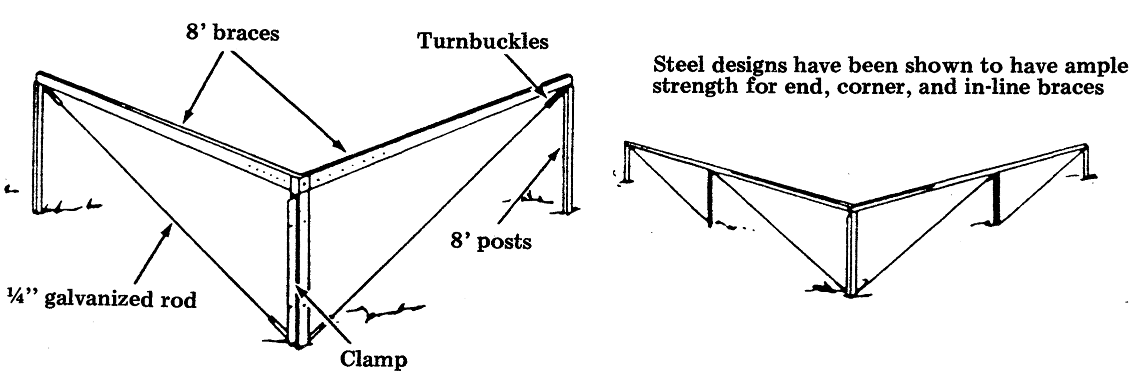
End guy with deadman.



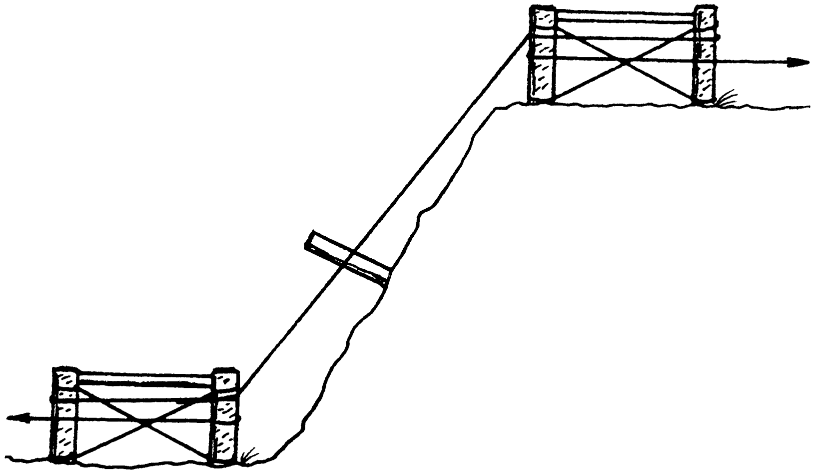
Interior horizontal deadman.



Interior diagonal deadman.

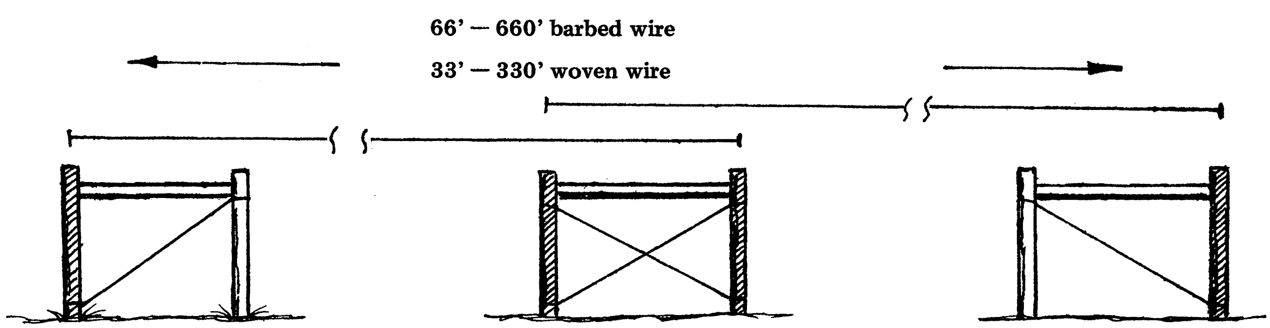


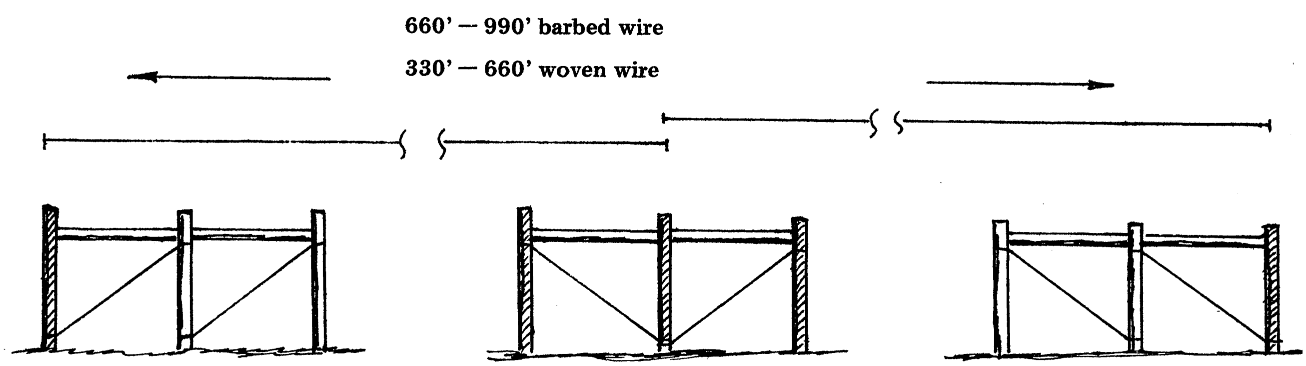
Horizontal steel braces.



Braces on the top and bottom of steep slopes.

The following schematic illustrates some basic horizontal brace designs and their spacing. Level terrain, firm soil and four strands of barbed wire are the only factors considered.





To install a wood or steel horizontal anchor-and-brace assembly, procede as follows:

1. Mark ground line on anchor-and-brace posts. Set depth at least 3 feet, 6 inches. The deeper the post, the stronger it will be.

2. Dig a 12-inch diameter hole for anchor post, 3 feet, 6 inches deep.

3. Place post in hole and tamp soil. Replace no more than 6 inches of soil at a time and tamp thoroughly. Install anchor post with a 1-inch lean away from the direction of fence pull. Check occasionally to see that it is properly aligned.

4. Measure from anchor post to first brace post and dig hole for brace post. Use post or pipe that you selected for horizontal brace for measuring distance. It should be at least 8 feet long. If you are using 1½-inch pipe or larger, or 2½-inch angle iron or larger, span length may be increased to 10 or 12 feet.

5. Place brace post in hole, but do not tamp.

6. Mark hole for dowel 8 to 12 inches from top of anchor post. If using pipe or angle-iron brace, mark post for notching with member centered 8 to 12 inches from top of post.

7. Bore hole same size as dowel, 2 inches deep. Be sure to remove all shavings. For pipe or angle-iron, make notch about ½-inch deep.

8. Bore same size holes to same depth in each end of horizontal brace member.

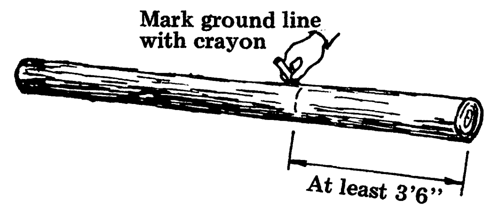
9. Insert steel dowel in anchor post.

10. Install brace member on anchor post. Position opposite end on brace post so brace member is parallel with ground line.

11. Insert dowel in brace post. Mark hole for dowel in brace post. Bore hole in brace post same size as steel dowel, 2 inches deep.

12. Install brace member between anchor post and brace post. Replace soil around brace post and tamp.

1



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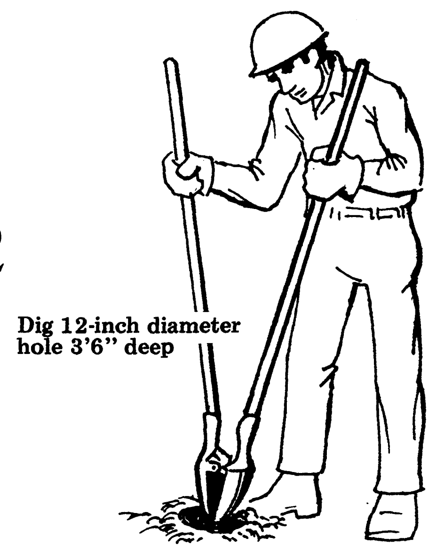

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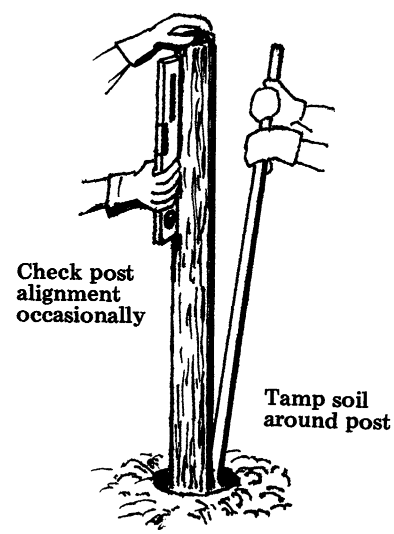

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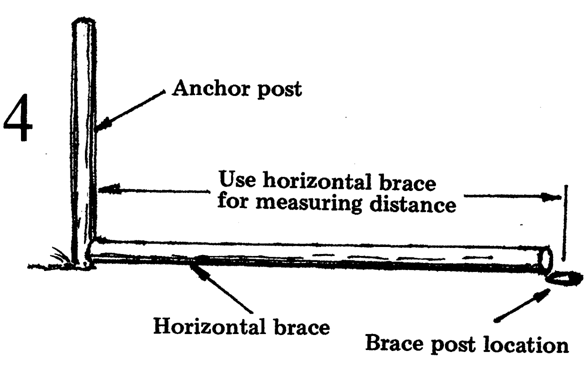

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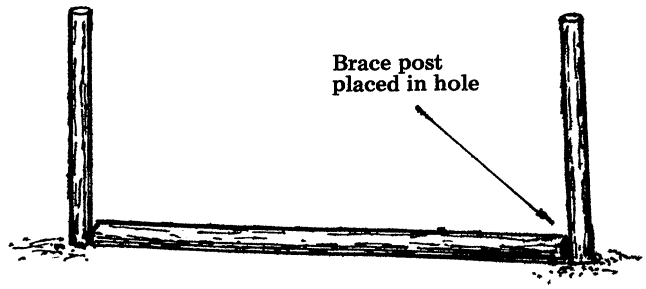

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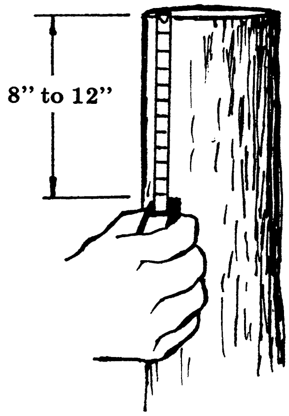

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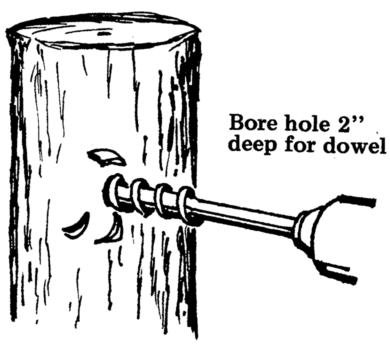

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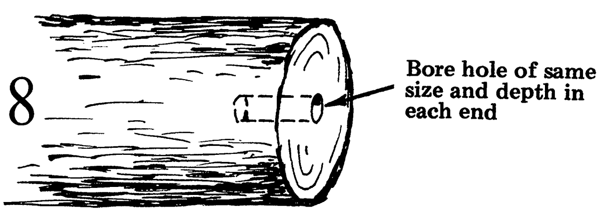

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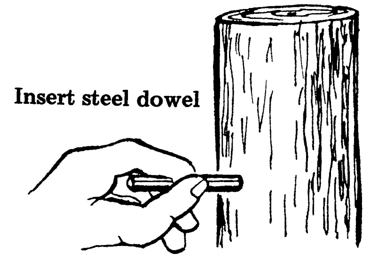

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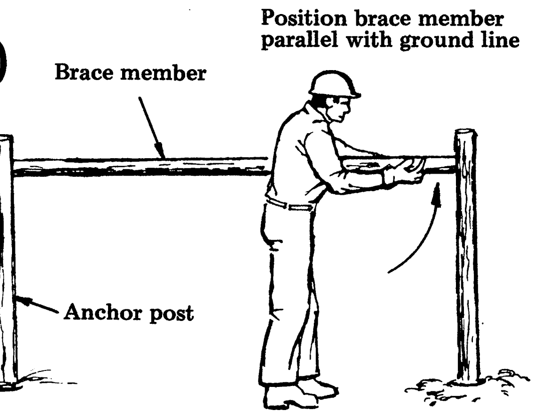

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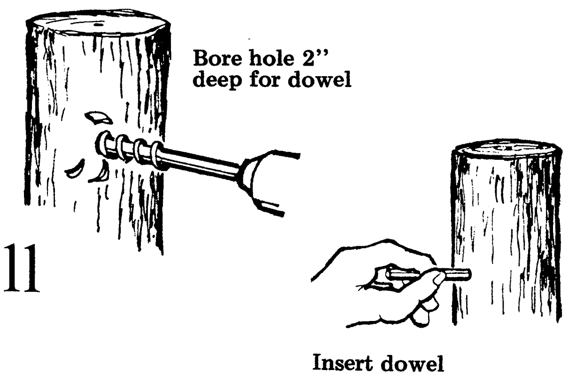

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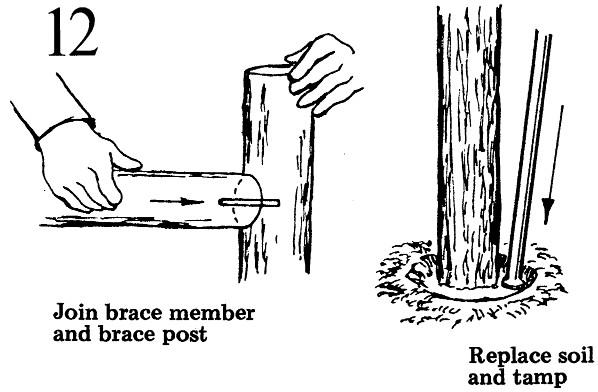


To install the brace wire:

1. Drive staple about half its length into brace post, about 4 inches above brace member on opposite side from brace.

2. Drive staple in similar manner on anchor post about 4 inches from ground line opposite side from brace.

3. Unroll enough brace wire for two complete loops around anchor and brace post. Use cord to determine length required. Do not loop wire off roll. Unroll it to avoid kinks.

4. Thread end of brace wire through one staple and then through the other. Repeat to form three wire strands. Remove rough slack from wire.

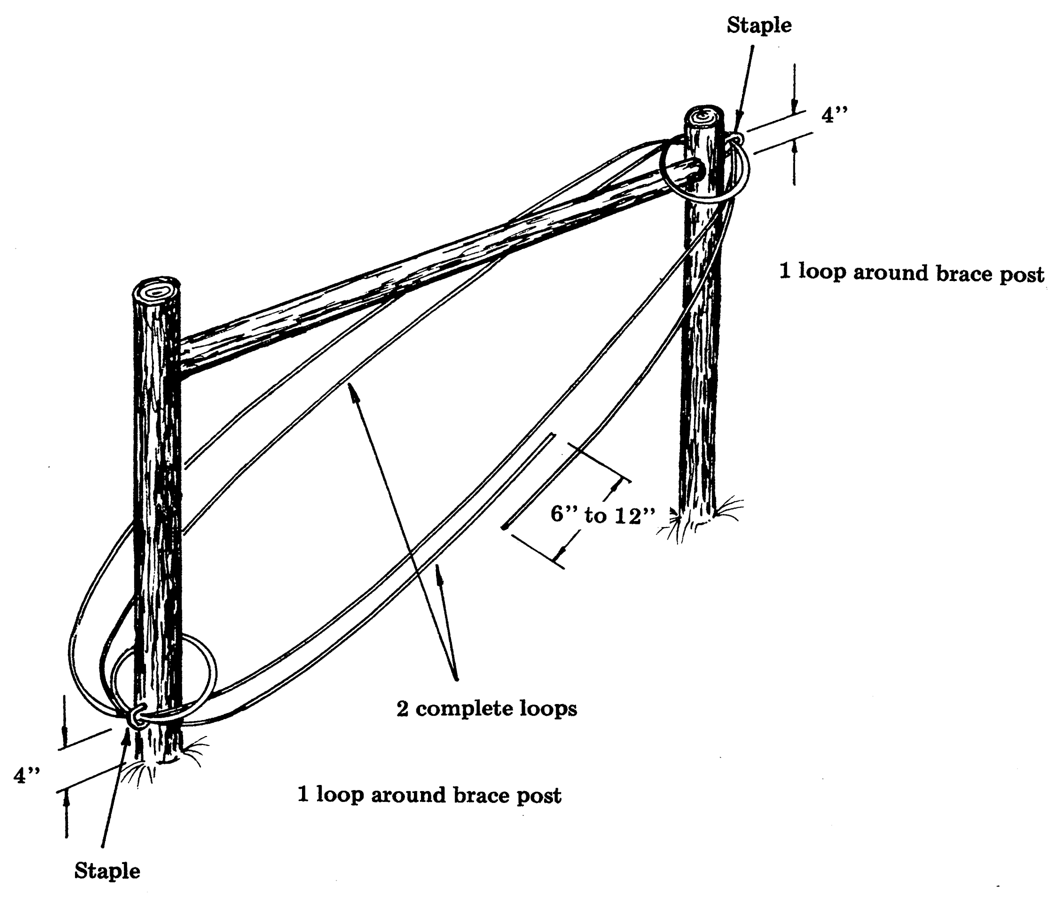
5. Wrap wire around anchor post and return toward brace post. Leave enough wire length so end extends about two-thirds of way back to brace post.

6. Cut brace wire from roll, allowing enough wire to wrap around brace post and extend 6 to 12 inches past other wire end.

7. Make splice.

8. Twist brace wire until whole assembly is rigid. Use a good strong stick, rod, or pipe approximately 18 to 24 inches long. As wire is tightened, tap with hammer where it wraps around post so it will fit smoothly and remain tight. Leave member used for twisting in place. Twisting stick should be attached in such a way that it will not unwind.

1-6



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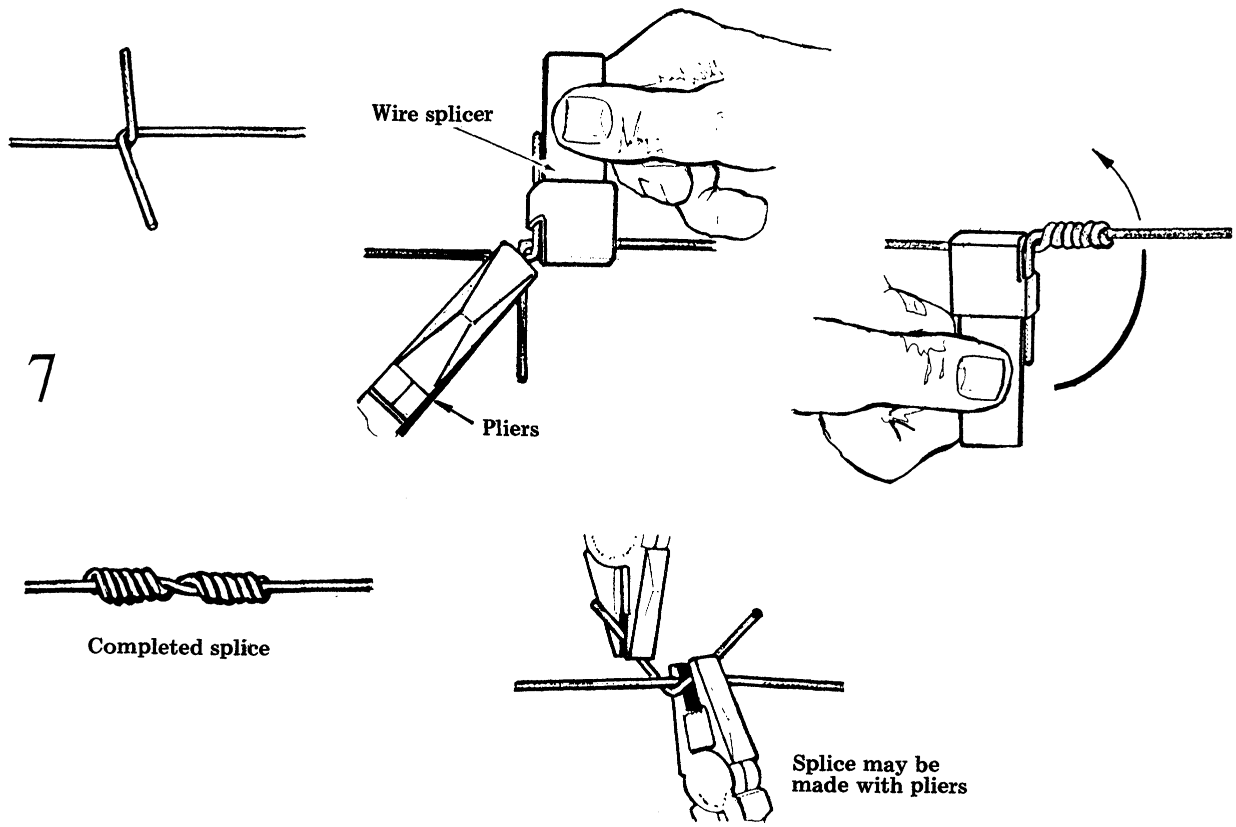
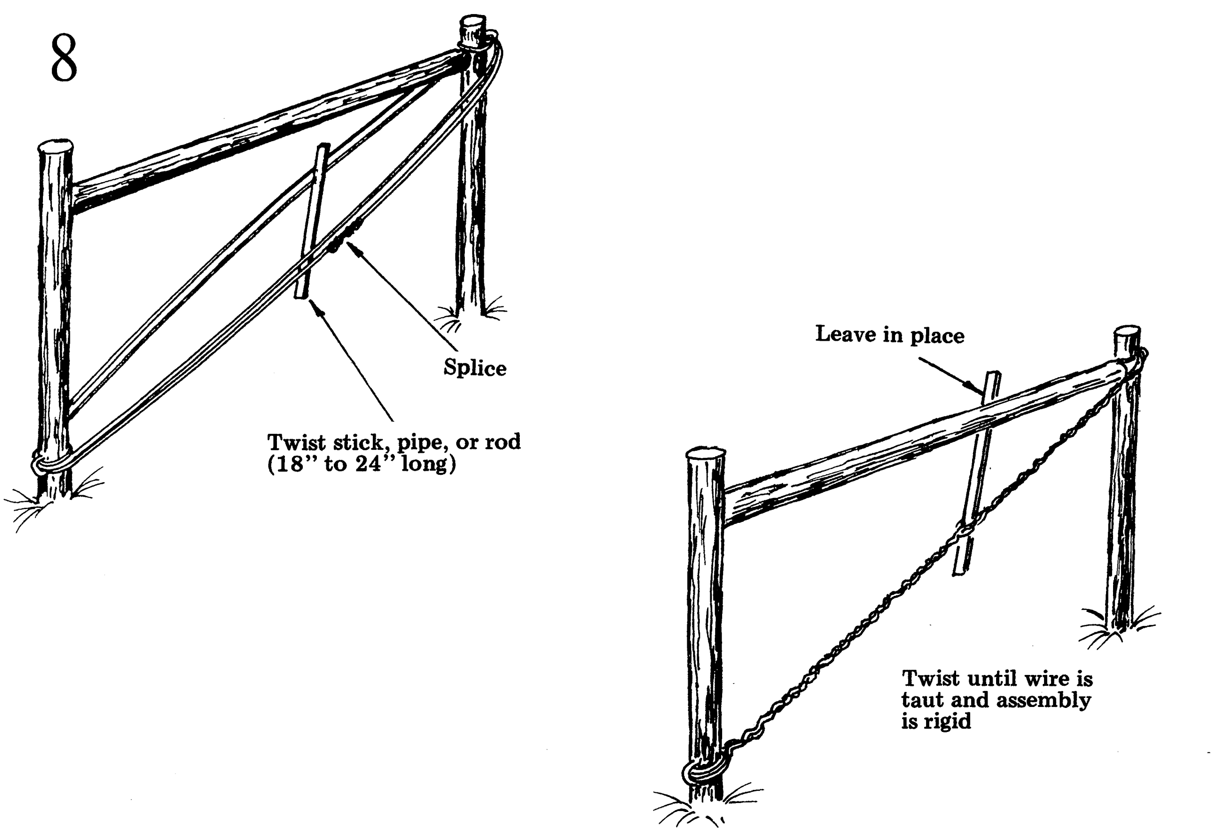

Wire splicer
Pliers
Completed splice
Splice may be made with pliers

8

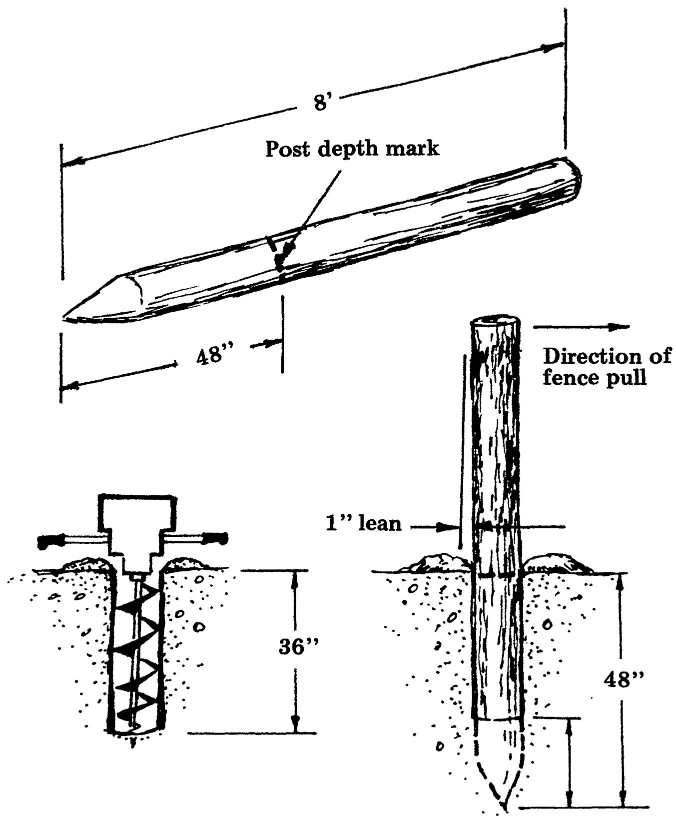

Splice
Twist stick, pipe, or rod (18" to 24" long)
Leave in place
Twist until wire is taut and assembly is rigid

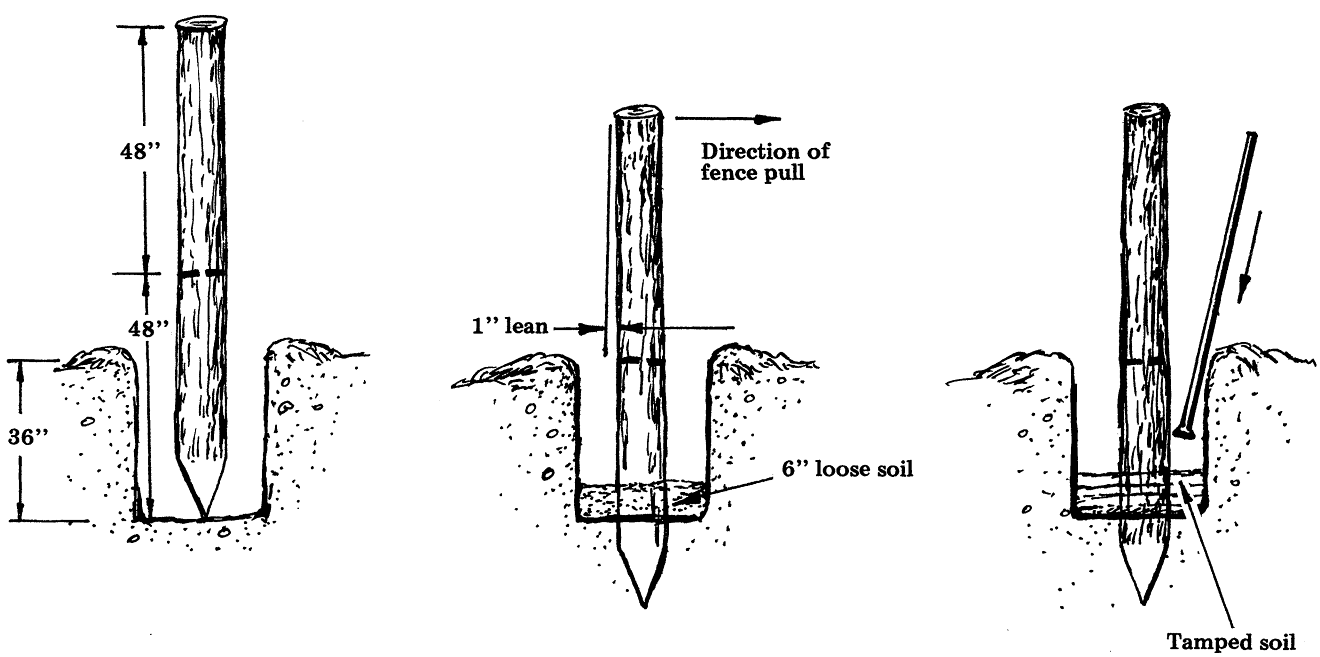
Wooden brace posts can also be set by:

First digging or augering a hole smaller or the same size as the corner, or gate, or first post of the line brace (for a 5-inch post, auger a 5-inch hole) to a depth 12 inches short of the recommended depth. Then, placing the anchor post in the hole and driving it to the correct depth (not less than 42 inches). Finally, installing the anchor post with a 1-inch lean away from the direction of fence pull.

If this method cannot be followed because the hole is larger than the post, then backfill 4 to 6 inches before tamping. Install the anchor post with a 1-inch lean away from the direction of fence pull.

Measure the distance needed for the horizontal brace (compression member) and mark the spot for the brace post. Make sure the posts are aligned with the fence line before setting the brace post. Follow the same procedure as with the corner, end, gate, or first post of a line brace (anchor post).



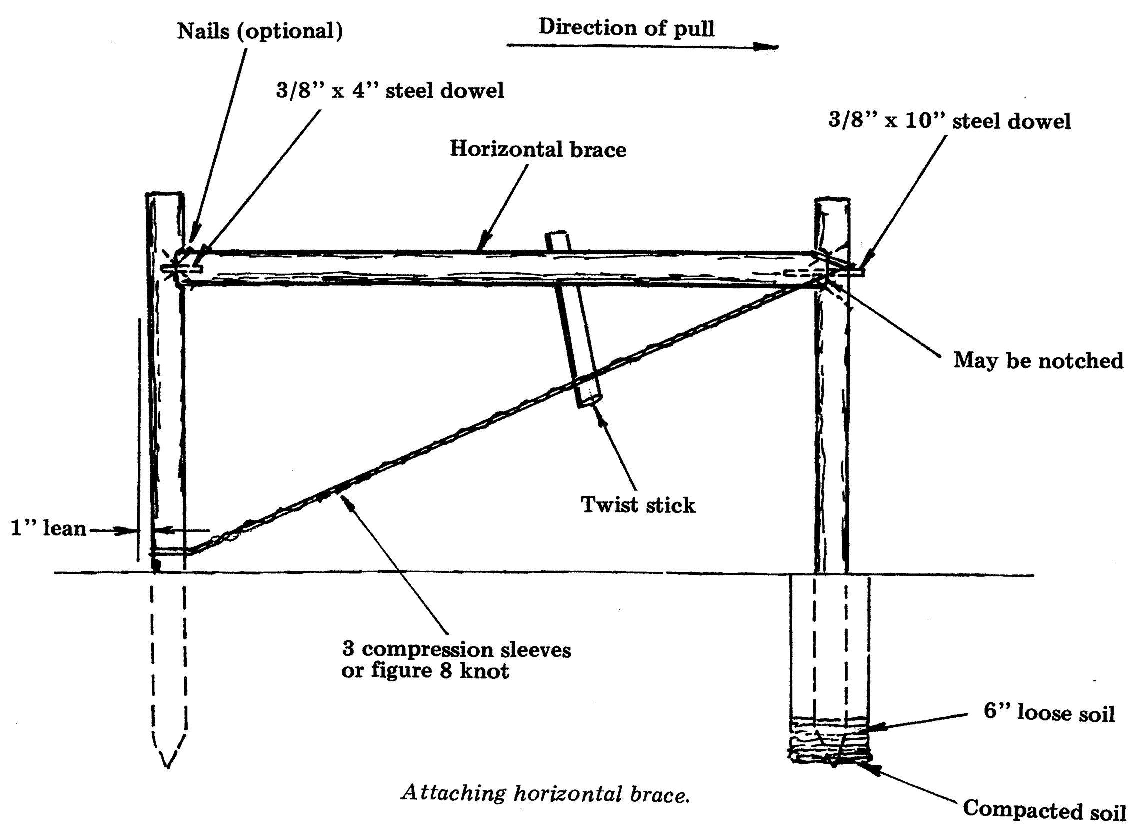


Setting wooden brace posts.

There are two methods for attaching the horizontal brace (compression member):

1. Drill a 3/8-inch hole 2 inches deep into the anchor post all the way through the brace post and into both ends of the horizontal brace. Drive a 4-inch long 3/8-inch steel dowel into the anchor post and a 10-inch long 3/8-inch steel dowel into the brace post until it is flush with the inside of the post. Drive the horizontal brace into the 2 inches of steel dowel sticking out of the anchor post. Now, while supporting the horizontal brace, drive the 10-inch steel dowel into the aligned hole of the brace pole. This will leave some of the steel dowel sticking out of the brace post to support the brace wire (tension member). Drive a 1-3/4 staple half its length into the outside of the anchor post 4 inches above the ground to hold the brace wire (tension members) down on this post. Place two wraps of No. 9 gauge wire or two wraps of No. 12½ gauge high tensile wire around these two points and tie off with a figure-eight knot or use three compression sleeves and crimp the two wire ends together. A wrap tie around the steel dowel will also work (see below). Be sure to remove as much slack as possible before tying off. Twist this wire to the desired tension with a stick and secure the stick so the wire will not unwind. The second brace rail for a double brace will be drilled and the steel pin used to hold the brace rail.

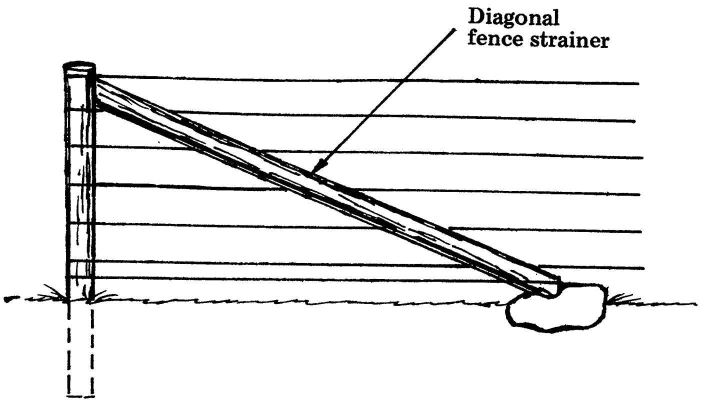
2. Notch out a hole on the inside of both posts by drilling holes and chiseling out with a wood chisel. Shape the ends of the horizontal brace (compression member) with an ax or saw if necessary. Set one side of the brace into the corner, end, or gate post (anchor post) and then bring the brace post up to the horizontal brace. Tamp around the brace post (a maximum 6-inch), then attach the brace wire (tension member) as described in method 1. It may be desirable to nail the horizontal brace to the posts.



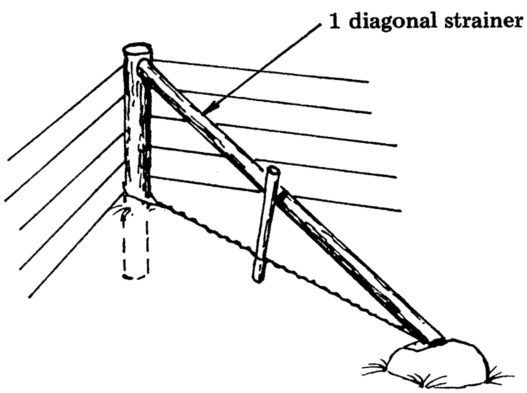
Attaching horizontal brace.

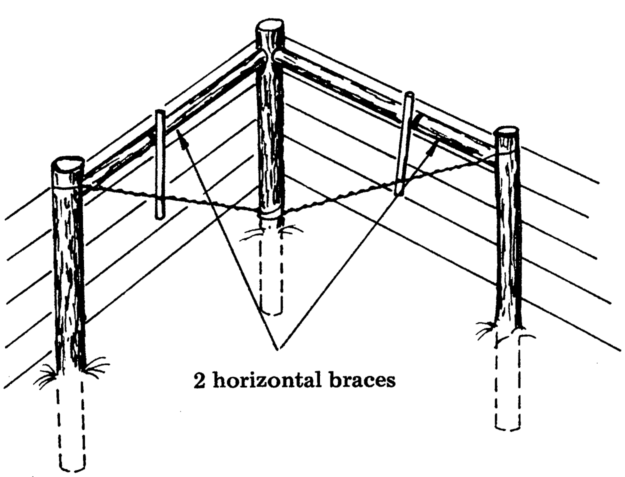
Diagonal Braces

A diagonal fence brace or strainer is structurally equal to the horizontal fence strainer. It requires one less post and only about half the labor to install.

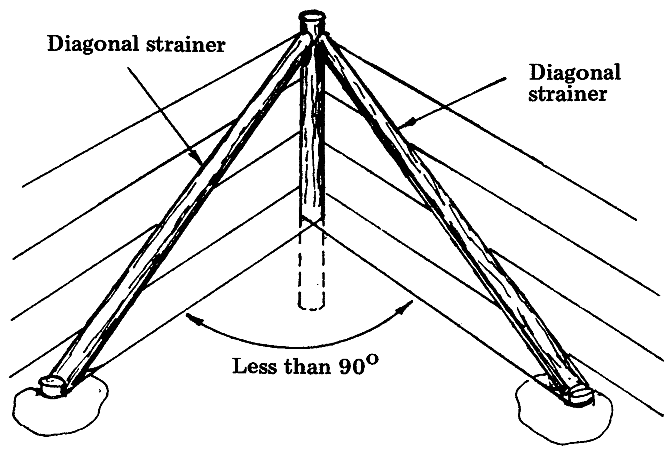


On a high tensile, smooth wire fence, one diagonal strainer can be used for a corner instead of two horizontal braces.





Bend the high tensile, smooth wire around the corner and tie it to the corner post. A single diagonal strainer works well for corners greater than 90°, but cattle can straddle the brace and calves can go under it. To avoid the problem, use two diagonal strainers running at the same angle as the fence. These diagonal strainers should be used on corners that are less than 90°.



To install a diagonal brace or strainer:

1. Make the brace as long as possible.

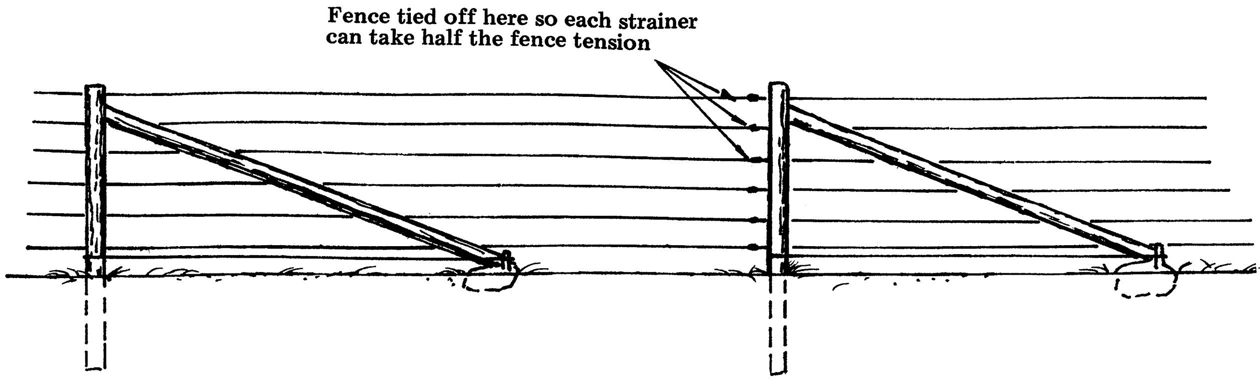
2. Be sure that the end of the diagonal brace that contacts the ground is free to move forward and that it is not blocked by a stake or post. A diagonal brace that bears against a stake or post reduces the ability of the strainer to resist pullout.

3. Although the diagonal brace can bear against the corner post from the middle of the post to the top of the post, it is best to have the contact at the top.

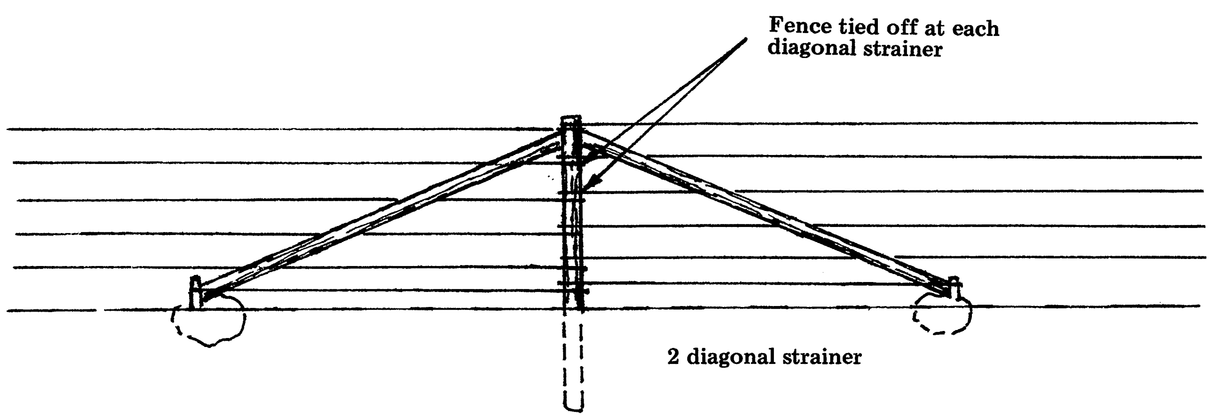
4. When installing a diagonal strainer, the corner post should be set first; then install the diagonal brace; then the bottom holding wire brace; and then attach the wires and set the tension. With this procedure, the lower wire brace will not have to be twisted tight.

5. The diameter of the corner post should be as large as possible.

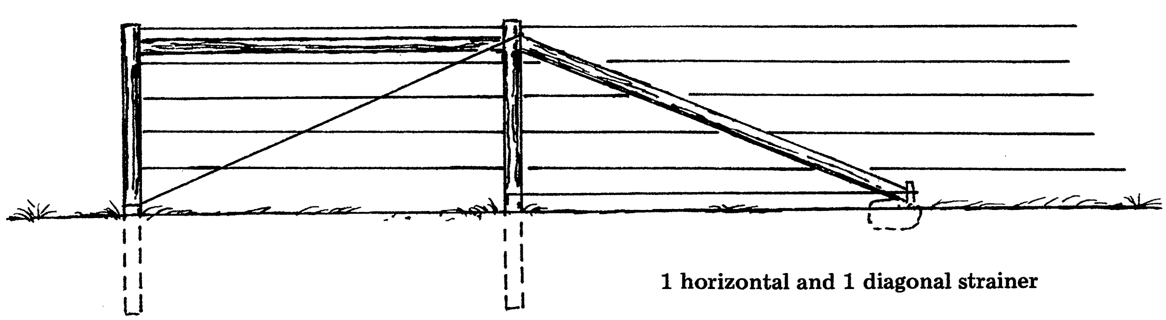
6. If one diagonal strainer will not hold the fence tension, a second diagonal strainer should be installed with each strainer taking half the tension of the fence.



Use two diagonal strainers to hold soft soil. One horizontal and one diagonal strainer can also be used. Each of the diagonal strainers takes half of the tension in the fence; therefore, the fence must be tied off at each diagonal strainer. When using the diagonal strainer as a line brace, do not over-tension the brace wires or the vertical post can be jacked out of the ground. However, high tensile, smooth wire eliminates the need for line braces.



2 diagonal strainer

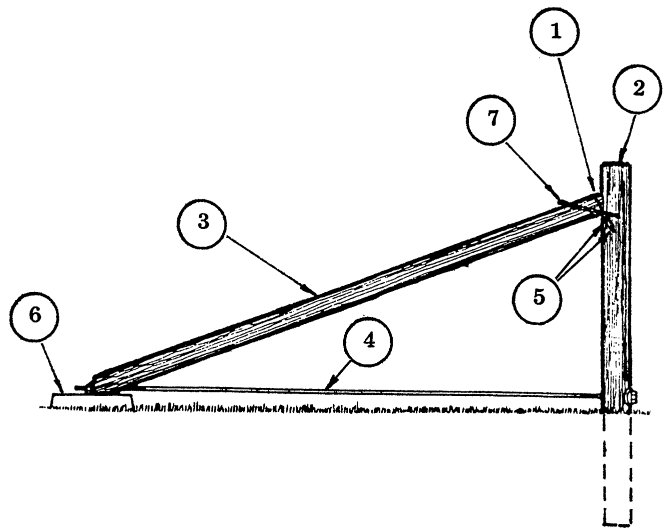


1 horizontal and 1 diagonal strainer

The *Kiwi Diagonal Brace* requires less material and less construction time than a standard double brace while providing equal strength. Kiwi has developed construction techniques and high quality materials for this brace that are particularly well suited for high tensile fencing.

Components for building the Kiwi Brace are:

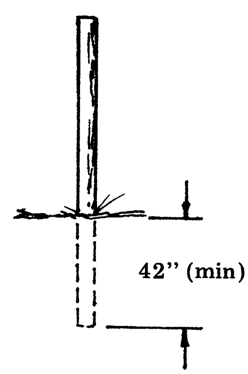
1. one 24-inch piece max-ten 200 high tensile wire
2. one 6-inch x 8 foot pressure treated end (or corner) post
3. one 4-inch x 10-foot pressure treated diagonal post
4. one Kiwi galvanized brace rod ½-inch x 10 feet x 6 inches
5. four 2-inch hot dipped galvanized staples
6. one Kiwi reinforced concrete brace block 4 inches x 12 inches x 20 inches
7. one 3/8-inch x 10-inch galvanized brace pin



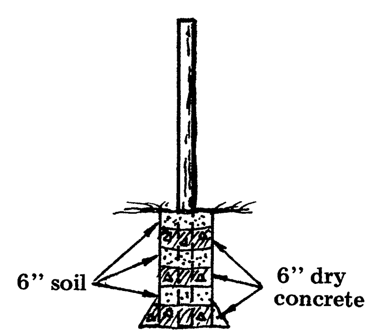
Kiwi diagonal with a float foot.

To construct the Kiwi brace:

1. Drive 6-inch x 8-foot post, small end first, at least 42 inches into soil; or, set by hand, bit end first. Tamp soil tightly around post in 6-inch layers or use alternating 6-inch layers of dry concrete mix and soil. Soil moisture will set the concrete.

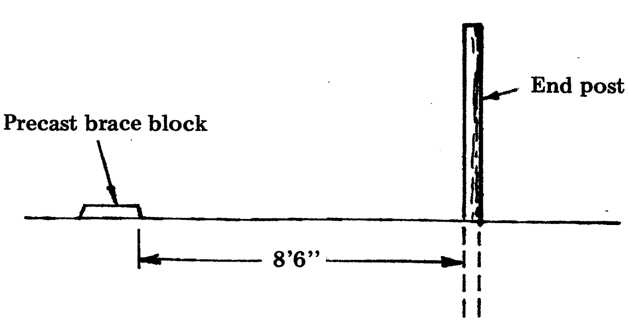


Driven post

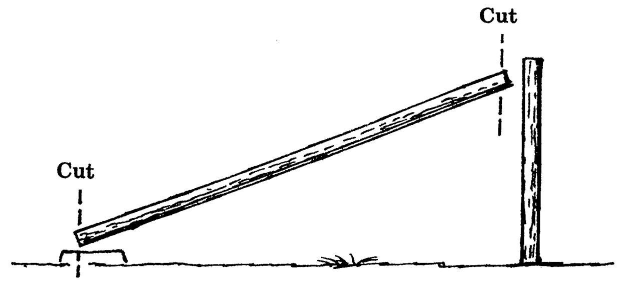


Hand set post with bell bottom

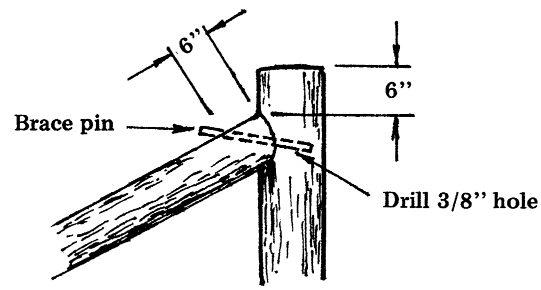
2. Place precast brace block approximately 8 feet, 6 inches from end post.



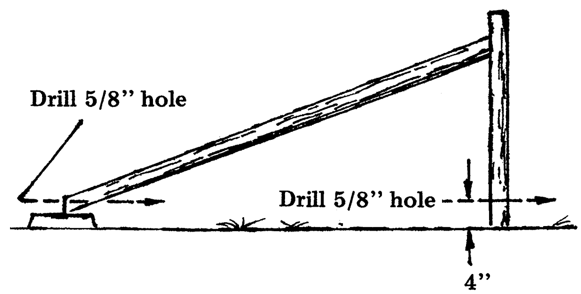
3. Hold 5-inch x 10-foot diagonal post in place and mark proper angles for cutting; then cut the appropriate amount from the diagonal post.



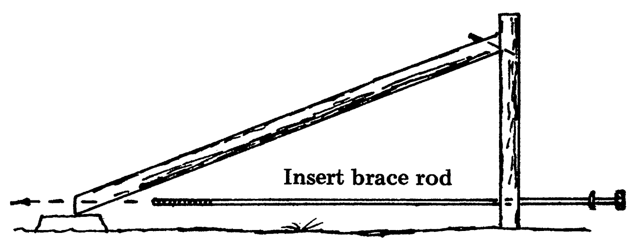
4. Holding the cut 5-inch diagonal post between two top wire spacings, drill a 3/8-inch hole at a shallow angle (approximately 15°) through the diagonal post, and into the 6-inch end post; then drive the 10-inch brace pin into the hole.



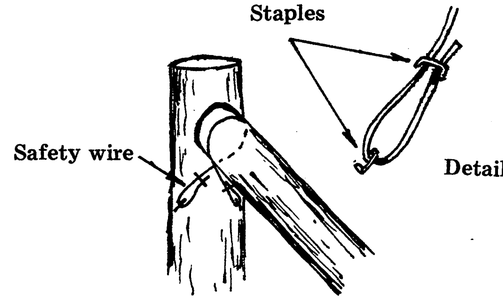
5. Drill a 5/8-inch hole through the 6-inch end post about 4 inches up from ground level. Also drill through the 4-inch diagonal post in the brace block end. These holes should be drilled parallel to the ground and facing each other in line with the fence.



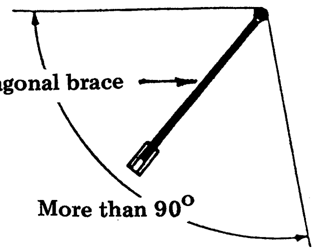
6. Install brace rod (remove the nut and flat washer), leaving the curved washer in place. Start the rod into the previously drilled hole; drive it toward the block and insert into the bottom hole drilled into the diagonal post. Replace the washer and the nut and tighten the brace rod until the nut is snug against the diagonal post (approximately 40 feet/pounds of torque).



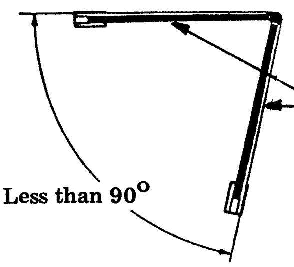
7. Install the safety wire by stapling one end of the wire to the end post just below and to the side of the diagonal post; then staple again. Take the wire under, over, and underneath the diagonal post. Pull the wire tight and double staple the wire to the opposite outer edge of the end post.



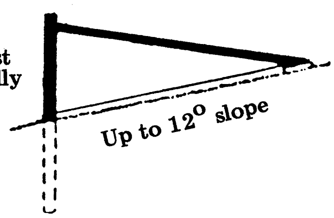
For corner angles 90° or more, use single diagonal brace.



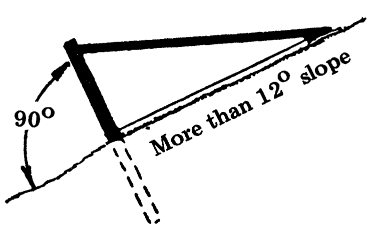
For corner angles less than 90°, use two diagonal braces.

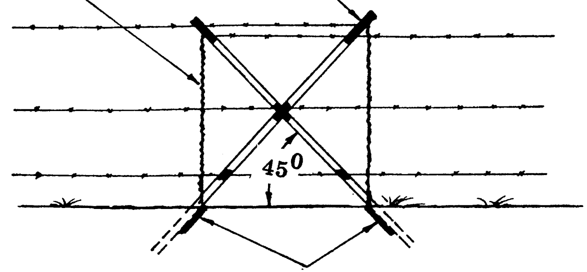


For 12° slope or less, set end post vertically.

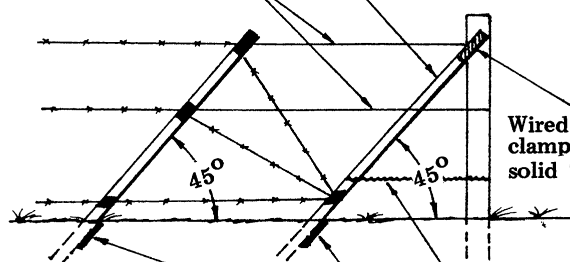


For more than 12° slope, set end post at right angle to terrain.



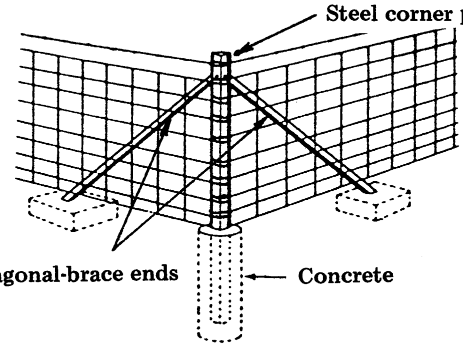


Steel stretch panel.

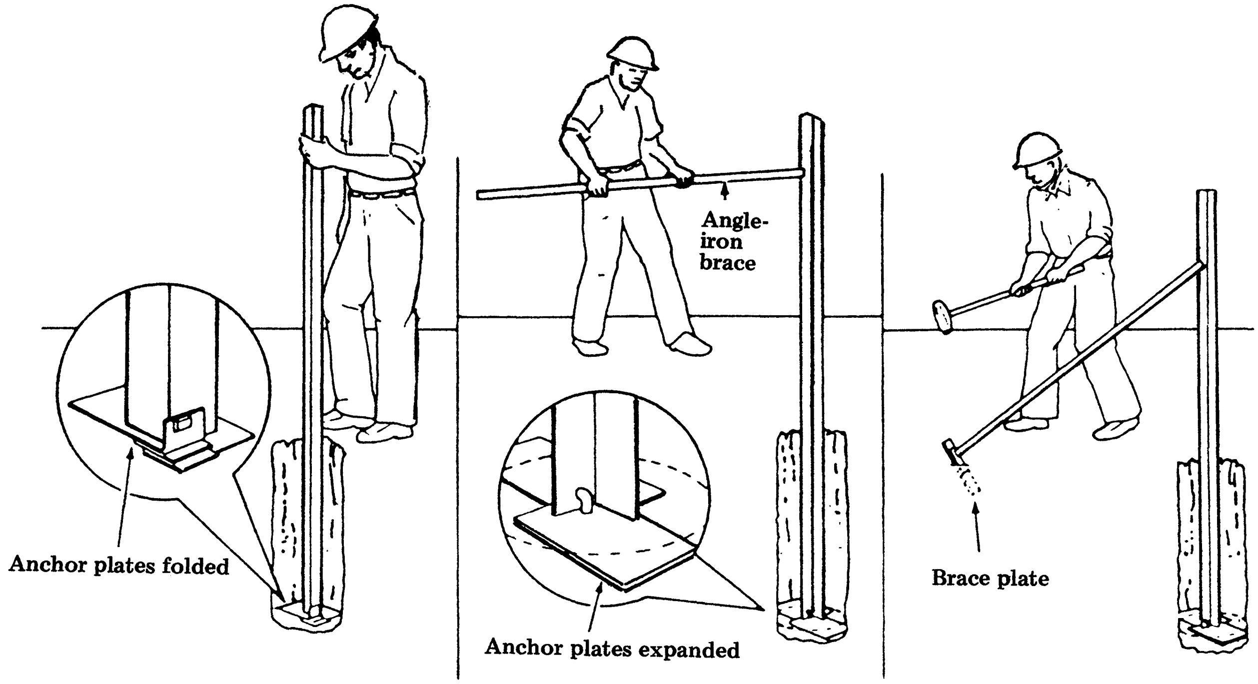


Steel corner, angle, or gate panel.

Steel diagonal-brace ends and corners have been used satisfactorily by setting the end or corner post in concrete and placing the diagonal braces in concrete. However, mixing the concrete and waiting for the concrete to cure add time and effort to the operation.



A steel *dirt-set diagonal-brace* end and corner has been found to withstand normal fence tension. It is simple, relatively easy to install, about half the cost of the steel horizontal-brace assembly, and it can be installed with a post driver.



To install commercial fence brace panels, follow these procedures:

1. Drive post No. 1. Post should be 7 feet long at least.

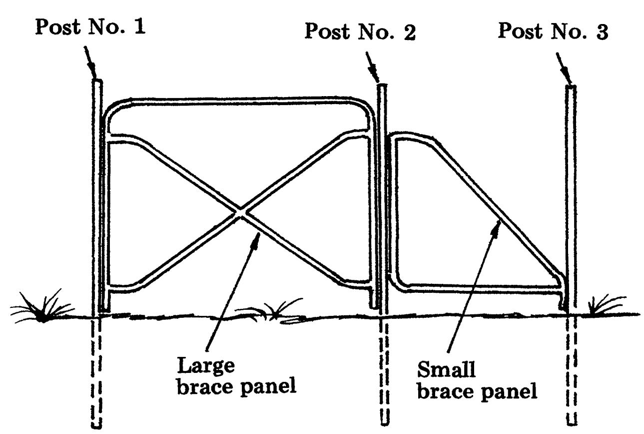
2. Clamp large brace panel to the post.

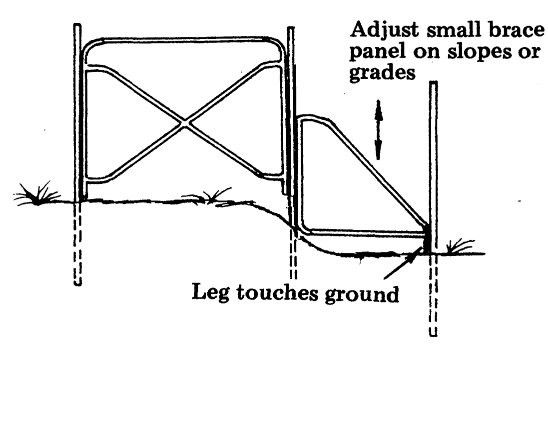
3. Drive Post No. 2. As the post is driven, angle it slightly for post hole driver to clear the brace panel. Be sure to keep the post tight against the brace panel.

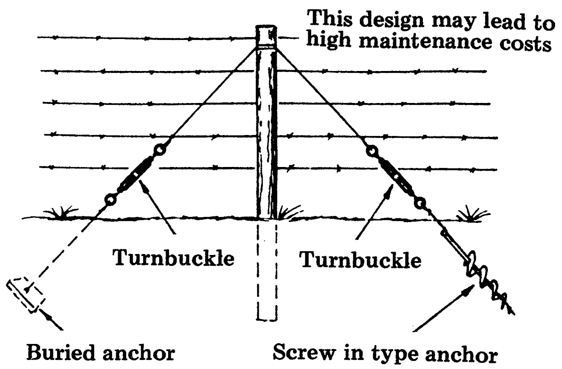
4. After driving Post No. 2., hold it tightly against the top of large brace panel. At the same time, secure both large and small brace panel at the top of the post with a clamp. Next, secure box brace panels at the bottom of the post. If rocky soil prevents post from fitting tightly against brace panel, use spacers (available at your dealer) between post and brace panel to insure a tight fit.

5. Drive Post No. 3 and secure small brace panel to it.

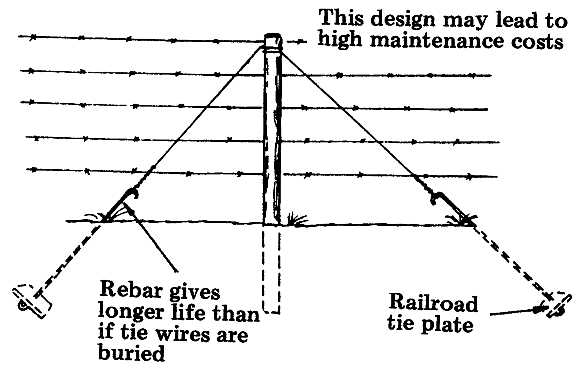
6. On slopes or grades, adjust the brace up or down to be sure that the leg is touching the ground.



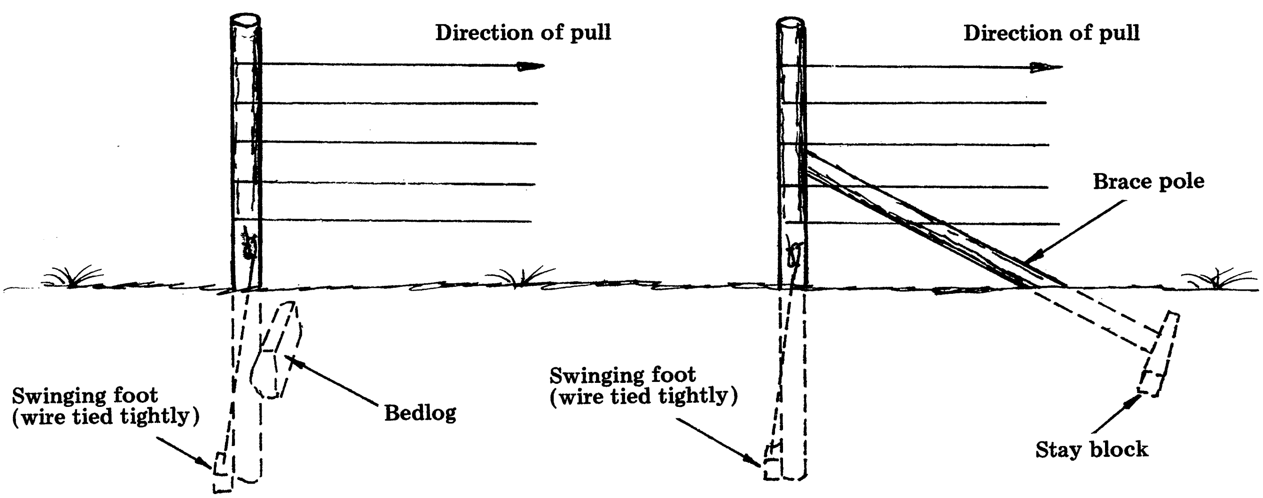


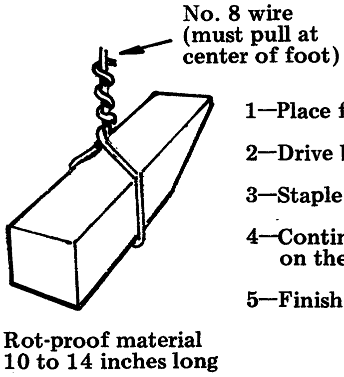


Low-cost tension member line brace to replace standard line brace.



Low-cost tension member line strainer using earth anchors for replacement of a standard line strainer.





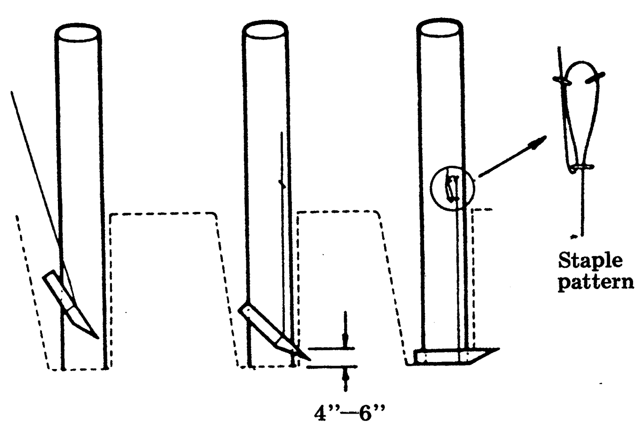
1—Place foot in by hand

2—Drive back of foot with hammer

3—Staple with one staple

4—Continue driving foot until it is flat on the bottom of the hole

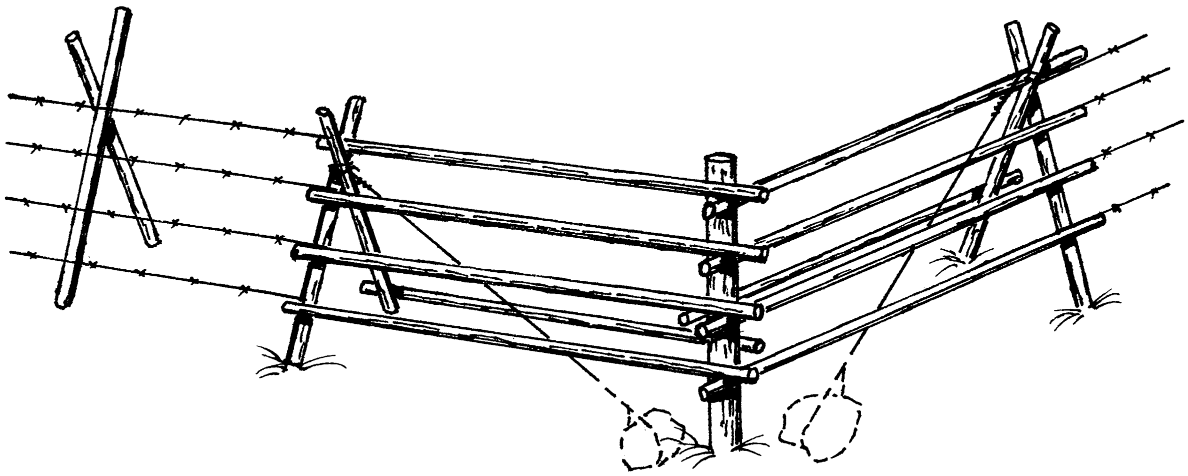
5—Finish stapling (3 staples)



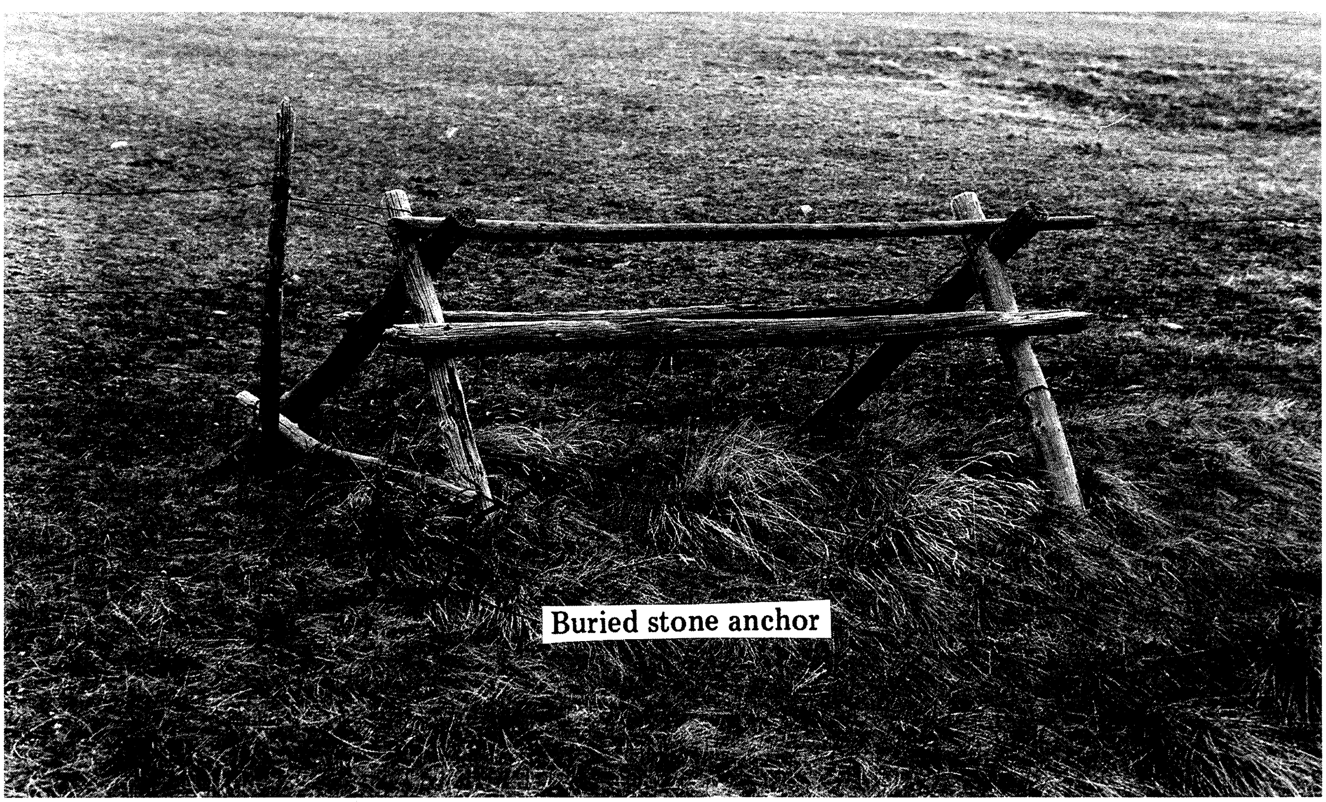
The New Zealand brace primarily used for electric fences.

Straddle Jack Braces

Straddle jack braces are used in terrain where it is difficult to dig or drive posts. Straddle jack braces are very stable.

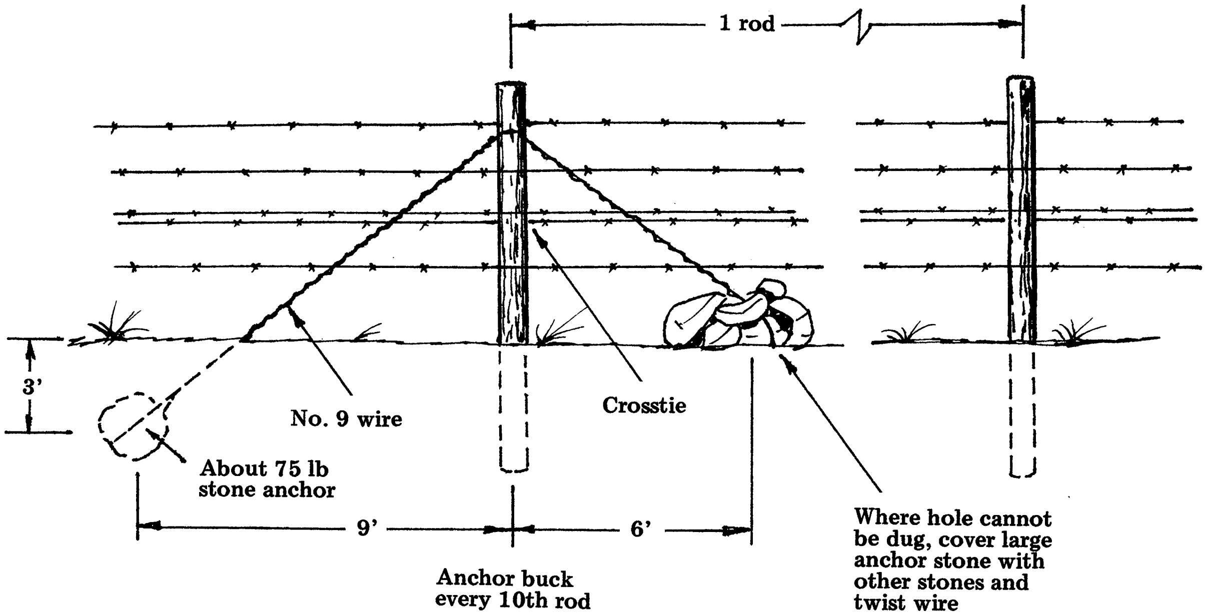


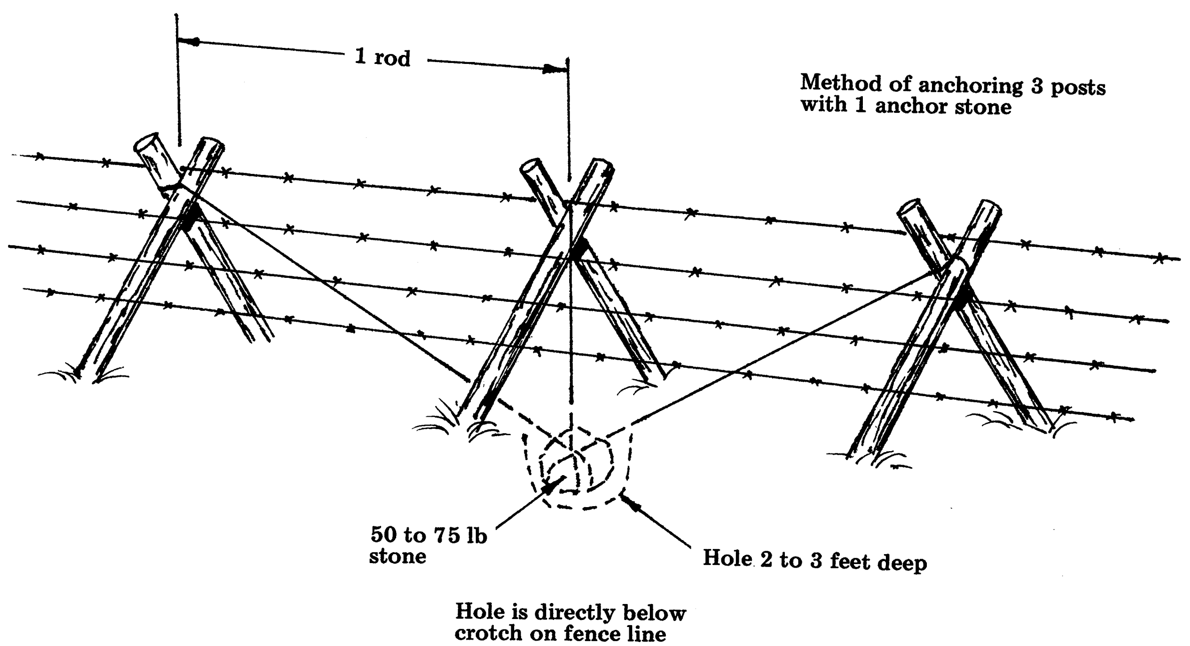
Corner brace foot straddle jack fence.



End brace or gate brace for straddle jack fence.

TWO METHODS OF ANCHORING FENCE BUCK:

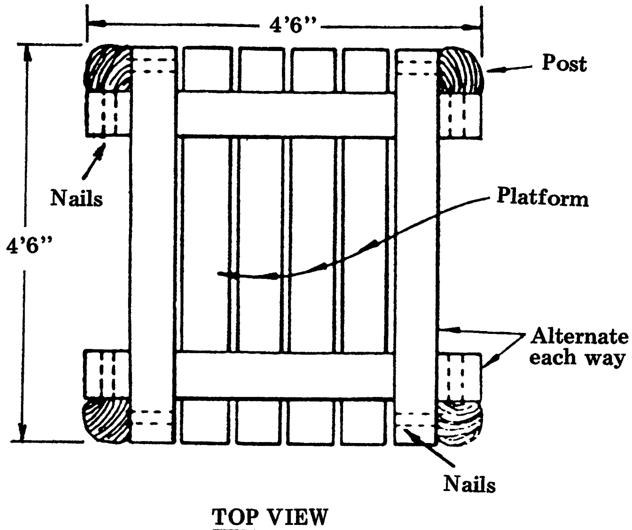


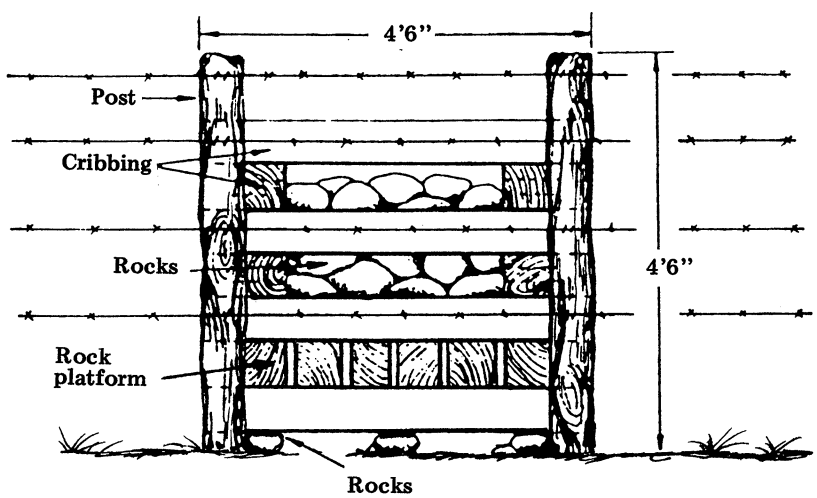


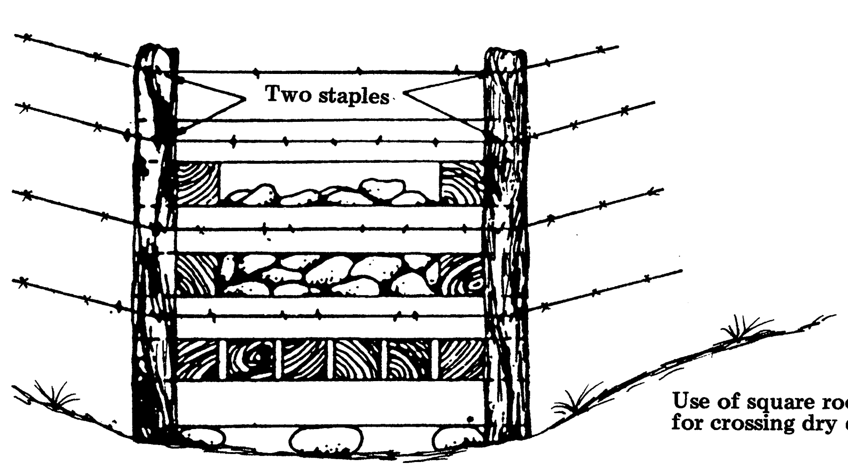
This design may lead to high maintenance. Buried wires are susceptible to rust

Square Rock Cribs

Square Rock Cribs may be used for fence corners, fence ends, or at gates where rock jack-post and figure-four fences are constructed. Or, they may be used to hold fence lines in place. They are stable and are constructed where it is difficult to dig or drive posts.

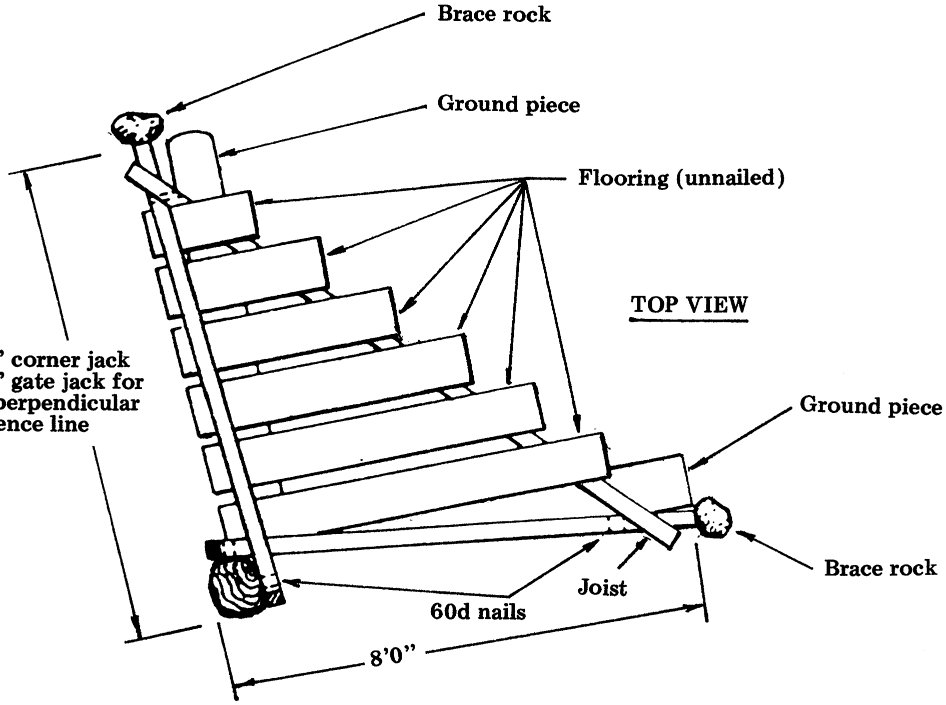


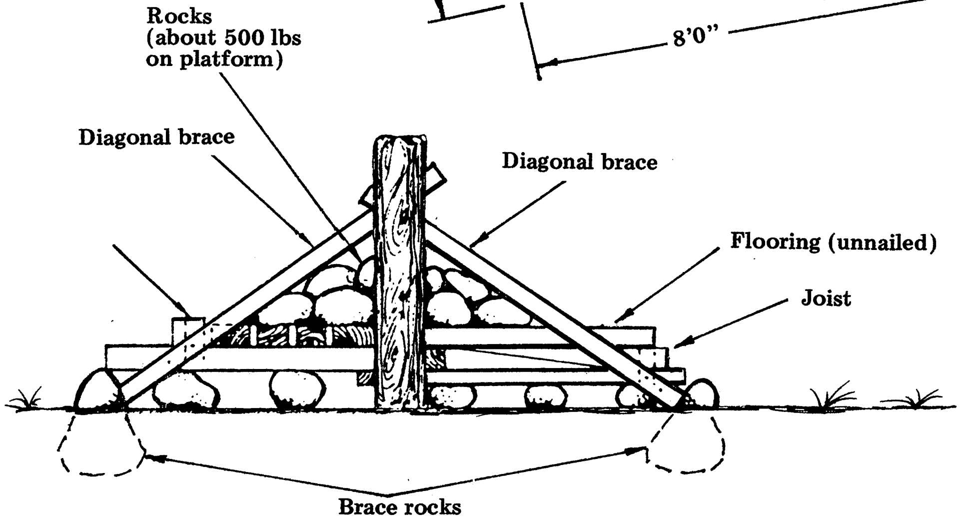




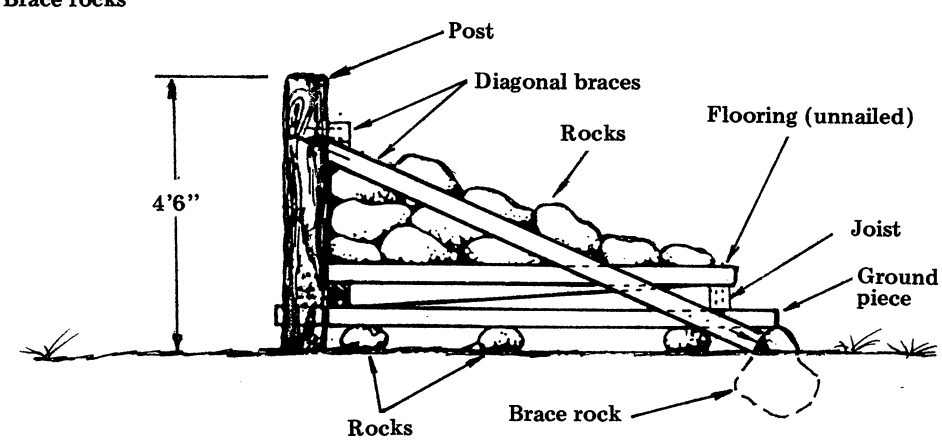
Use of square rock crib for crossing dry draws

The corner gate jack is an alternative to a rock crib brace. At gates and fence ends, the leg perpendicular to the fence should be shortened to about 5 feet.





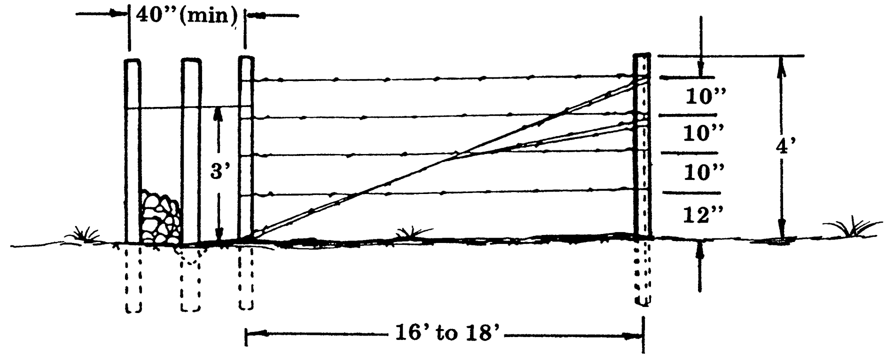
CORNER VIEW

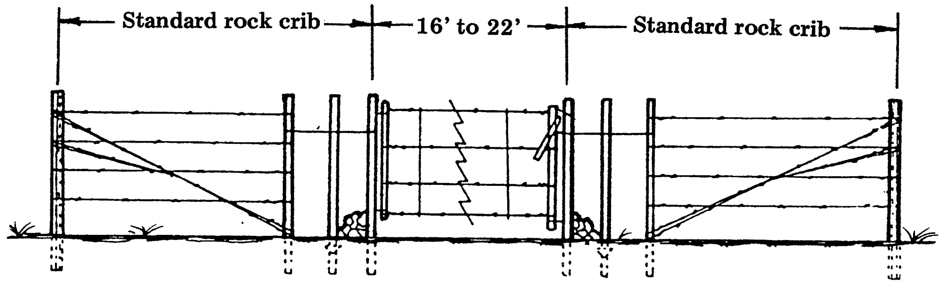


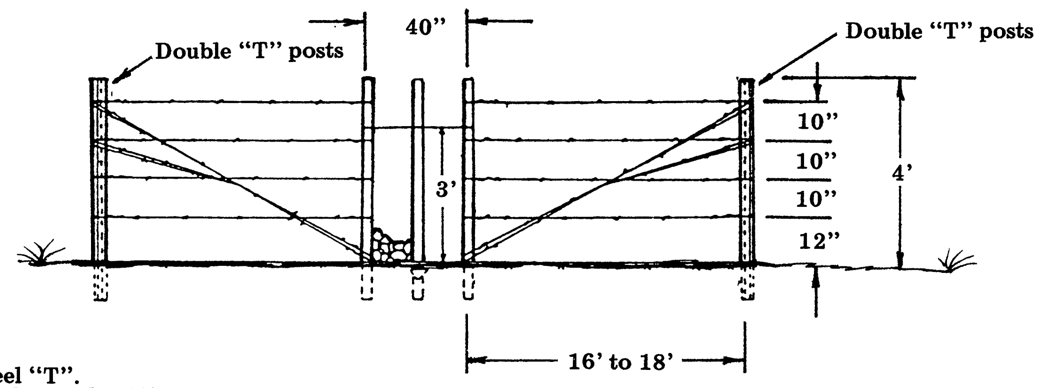
SIDE VIEW

Rock Jacks

Rock Jacks are constructed where it is difficult to dig or drive posts. They are stable and can be constructed at corners, fence ends, gates, or in-line. They are constructed as follows:







Notes: Posts are 5½" steel "T".
Diagonal braces: 2 strands 12½ gauge barbed wire.
All wires to be double wrapped around posts

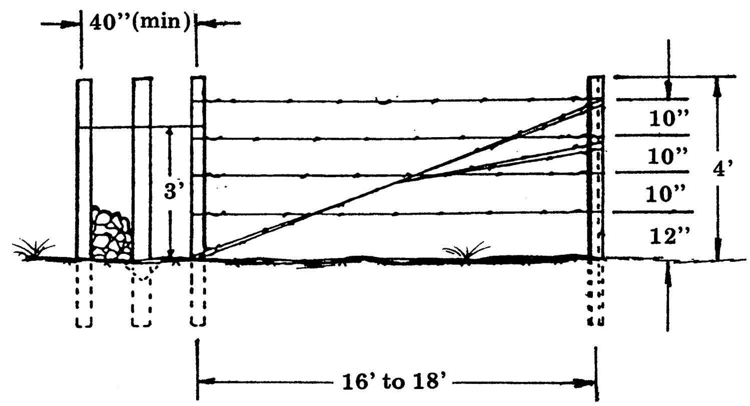
1—Construct crib and set double "T" post.

2—Allow 12" to 18" overlap No. 1348 nonclimbable wire 3' high (tie crib wire to 4 posts at top, center, and bottom.

3—Stretch and tighten brace wires between crib and double "T" post (twist top 2 brace wires together).

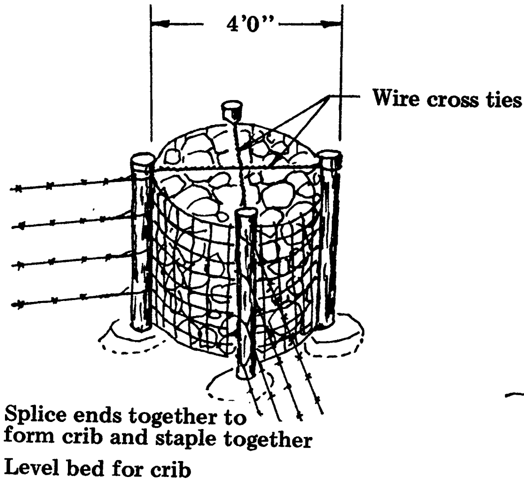
4—Fill crib with rocks less than 20" dia., max. void 6" largest measurement.

5—Stretch line wires to double steel posts.

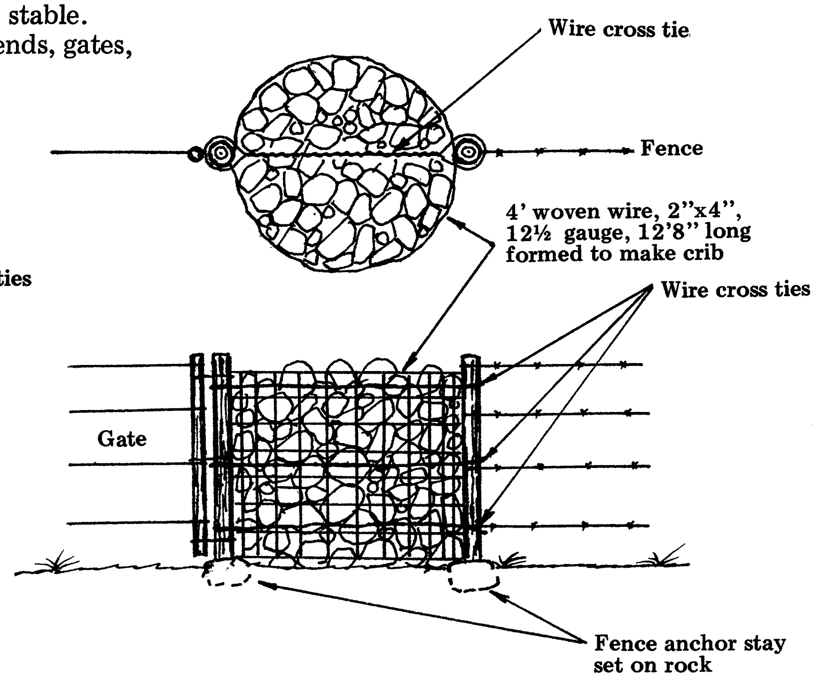


Wire Fence Cribs

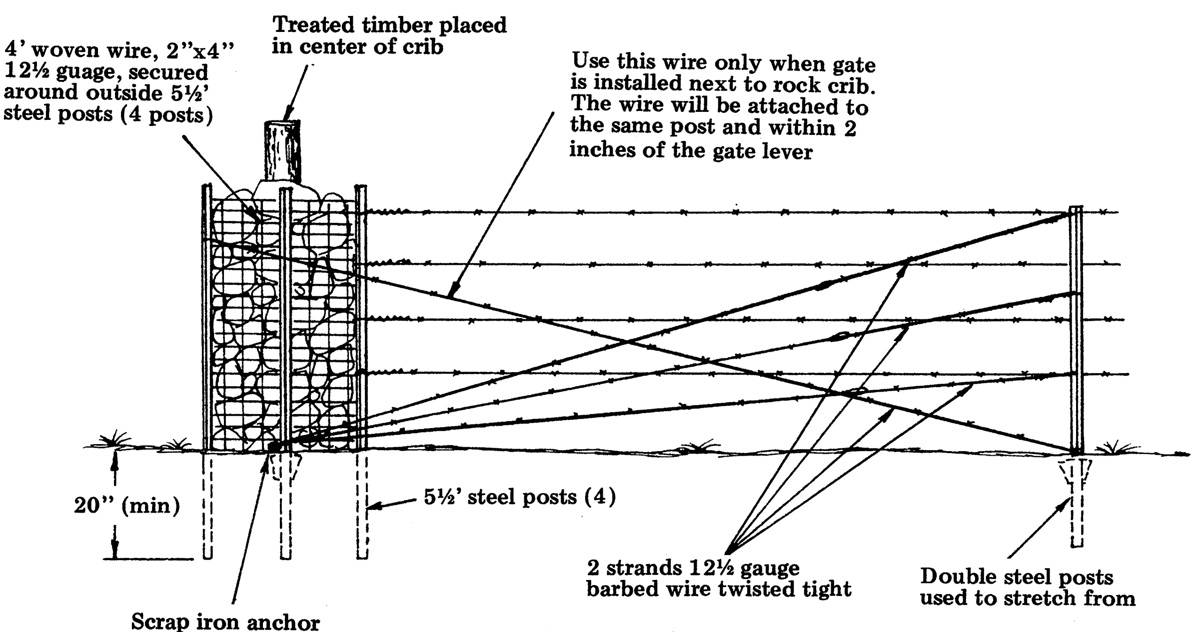
Wire Fence Cribs are used where it is difficult to dig or drive posts. Wire fence cribs are stable. They are constructed at corners, fence ends, gates, or in-line.



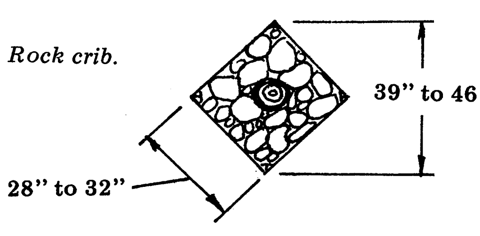
Rock crib corner post



Rock crib gate post



Rock crib.

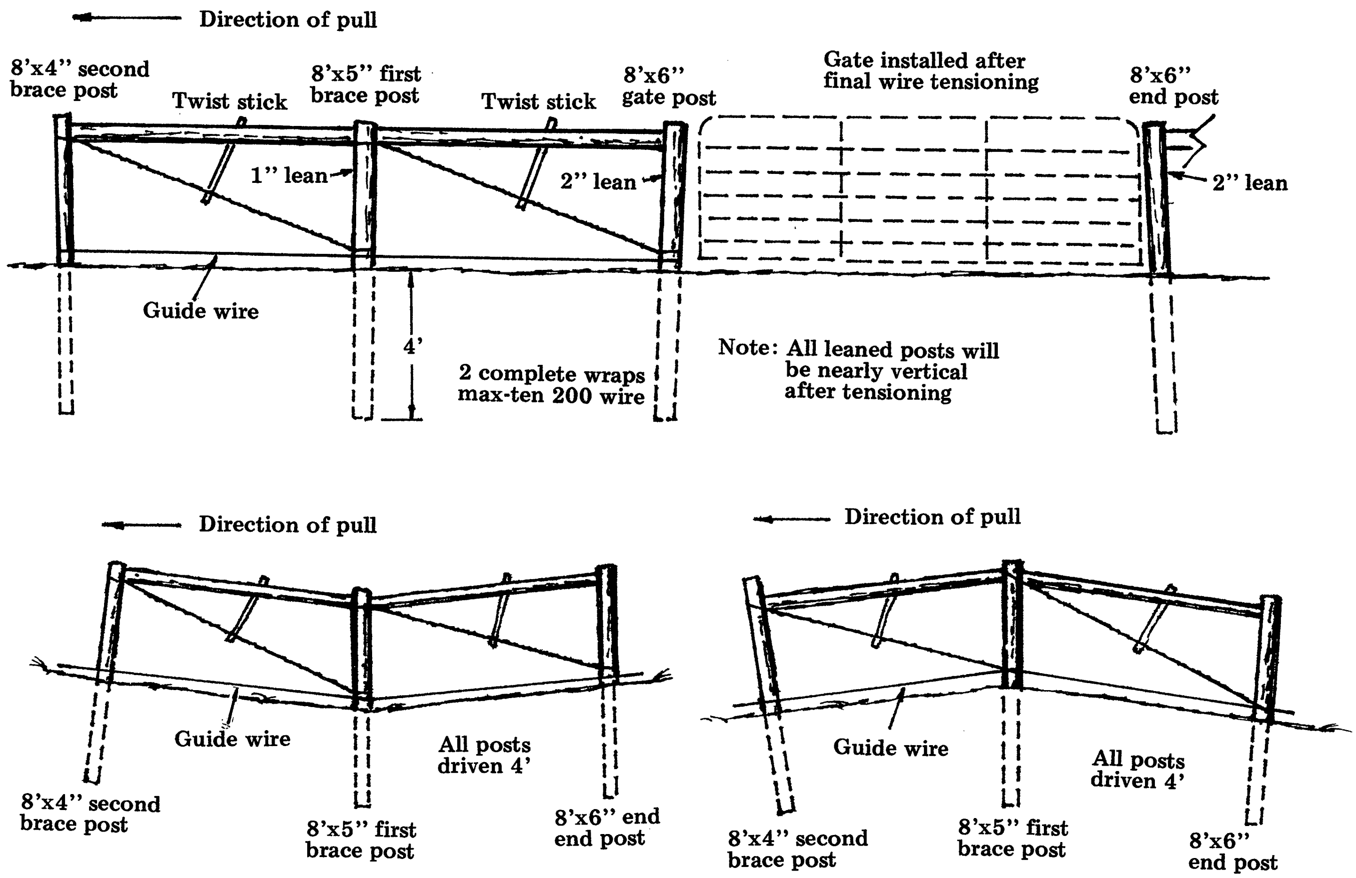


No rock spaces larger than 6" in crib.

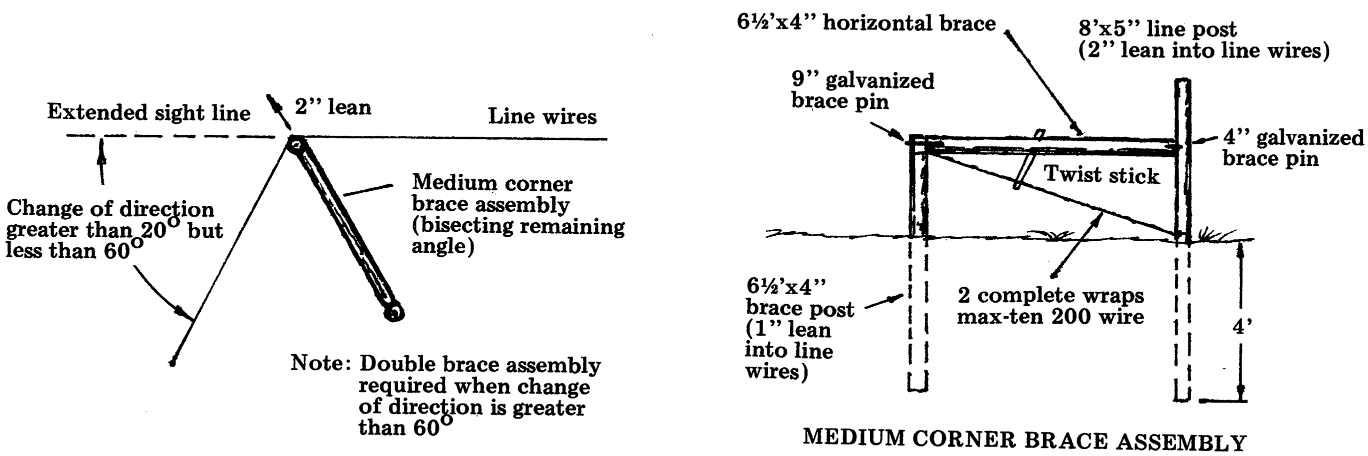
The woven wire ends will have 12" overlap and be wired to itself, using the ends of each longitudinal wire to make a splice with at least 4 turns. The wire shall be attached to each post in the crib at the top and bottom wires and at a minimum of 2 intermediate horizontal wires.

Corners And Gate Posts

Corner and Gate Post Braces are perhaps the most important component of high tensile wire fences. These braces must be sturdy and durable. Procedures for construction of various fence designs follow:

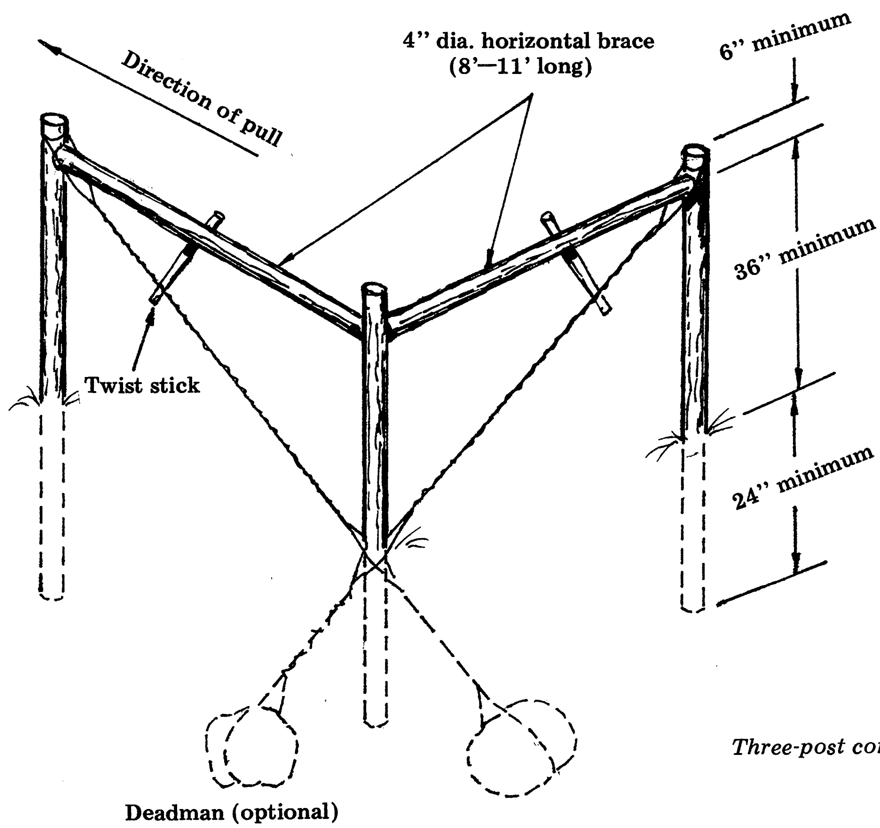


Brace construction for high tensile fences of seven or more wires.

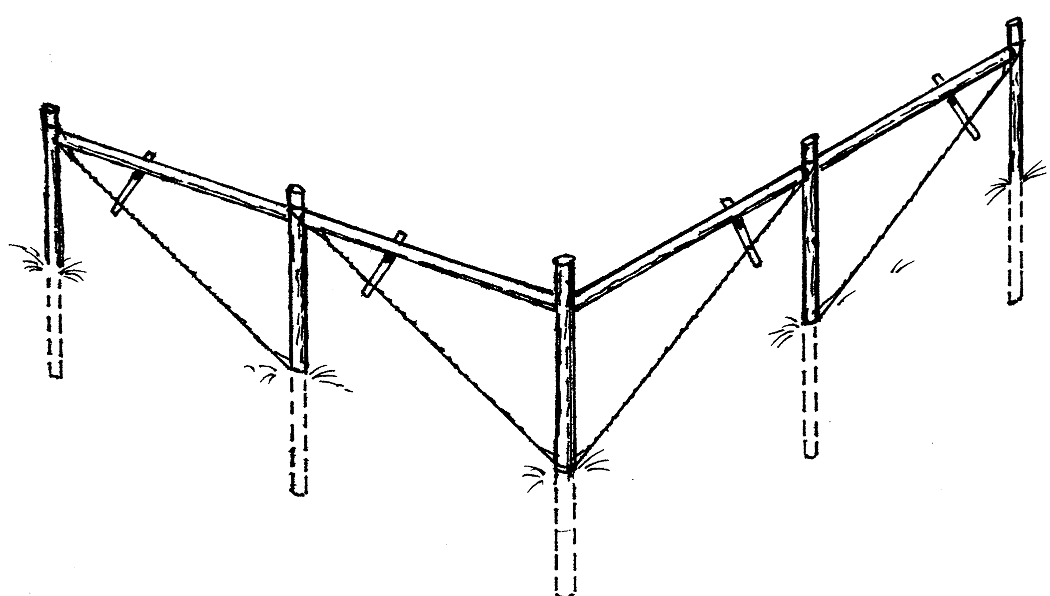


Corner brace construction for high tensile fences of seven or more wires.

Corner braces with deadman in line with each fence line reduces the required depth of end post embedment and provides needed stability in loose soils. The use of stainless steel wire eliminates rusting.

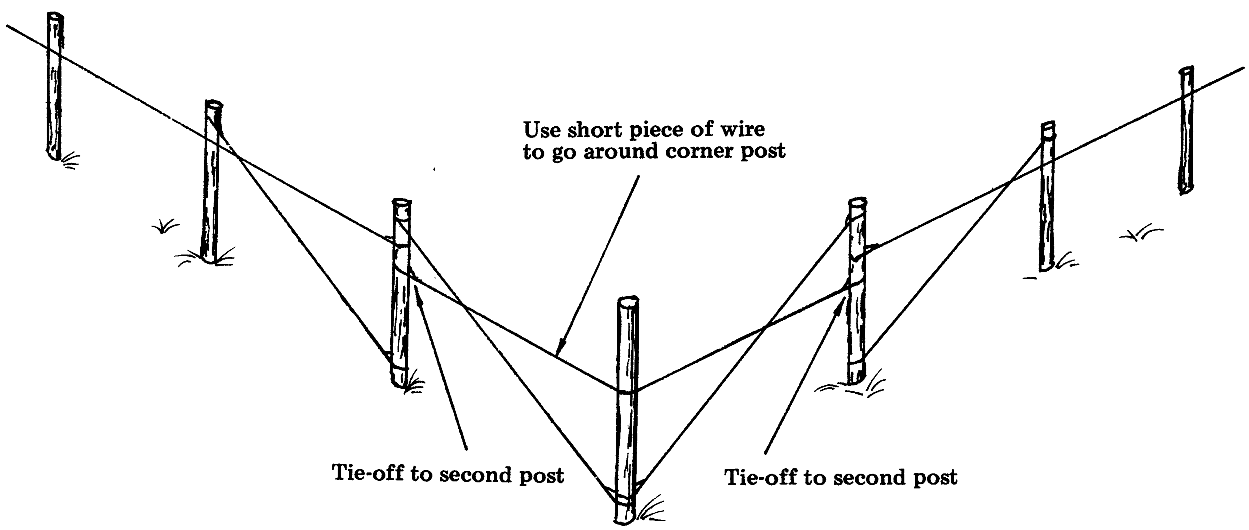


Three-post corner brace.



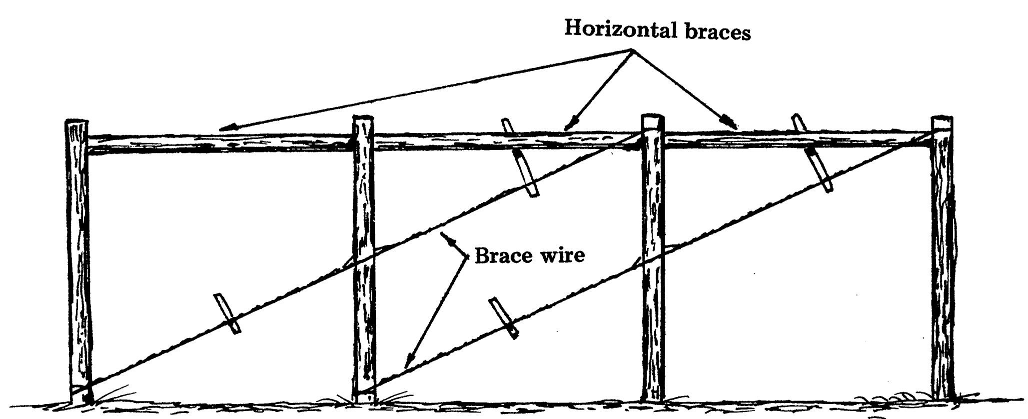
Five-post corner brace.

An alternative to the corner post tie is the tie-off to the second post of a double corner panel brace. This tie-off will insure that even if the corner post fails, neither fence line will fail. It also eliminates force on the corner post.

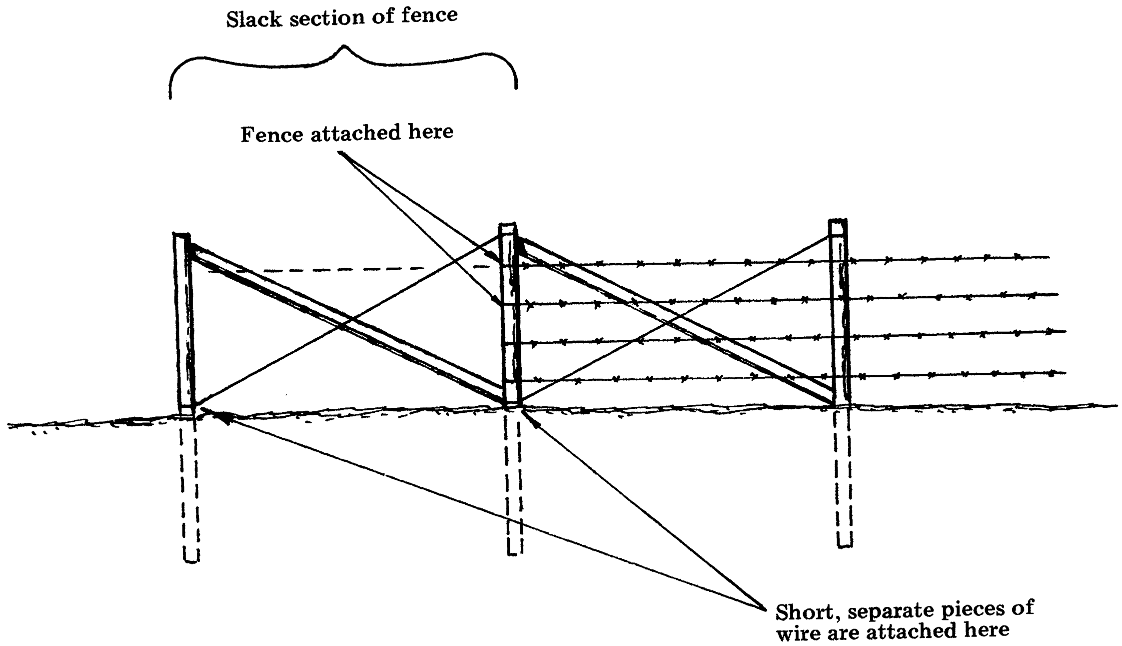


If you need extra strength in your end or corner, there are two other effective horizontal-brace designs. They do require more labor and more material:

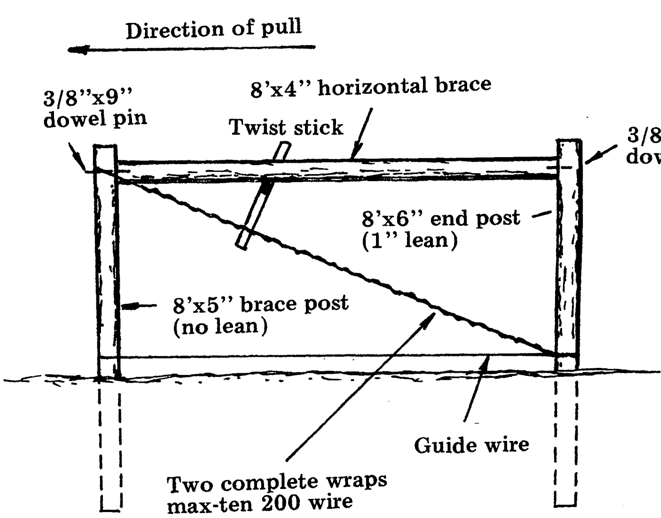
1. The *Rosemount design* has a two- or three-panel construction. The brace wires extend their pulling action over two panels at a time instead of one, which decreases the tendency of the end post to lift. The Rosemount horizontal brace is particularly valuable where snow collects against the fence or where wind loads the fence with leaves and grass.

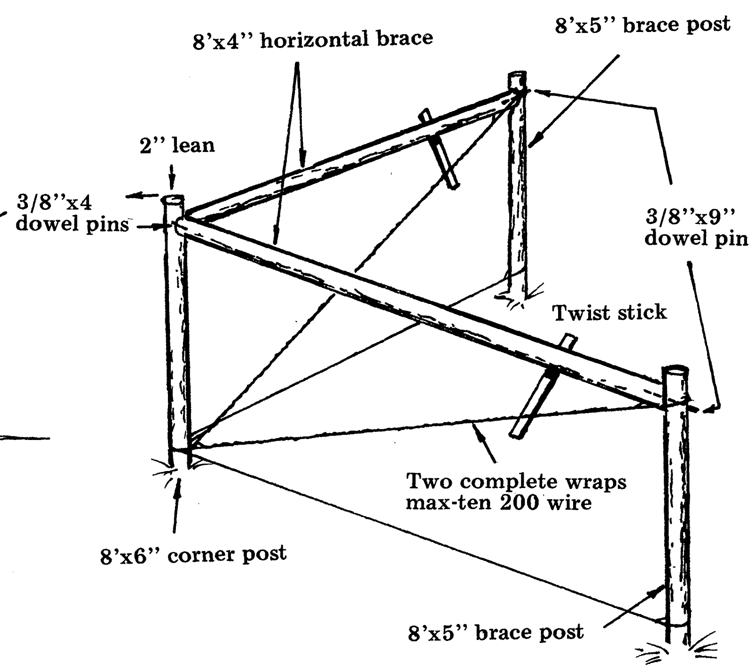


2. The *cross-brace, double-span assembly* is another heavy-duty design. The fence is attached to the center post. The fence will be slack between the middle and the end post.



High tensile wire fences with up to six wires require single-span brace assemblies at the beginning, end, and gate post locations, as well as at 90° corners.





Constructing End, Corner, And Gate Braces

1. Having driven the end posts with a 2-inch lean opposite the direction of the wires' pull (and after you have strung and tensioned the guide wire), lay an 8-foot long by 4-inch diameter brace on the ground parallel to the guide wire and butt it against the end post to measure the location for driving the first brace post. Holding the guide wire out of the way, auger a 3-foot deep 3-inch diameter hole with a 1-inch lean opposite the direction of pull.

2. Drive the first brace post (8-foot long by 4-inch diameter) 4 feet deep. Leave 4 feet above ground. When the guide wire is released, it should touch the post.

3. Hold the guide wire out of the way: Use the second 8-foot long horizontal brace to measure; auger a 3-inch diameter hole 3 feet deep with no lean.

4. Drive the second (8-foot long by 4-inch diameter) brace post 4 feet deep. Leave 4 feet above ground. When the guide wire is released, it should touch the second brace post.

5. On the end post, make a mark 44 inches up from the ground on the surface facing the far end post and drill a 3/8-inch hole 2 inches deep, parallel to the line wire.

6. Drive a 3/8-inch by 4-inch galvanized steel dowel pin 2 inches into the end post.

7. Mark the first brace post 44 inches up from the ground and drill a 3/8-inch hole through the post parallel to the line wires.

8. Drive a 3/8-inch by 9-inch galvanized steel dowel pin into the first brace post. Stop when the pin is even with the surface of the post on the side facing the first pin.

9. Mark the second brace post 44 inches up from the ground and drill a 3/8-inch hole through the post in the same manner as the first brace post.

10. Drive a 3/8-inch by 9-inch galvanized steel pin through the second brace post. Stop when the pin is flush with the surface of the post facing the first brace post.

11. Drill a 3/8-inch diameter hole 2 inches into the centers of both ends of the first and second 8-foot long top horizontal braces.

12. Lift the first horizontal brace and position it onto the pin in the end post. Align it with the pin on the first brace post and drive the pin 2 inches into the horizontal brace. Leave 2 inches of pin projecting from the first brace post to receive the second horizontal brace.

13. At the end post, on the side opposite the pull of the wires, mark the post 4 inches above the ground and drive a 1-3/4 inch galvanized staple half its length horizontally into the post.

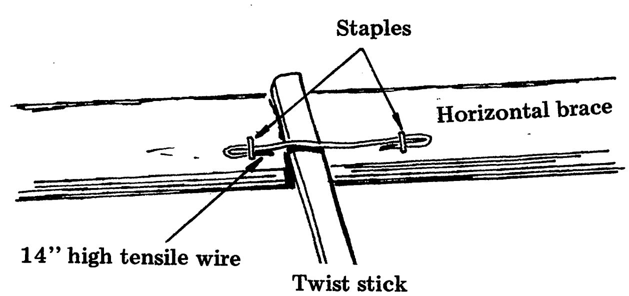
14. Cut a 40-foot length of high tensile fence wire and bend a 6-inch loop on one end and hook it on the pin projecting from the first brace post. Maintain hand tension on the wire. Wrap the wire diagonally around the end post under the staple and over the pin on the first brace post. Complete two tight wraps in the same manner and hook the end of the wire over the pin in the first brace post.

15. Pull as much slack out of the diagonally wrapped wire as possible. Adjust the final loop to maintain tension and staple the ends of the wires to the first brace post.

16. Facing the diagonal wires on the side of the assembly opposite the livestock (wire) side, insert a 1½-inch by 2-inch by 24-inch pressure-treated hardwood twist stick about 2 inches of its length between the four diagonal wires that are perpendicular to the diagonal wires so that the top of the twist stick rests against the horizontal brace.

17. Using both hands, tilt the twist stick toward the end post to clear the horizontal brace and pull the twist stick toward you to twist the diagonal wires. Maintain a firm grip on the twist stick. Make six to eight complete revolutions, twisting the diagonal wires. Stop with the stick upright on your side of the horizontal brace. Tilt the stick back toward the first brace post so it rests against the horizontal member.

18. Cut a 14-inch length of high tensile wire and double staple it over the twist stick onto the horizontal brace.



19. At the bottom of the end post, bend the horizontal staple over to secure the diagonal wires.

20. Lift the second horizontal brace onto the pin to protect it from the first brace post. Align the other end with the pin in the second brace post. Drive the second brace pin 2 inches into the horizontal brace.

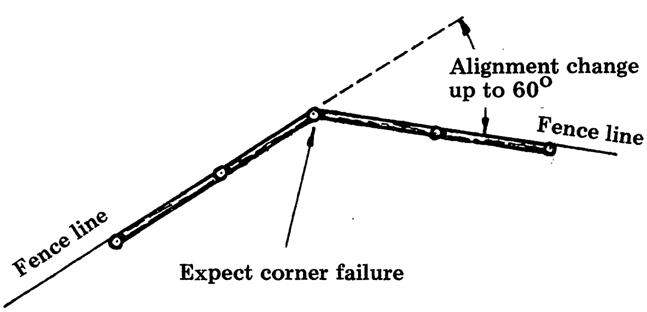
21. Drive a staple horizontally into the back of the first brace post 4 inches up from the ground. Repeat the double wrap of high tensile wire and staple it as described.

22. Twist up the diagonal wires on the second brace assembly, as described, and stay the twist stick. Bend over the staple at the bottom of the first brace post.

23. At the far end of the fence line, repeat all operations necessary to complete a double-span brace assembly, which is a mirror image of the assembly at the starting end of the fence. All details must be followed to withstand the pull of the wires in the opposite direction.

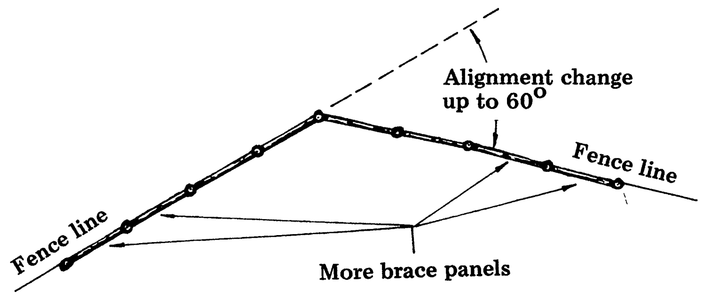
End post assemblies erected with these procedures will withstand the tension of the wires on all nonelectric as well as electric high tensile fences. If carefully constructed, braces should be close-fitting. You should not have to saw them shorter than their 8-foot lengths, nor have to notch the brace posts to fit them into position on the pins. In most soils, setting the final tension on the line wires will pull brace assemblies nearly into vertical alignment.

Most pullout occurs at dog legs, small changes in fence alignment—up to 60 degrees. Small angle changes are difficult to hold.

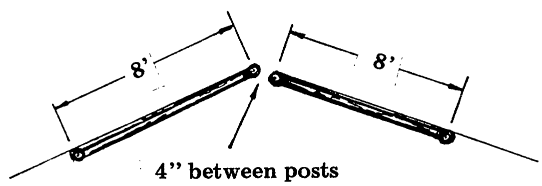


To prevent dog-leg failures:

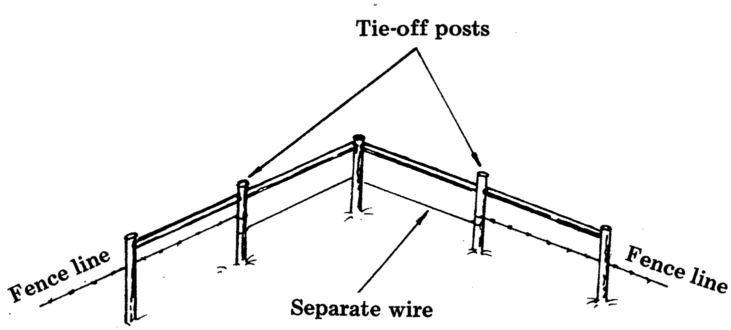
1. Install more brace panels at the dog leg.

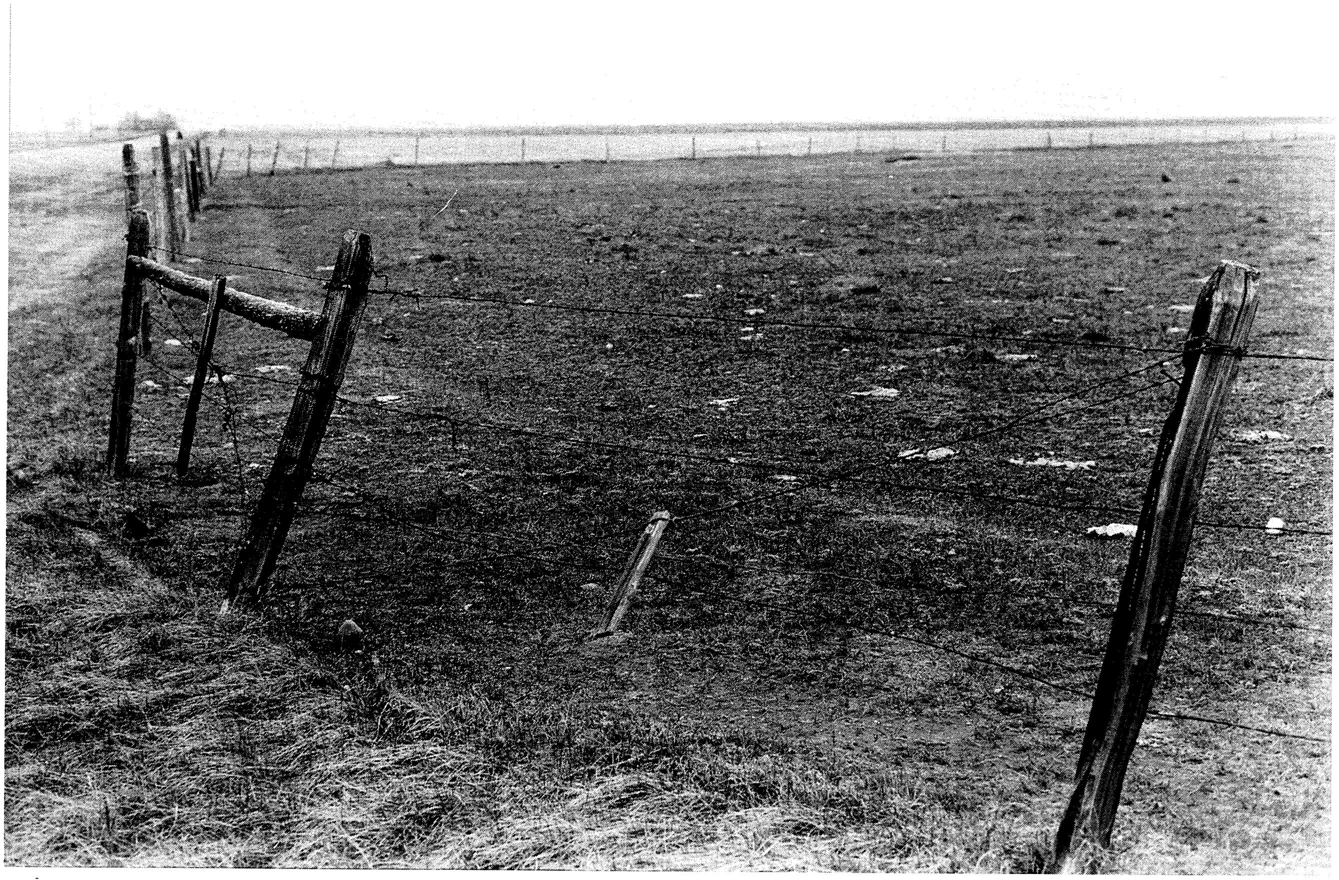


2. End each fence line with separate end braces.



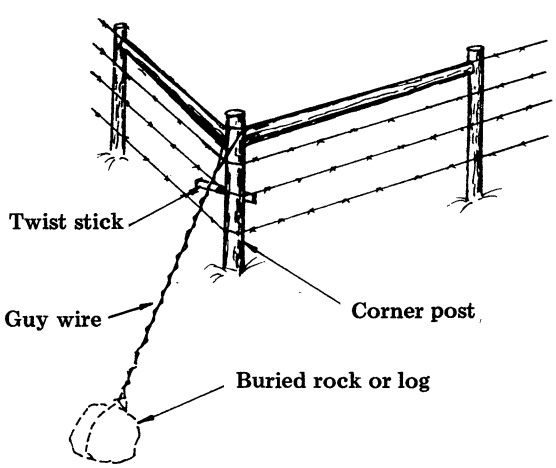
3. Install a desirable panel corner brace and tie off each fence line to its first brace post. Then use short separate pieces of wire to go around the corner post.

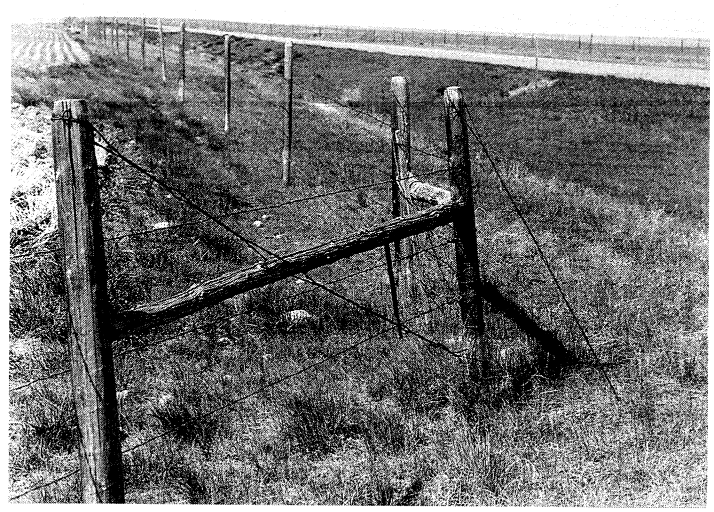




Dog leg failure.

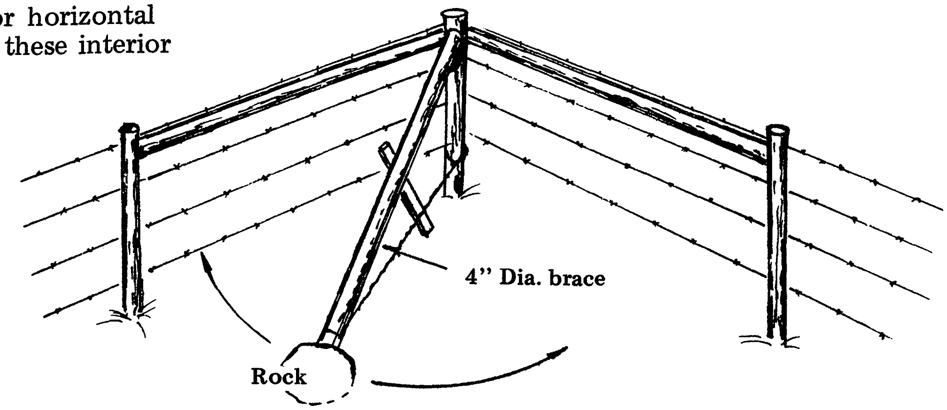
4. Install a deadman anchor tie-back on the corner post.

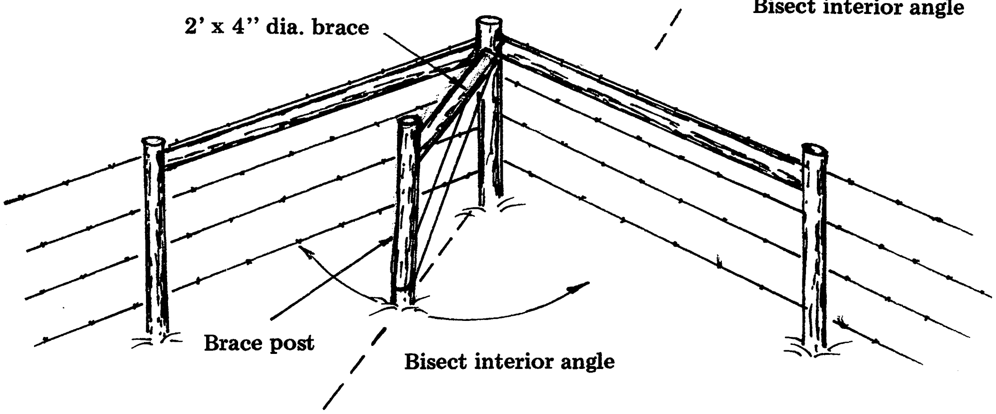




Deadman anchor on corner post.

5. Install interior diagonal and/or horizontal deadman post. Animals may abuse these interior deadman posts.





Line Posts

Line posts are used to suspend the wire or rails of a fence. If there is a change in horizontal or vertical direction, a corner or brace is needed. Line posts can be metal, wood, plastic, or fiberglass. The fence design will dictate the type of post to be used, the size of posts, and post spacing. The depth the post is to be set will depend on the type of soil and the height of the fence. The type of line post chosen also depends on the vegetation in the area, the desired life expectancy of the fence, maintenance requirements, esthetics, or environmental factors. For example, a small steel post works well in a temporary electric fence, but is not adequate for a woven wire fence. The recommendations below will help you determine proper spacing, size, and depth.

Wood—Available in lengths of 5½ to 8 feet and 2½ inches and larger in diameter.

Reinforced concrete—formed to any desired size.

Steel—Available in 5-, 5½-, 6-, 6½-, 7-, and 8-foot lengths. The 6½- and 7-foot lengths are easiest to obtain from most dealers.

Fiberglass—Available in 4-, 5-, 5½-, 6-, 6½-, 7-, and 8-foot lengths.

Plastic—Available in 5- to 7-foot lengths and is 2-3/8 inches in diameter.

Life expectancy of wood line posts varies with species.

Line posts are usually set 2½ feet into the ground. The deeper the post, the stronger it is. Increasing the post depth in loose soil will help prevent failure. Driven posts are more rigid than posts set in oversized holes and tamped. Posts set by hand can be firmly set if the hole is dug as vertical as possible, and no more than 6 inches of soil is tamped and compacted before adding the next 6 inches to be tamped.

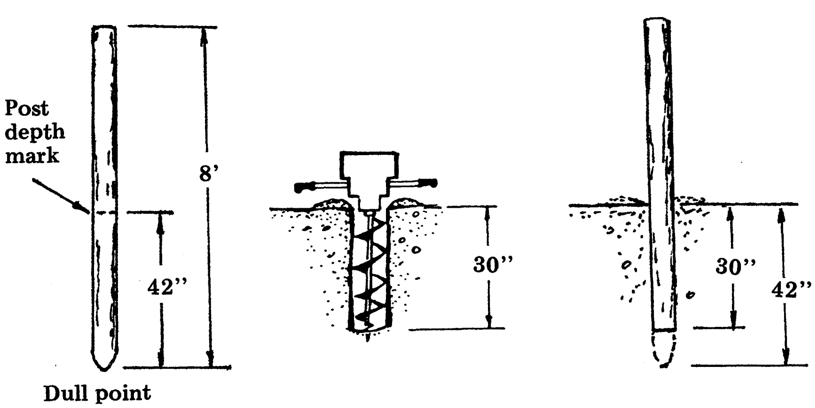
Driven posts should have a dull point to displace soil around the post and compact the soil. A mechanical auger (auger diameter same size or smaller than post diameter) can be used to predrill post holes 12 inches shallower than the marked post depth:

Life Expectancy of Treated and Untreated Fence Posts

Kinds of Wood	Untreated Heart-wood*	Pressure copper napthenate**	Treated Round Posts copper napthenate** Hot Soak	Cold Soak	End Diffusion (Zinc chloride or chromated zinc chloride)	Double Diffusion (Copper sulfate and sodium flouride)	Salt Treatments (Osmose, tanalith and celcure)
	years	years	years	years	years	years	years
Osage Orange	25-30						
Red Cedar	15-25	20-25	20-25	10-20			
Black Locust	15-25						
Sassafras	10-15	20-25	15-20				
White Oak	5-10	20-30	15-30	10-20	8-9		
Blackjack Oak	5-10	15-25	10-20	10-20	8-9		
Cypress	5-10	20-30	15-30				
So. Pine	3-7	25-30	15-20	10-20	10	20-30***	25***
Sweetgum	3-6	20-30	20-30	10-20			
Hickory	2-6	15-20	10-15	10-15			
Red Oak	2-6	20-30	20-30	10-20	6		17***
Sycamore	2-6	20-25	15-25	10-20	8-9		
Yellow Poplar	2-6	20-25	15-25	10-20	8-9		
Cottonwood	2-6	15-20	10-15	5-10	5		
Willow	2-6	30	28-37	7-20	5		
Ponderosa Pine	4-14	35	30	18			
Lodgepole Pine	4-12	35	35	20			
Rocky Mt. Juniper	29						
Douglas Fir	7-12	20	25	2			
Aspen	7-12	20	25	20			

*Sapwood of all species rots readily in one to three years depending on local soil and weather conditions.
**Data based on an absorption of 6 pounds or more per cubic foot of wood with complete penetration of sapwood. All preservatives applied in an oil solution. Posts barked and seasoned before treatment.
***Water solution ¼ - 1 pound of dry salt per cubic foot of wood. Posts must be green when treated.

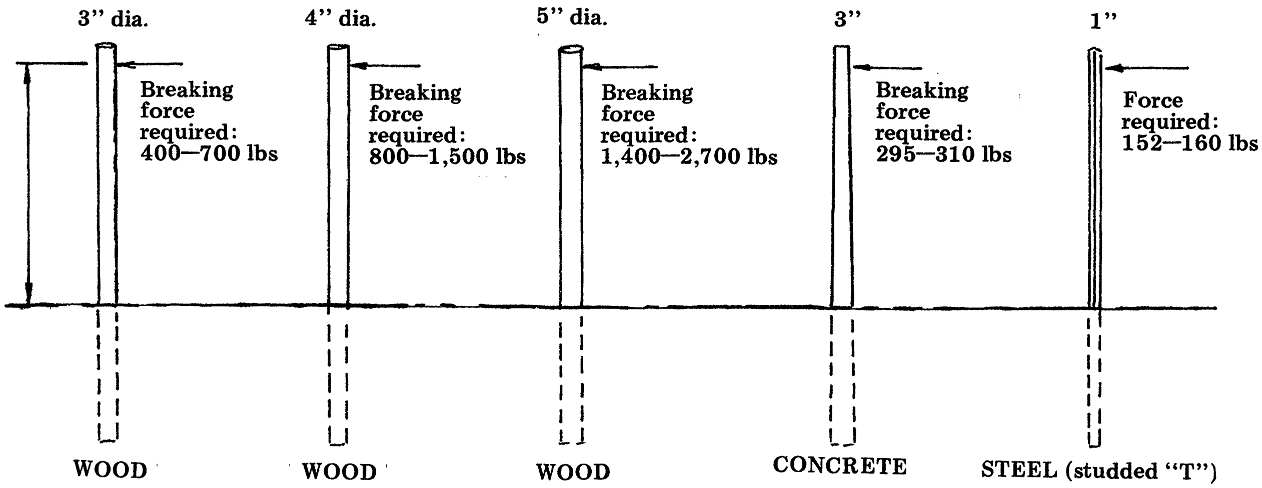
Prepared by the Coordinated Wood Preservation Council, an organization of southern agricultural colleges and experiment stations; the Forest Utilization Services of the Southern and Southeastern Forest Experiment Stations; and the Division of Forestry Relation, T.V.A. Supplemented with references as numbered. Data for Rocky Mountain area posts were obtained from Forest Products Laboratory USDA, Report 068.



Auger Diameter Versus Post Size

Post Size Diameter *Inches*	Auger Diameter *Inches*
3 - 4	3
4 - 5	4
5 - 6	5
6 - 7	6

Comparative strength of posts is given in the following figure. Small values for each size of wood post are for northern white cedar; larger values are for white oak, jack pine, and tamarack. Most other species fall between these extremes. Strength is computed for force exerted 4 feet above ground line on green posts.

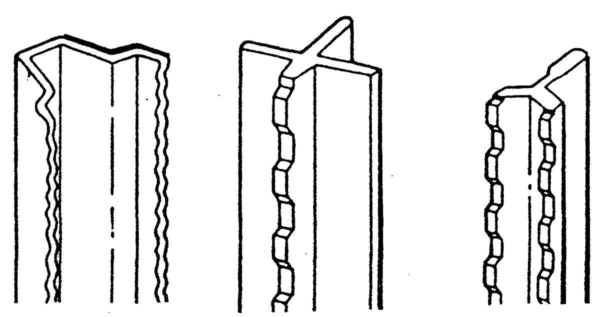


Approximate breaking strength of square concrete posts with 5-inch base and 3-inch top reinforced with four 3-gauge wire is 295 to 310 pounds. The same post with 6-gauge wire reinforcement has a breaking strength of approximately 162 pounds (721 N). A post 3-5/8 inches x 3-5/8 inches top and bottom with 6-gage reinforcing wire has a breaking strength of approximately 132 pounds (data from Portland Cement Association).

In straight and contour, open-field fencing any of the standard steel fence posts, standard 4-inch concrete posts, or 2½-inch or larger wood posts are satisfactory. For contour fencing lengthen the spans and use 4- or 5-inch wood or concrete posts for greater resistance to overturning. In sandy or wet soils use 4- or 5-inch posts to resist overturning.

Fiberglass posts are much lighter than steel posts and withstand greater side stress. Fiberglass posts are completely rot-resistant and require no insulators for electrical fences. Fiberglass posts are set 20 feet apart. A wood line post should be set every 200 feet. If the posts are "T" shaped, they should be at least 1¼-inches across and, if round, at least 3-3/8 inches across.

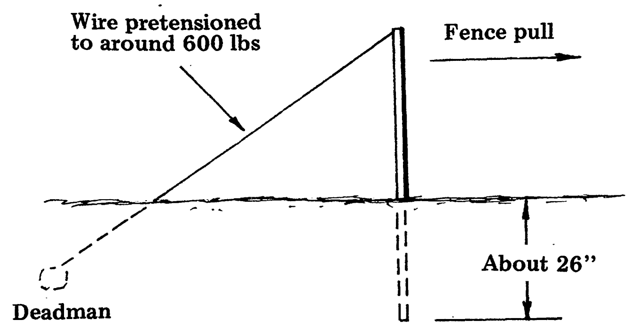
Polypropalene plastic posts are stronger than a 4-inch wood post. Ringed shank staples 1½-inches long are used with this plastic post. They are rot-resistant and require no insulators for electrical fences. These plastic posts are not resistant to high temperatures and should not be used where burning is common. Because of their flexibility, plastic posts cannot be used in brace assemblies. A studded "T" post will withstand 152 to 160 pounds, but will have a 1-inch permanent deflection.

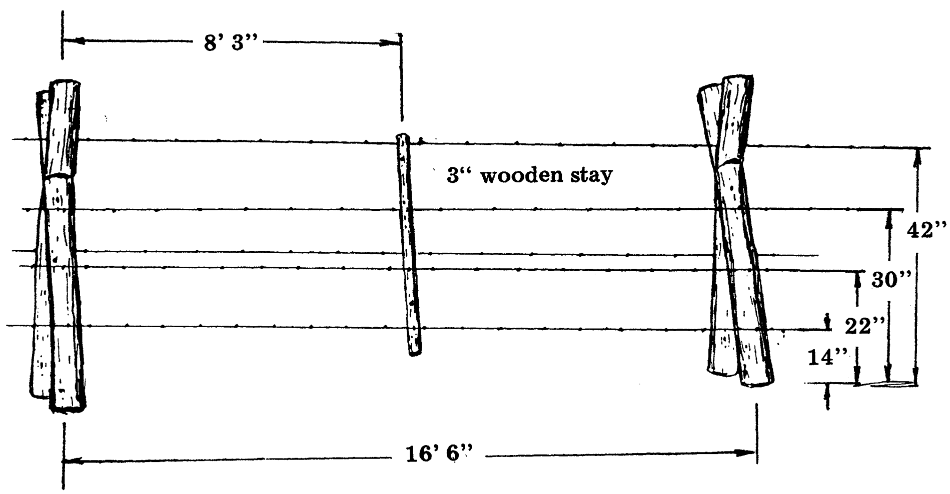


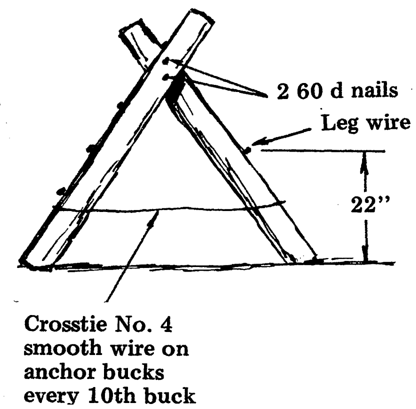
"U" BAR STUDDED "T" STUDDED "Y"

In loose or sandy soil post spacing should be as close as 10 feet. Additional stability in these loose soils is gained through increasing line post size, both in diameter and length. Plastic posts should always be driven. By increasing the depth of the post by one-third, resistance to overturning is doubled. Pre-tensioned deadman anchors drastically reduced required post depth.

In rocky soils, jackleg or buck and figure-four posts eliminate digging or driving posts.

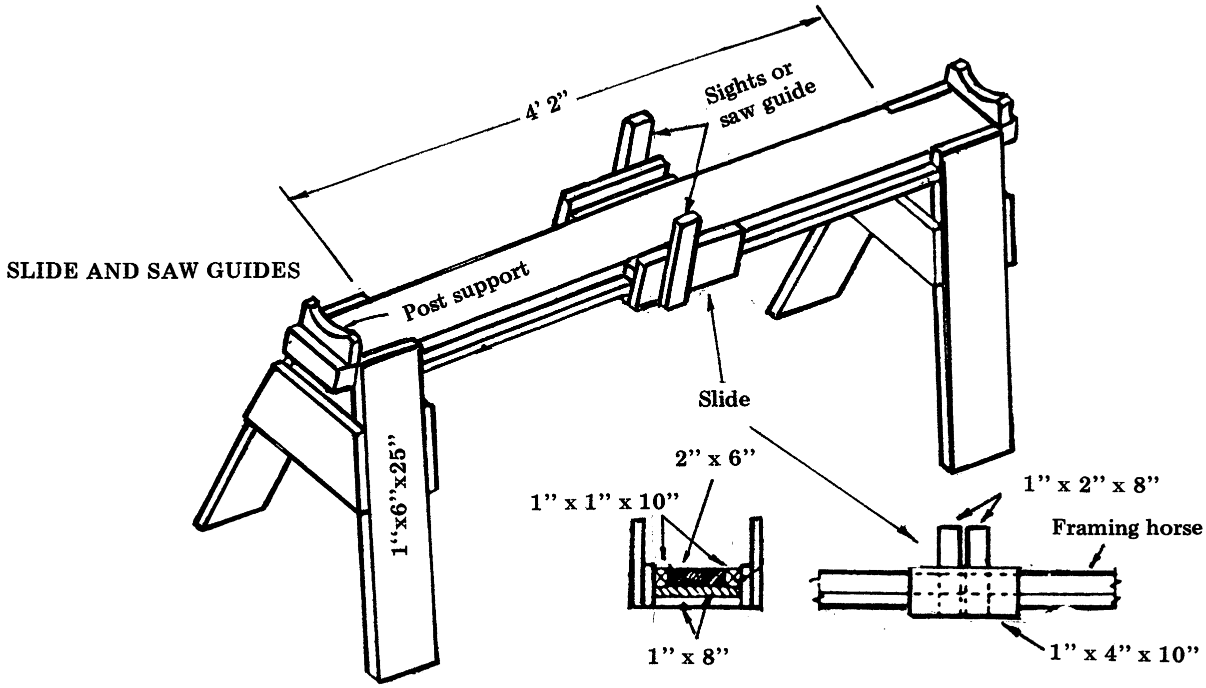




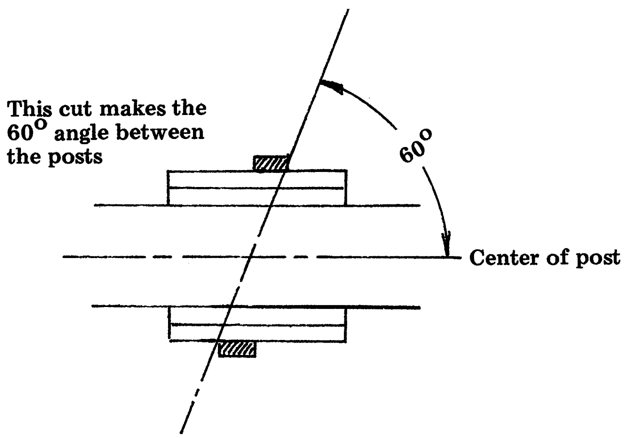


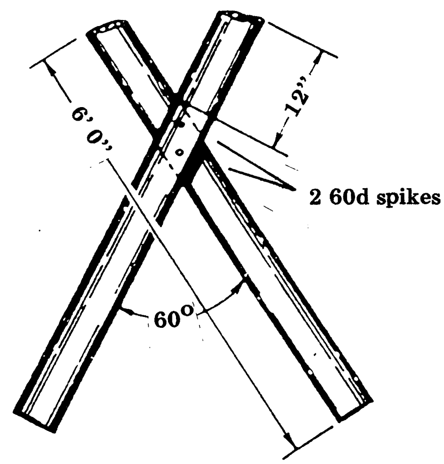
Jack leg or buck post.

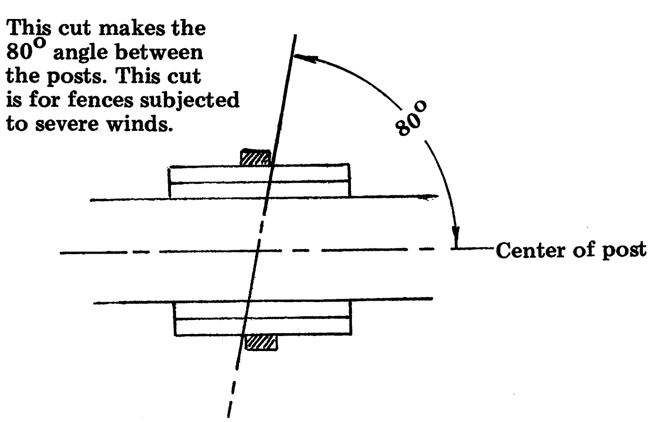
Jack leg or buck post.

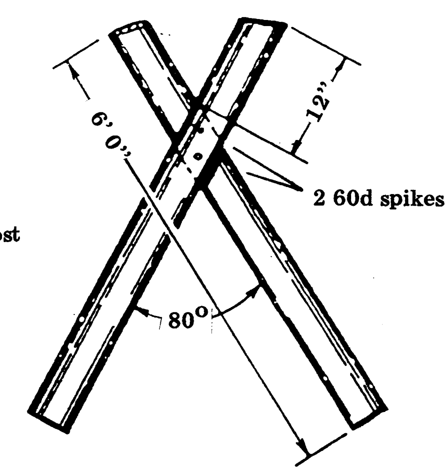


Framing horse for jack leg of buck mortice joints

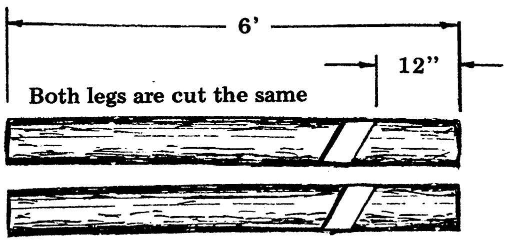




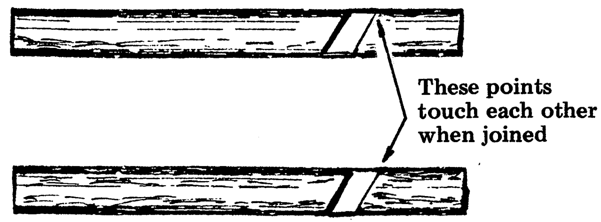




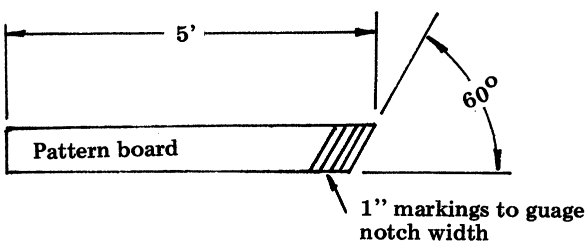
If possible the matching sides of a jackleg or buck post should be from the same or similar-sized logs.

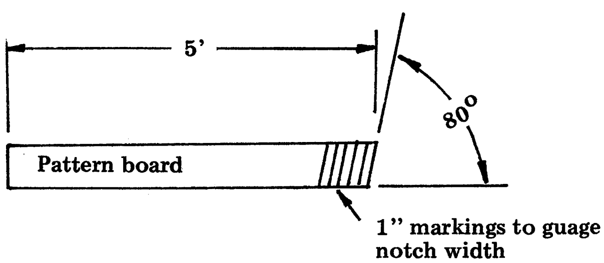


The notch width of a post is determined by the diameter of the post it is to be matched with. The fit should be snug.

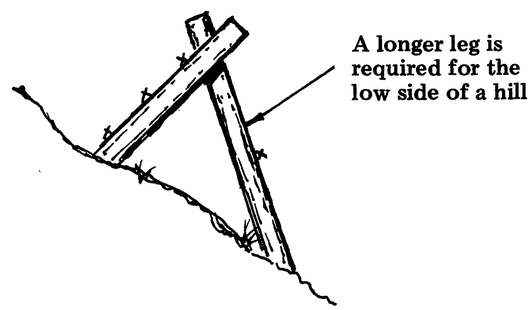


To fit mortice joint together, place the high point of the cut on both legs together.





Use a pattern board to guage notch width



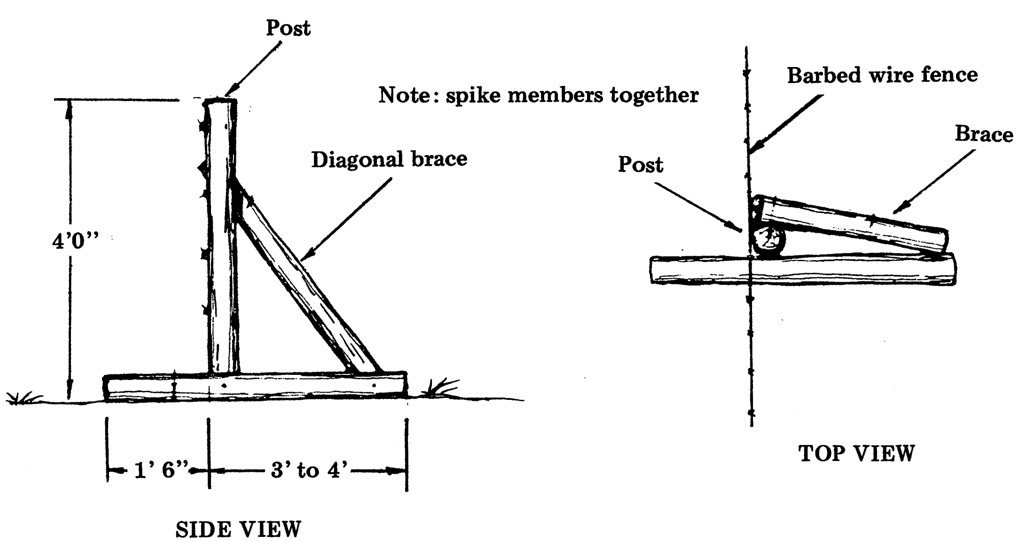
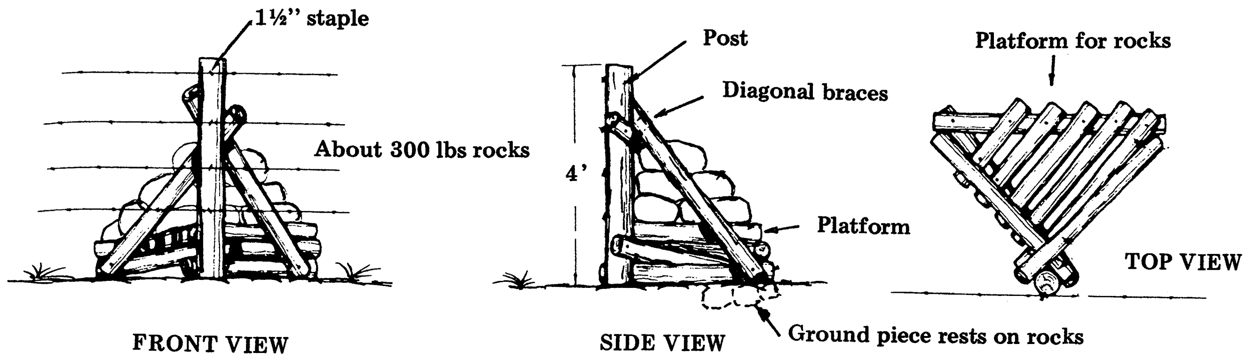
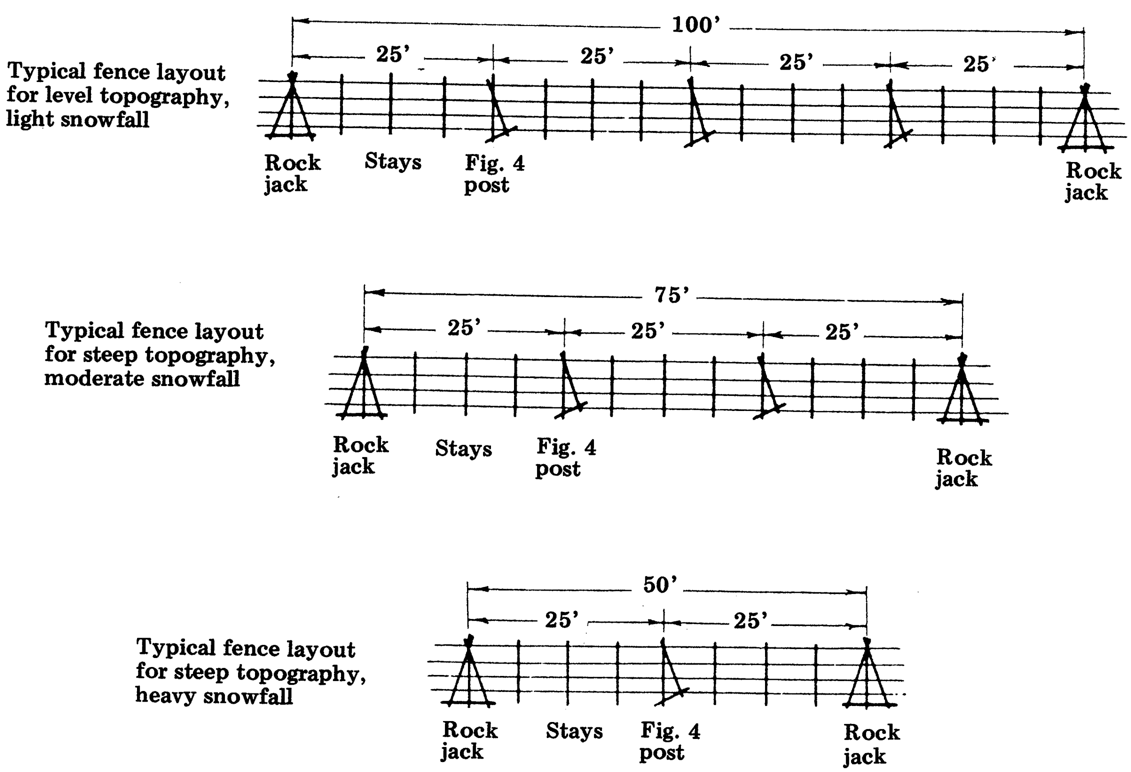


Figure-4 post.

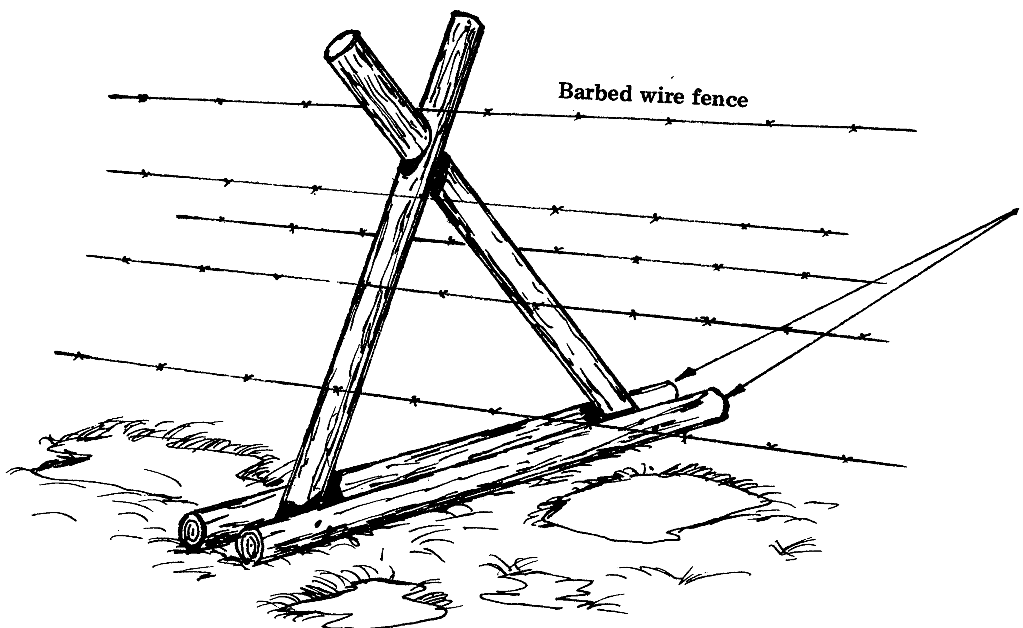


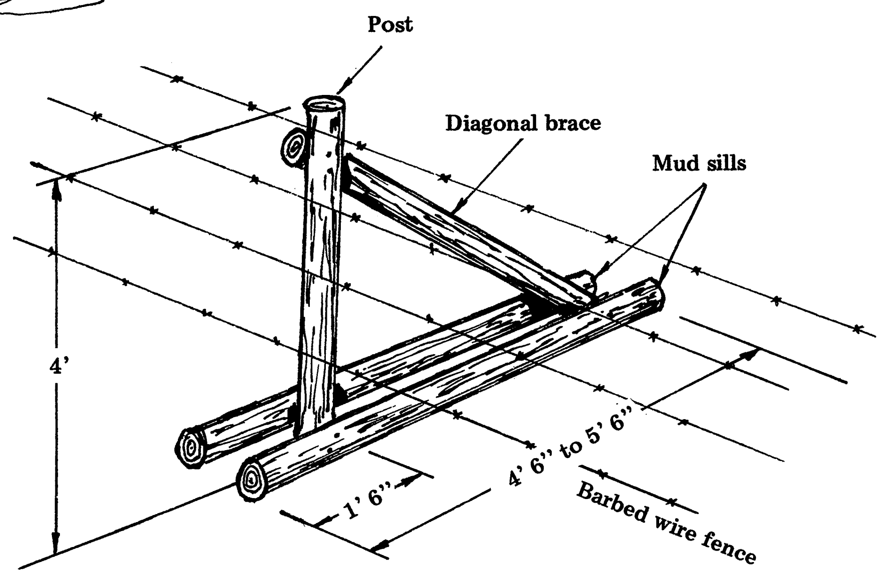
Rock jack post.



Spacing diagrams for rock jack posts and figure-4 posts.

In swampy ground two long poles are attached to the bottom of jacklegs, bucks, or figure-four posts to act as floaters. These long poles, called mud sills, keep the posts from sinking into the wet soil. Either a pole or wire fence design may be used.





A 15-to 17-percent increase of soil moisture can cause deflection rates to increase over seven times for a post depth of 2½ feet. Therefore, under heavy rain or spring thawing conditions soils may become radically weak in bearing capacity. To solve this problem:

1. Increase post depth to 3½ feet.

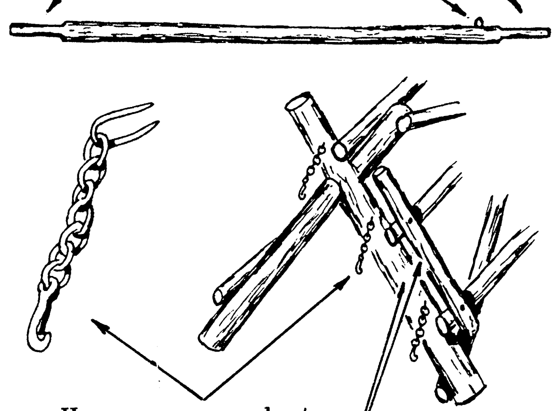
2. Increase post diameter from 2½ inches to 4 or 5 inches.

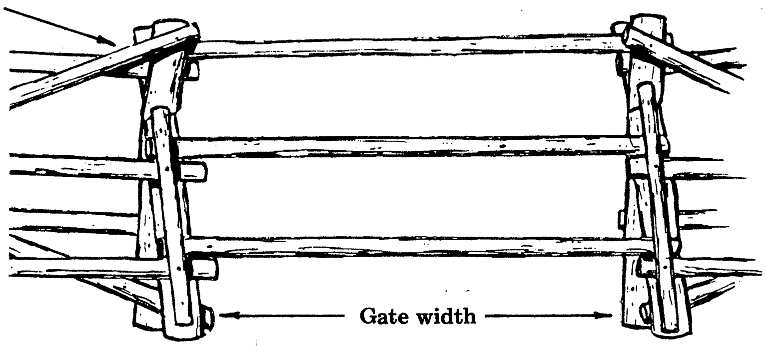
Gates

Gates allow access to both sides of a fence. They can be opened for short or extended periods of time. Gates are made of wood, metal, wire, fiberglass, plastic, or any combination of these materials. Any gate can be adapted to any fence design. However, for esthetics and ease of construction, it is best to build the gate to match the fence design. Some of the more conventional gate designs are shown below.

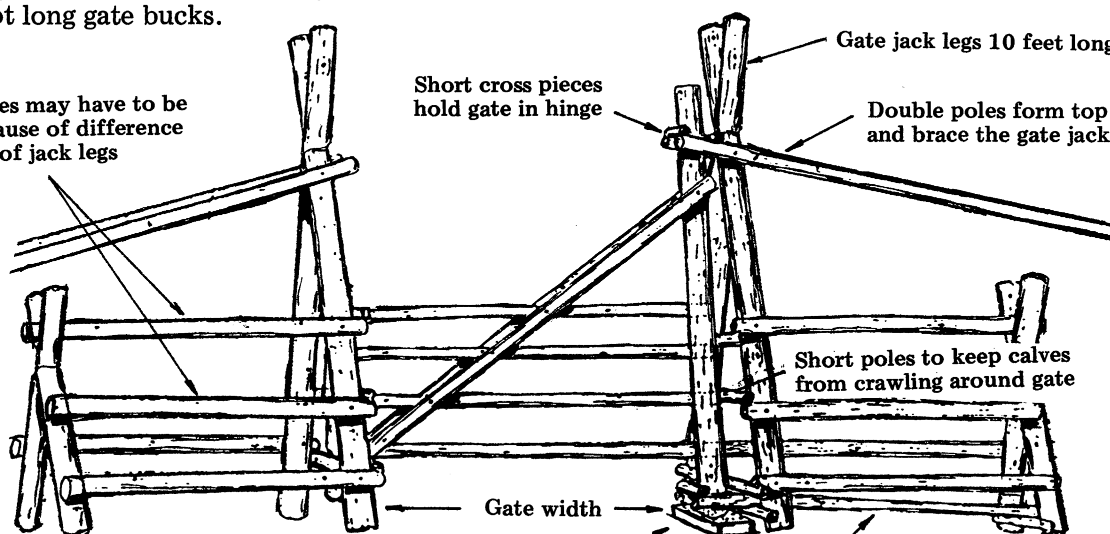
The following gates are most often used with buck fences.

In rocky ground where holes cannot be dug for gate posts, a sliding pole gate may be constructed between two bucks. Two spans on both sides of this gate should be braced.

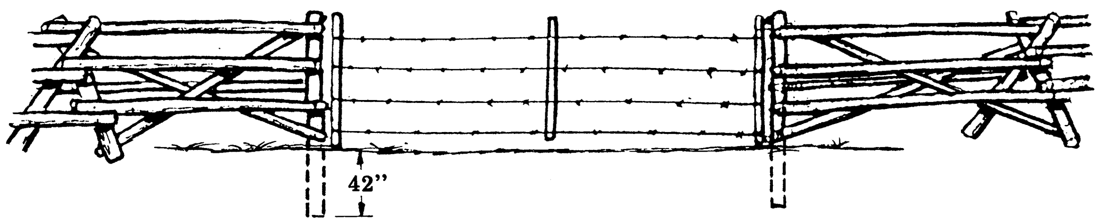


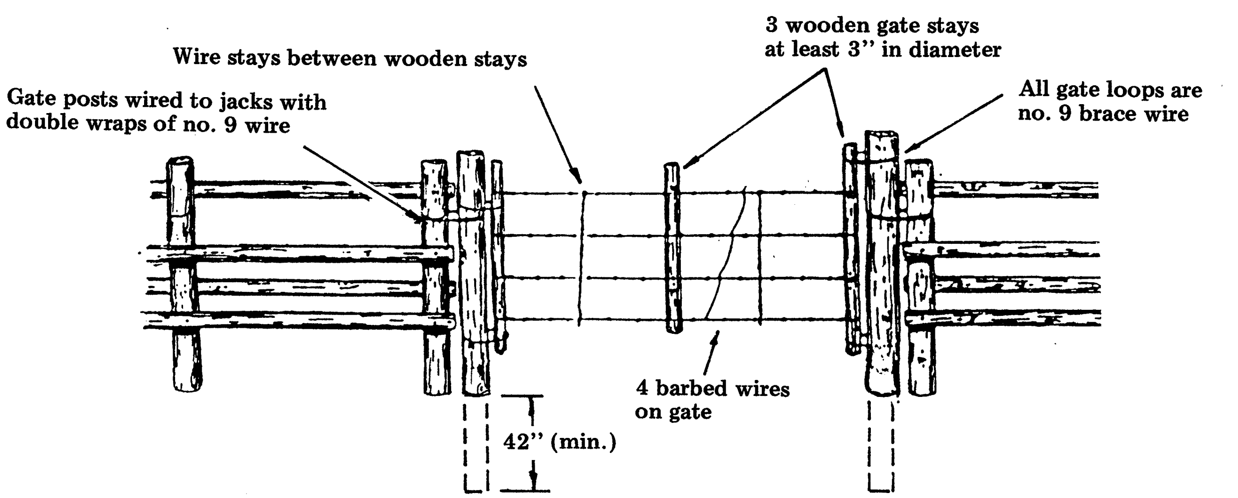


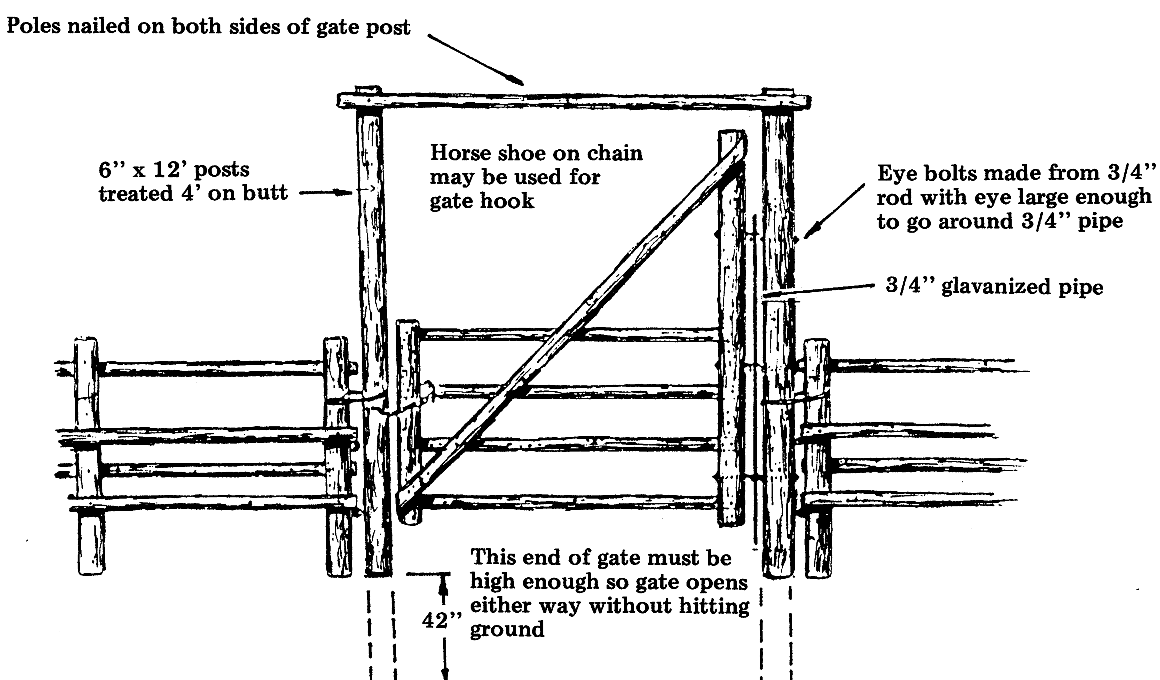
A swinging gate can be made for rocky ground by using 10-foot long gate bucks.

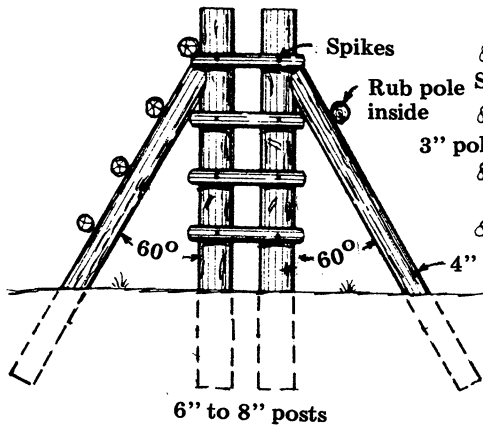


Where the ground permits gate posts to be buried, gates can be made separate from the buck fence.

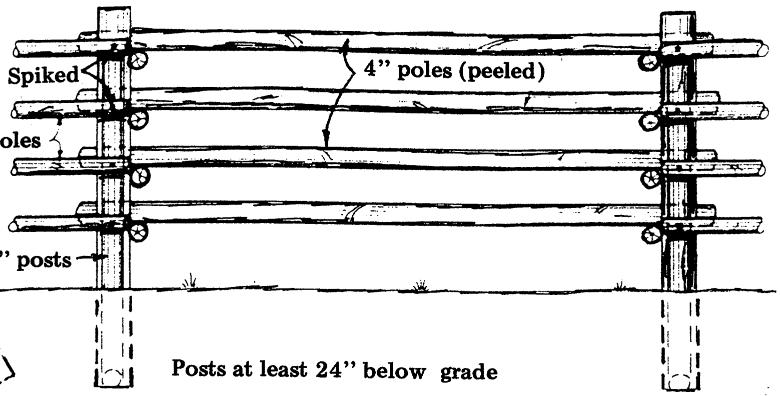




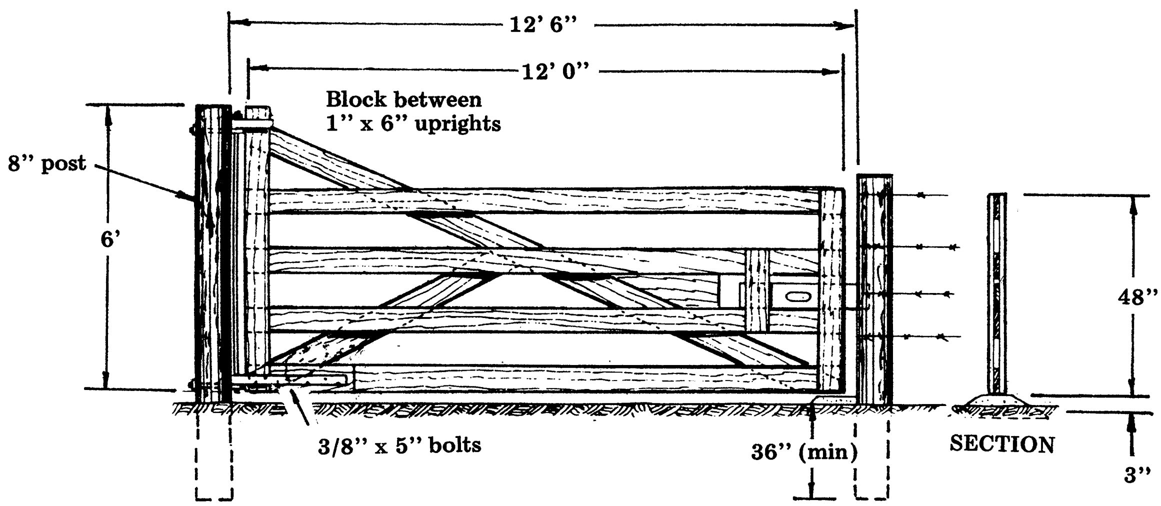


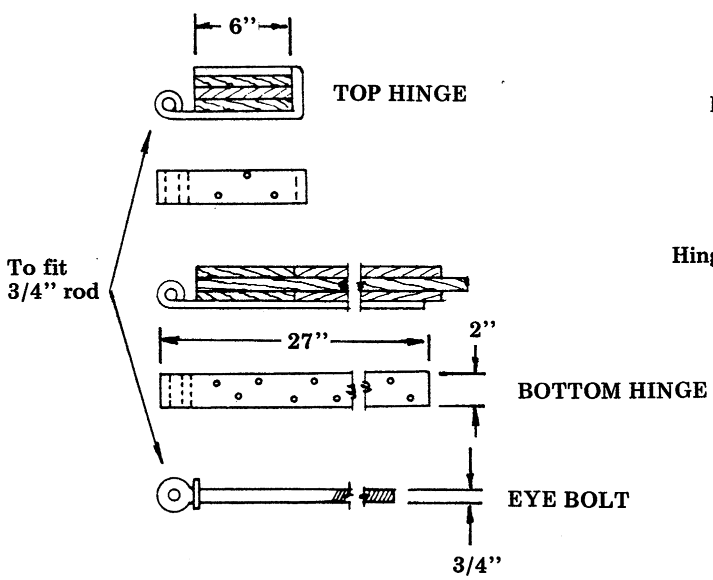


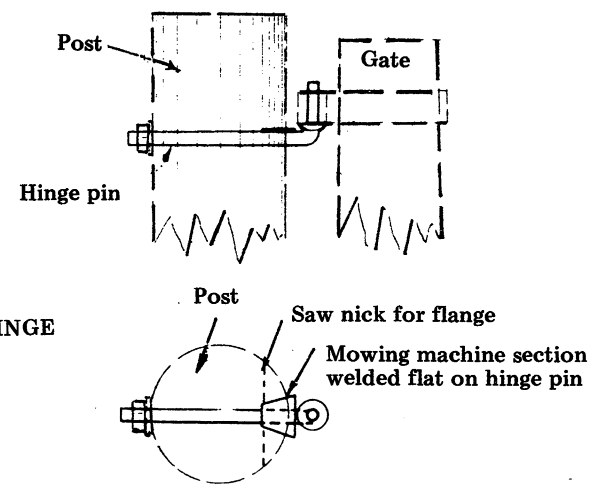
SECTION THROUGH GATE



VIEW OUTSIDE OF GATE

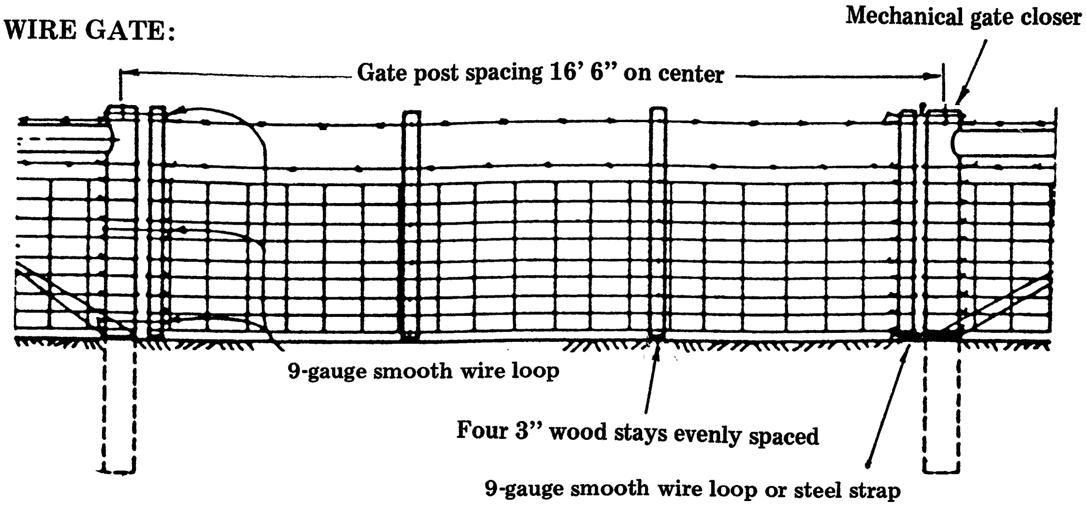




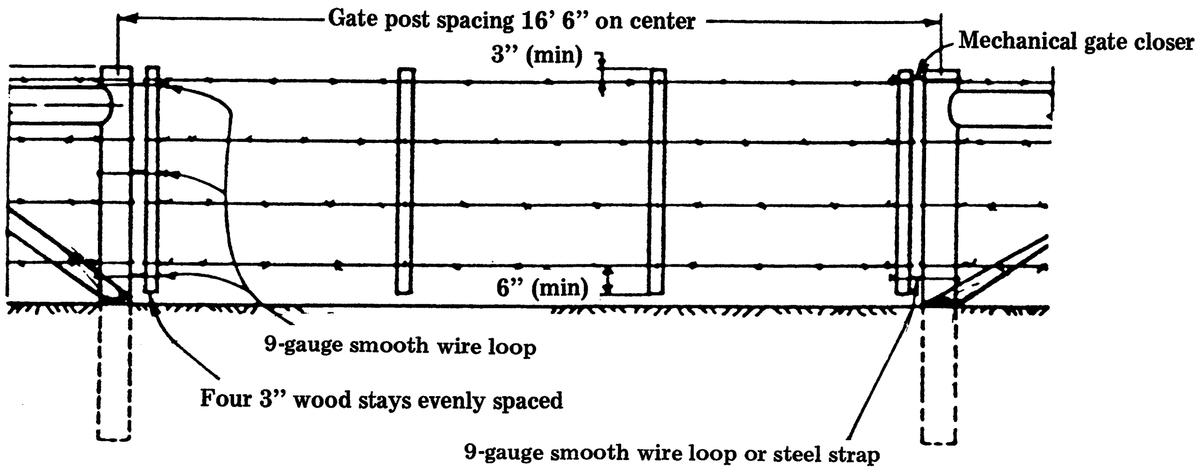


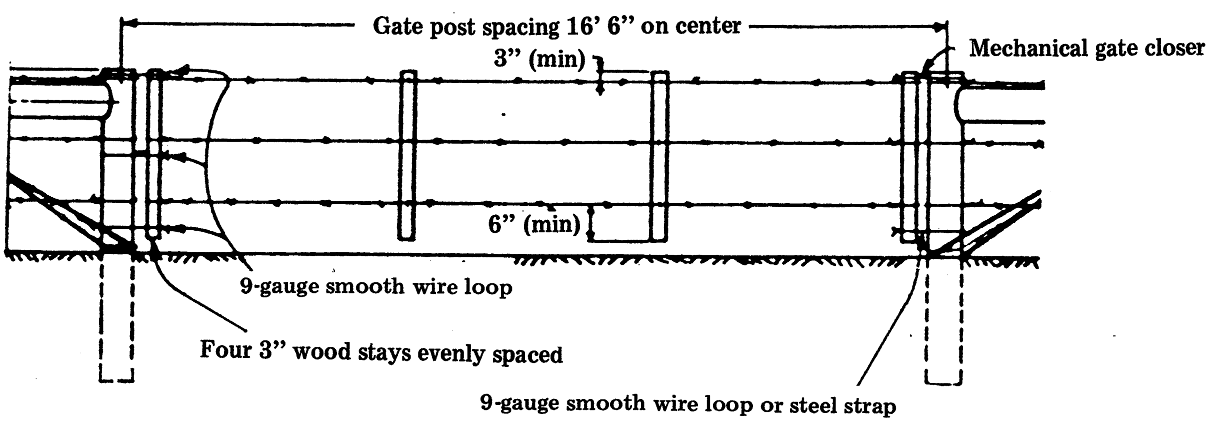
FLANGED HINGE PIN
(to prevent turning of pin
when gate swings)

WOVEN WIRE GATE:

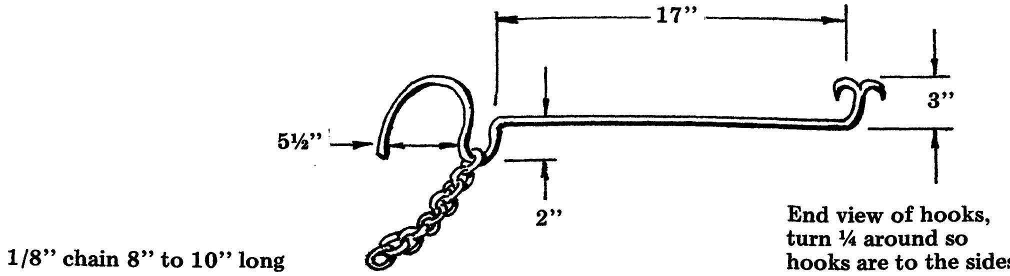


BARBED WIRE GATE:

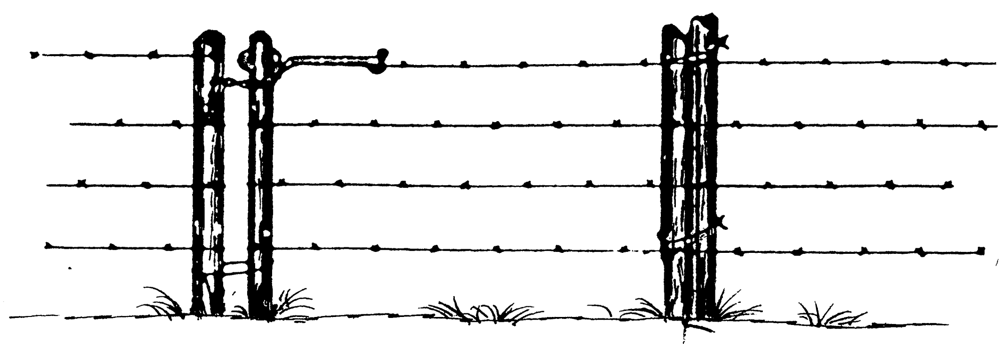




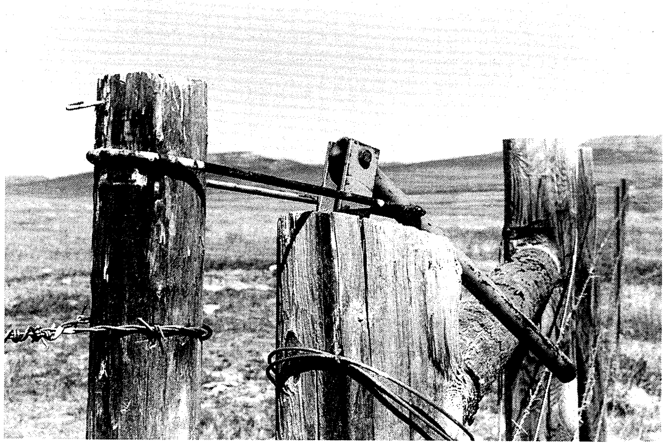
WIRE GATE FASTENERS:



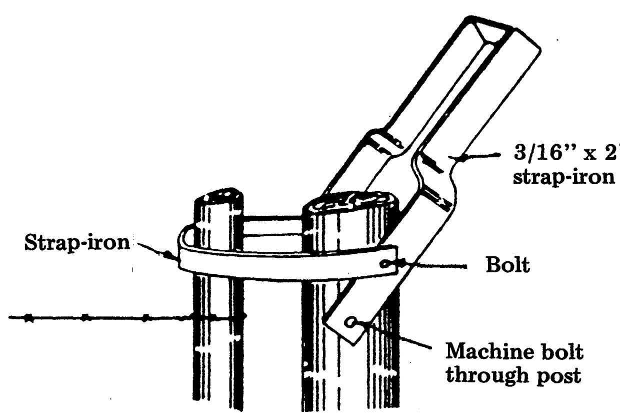
Make large hook on one end of a half circle, 5½" to 6" on the inside, bend down to an eye. Run through link in end of chain, bend at a right angle, then straighten 17", bend up at 90° 3", flatten 1" on end and split, bending one to each side, making two hooks to hook onto fence wire.

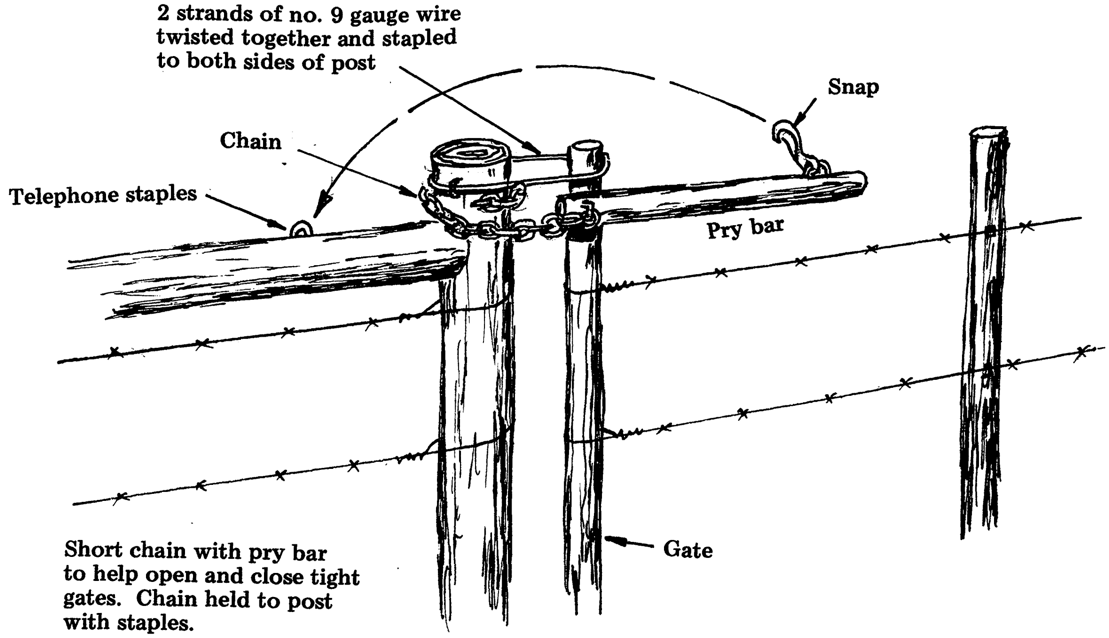


When closing gate, hook large hook around gate stick, bring other end toward gate and hook one of the small hooks to top wire.

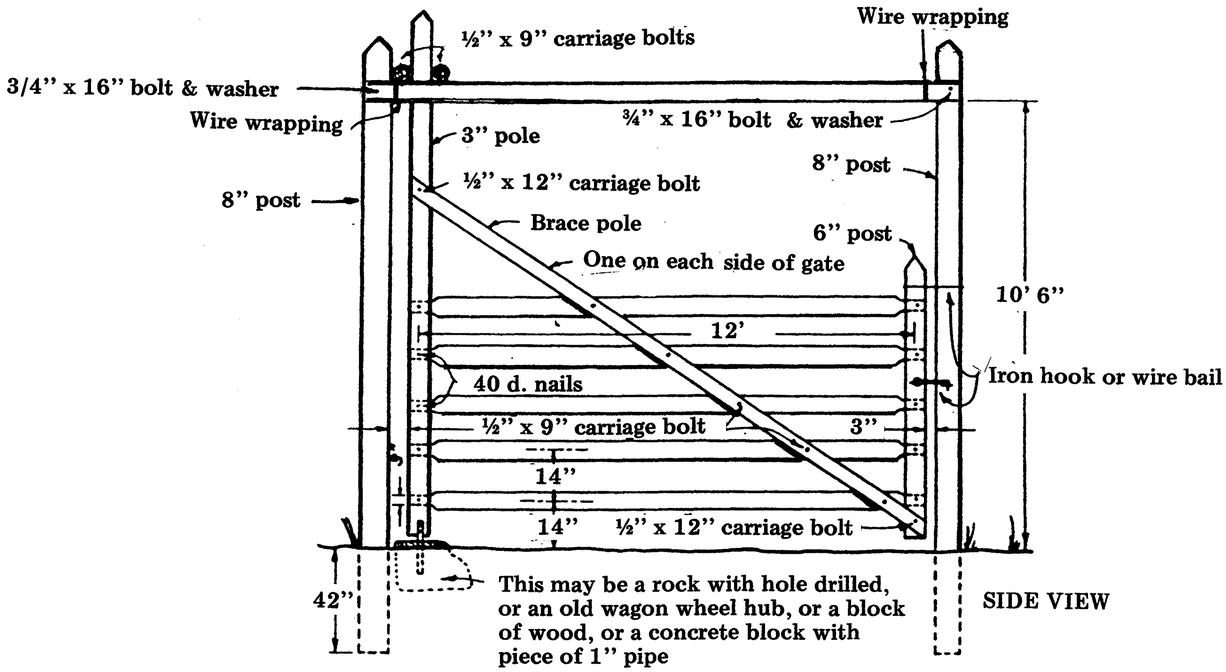


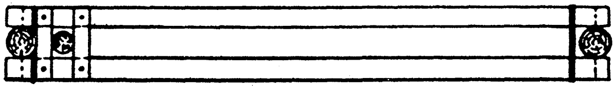
Wire gate fastener.



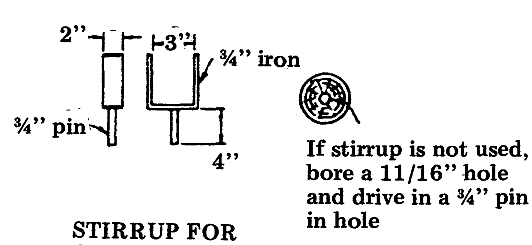


WOODEN SWINGING GATES:

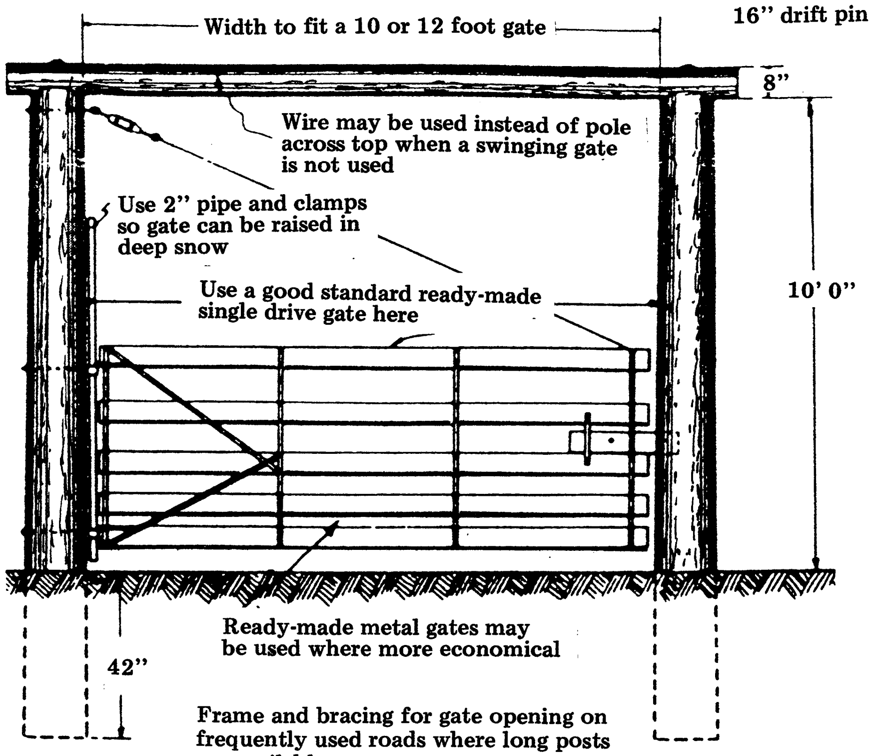




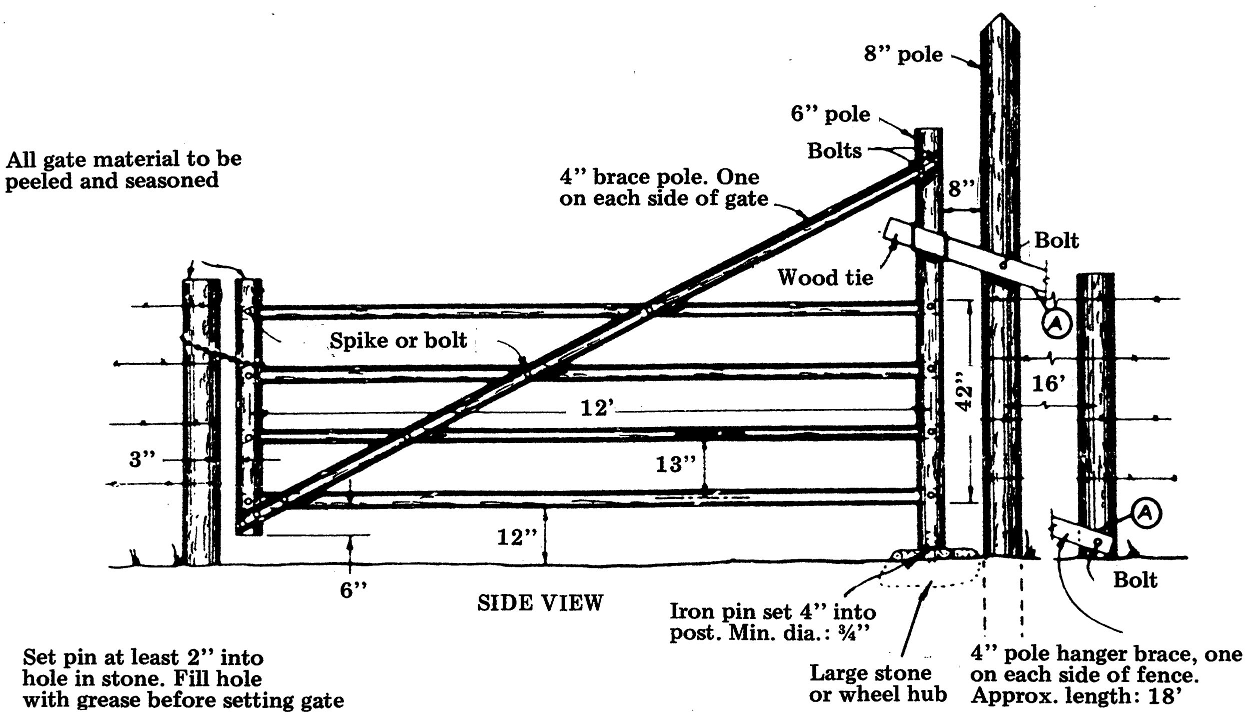
TOP VIEW



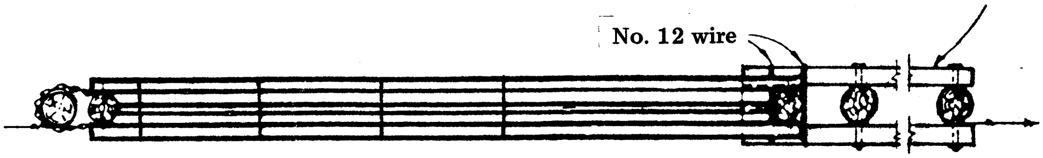
STIRRUP FOR GATE POST



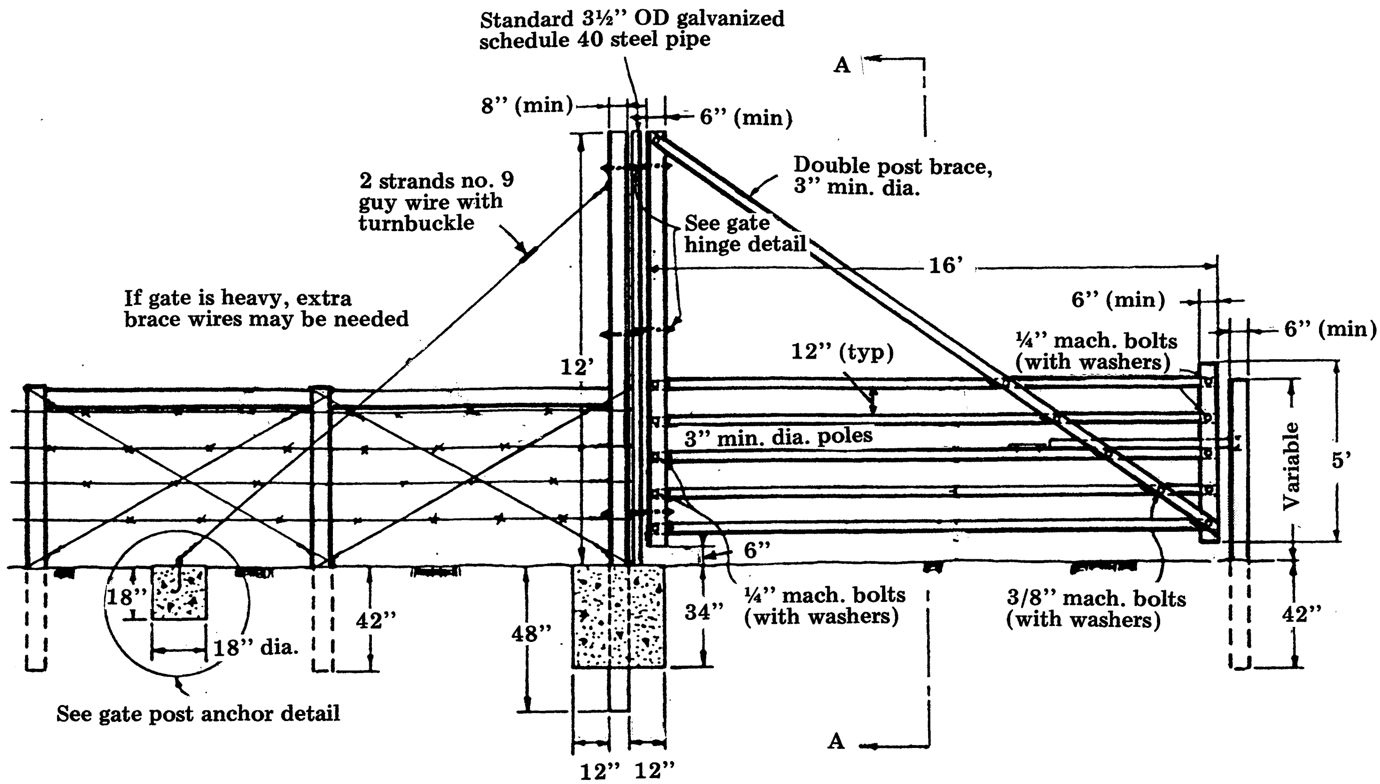
Frame and bracing for gate opening on frequently used roads where long posts are available

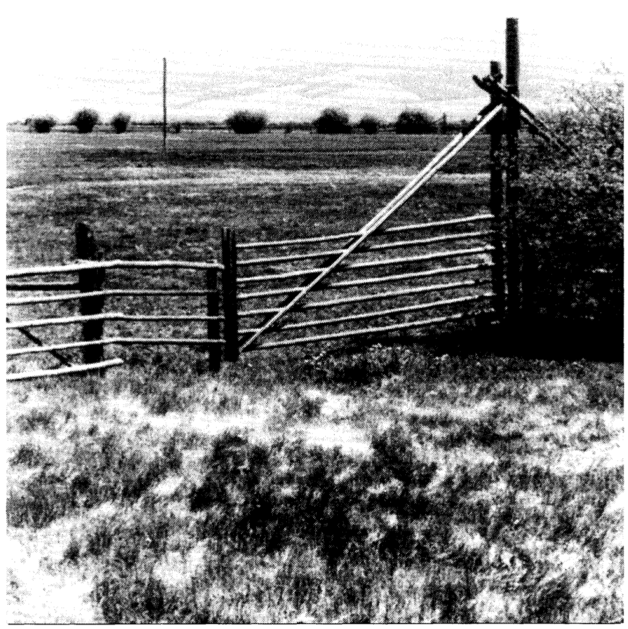


SIDE VIEW

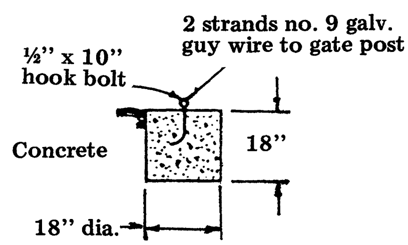


TOP VIEW

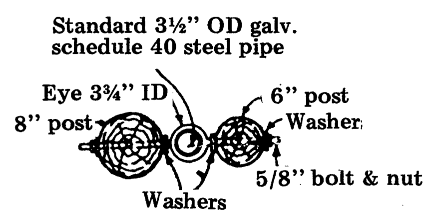




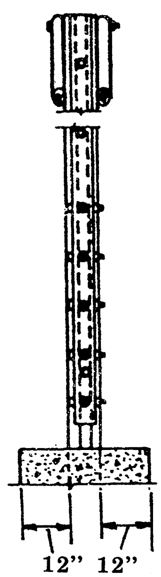
Wooden swinging gate.



GATE POST ANCHOR

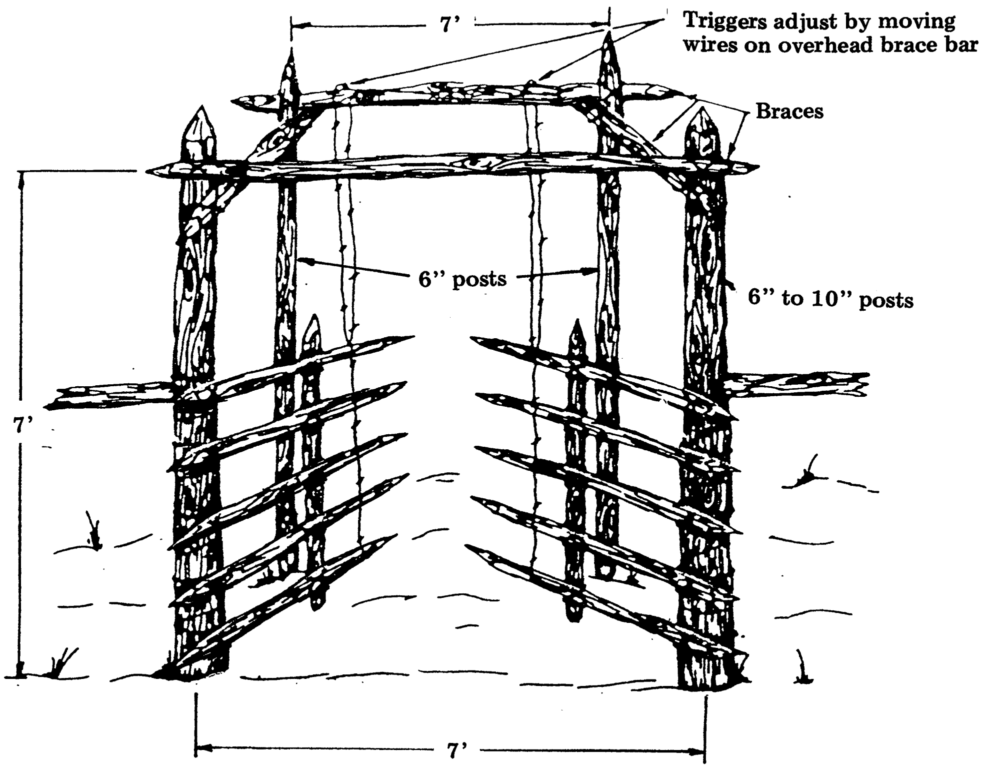


GATE HINGE

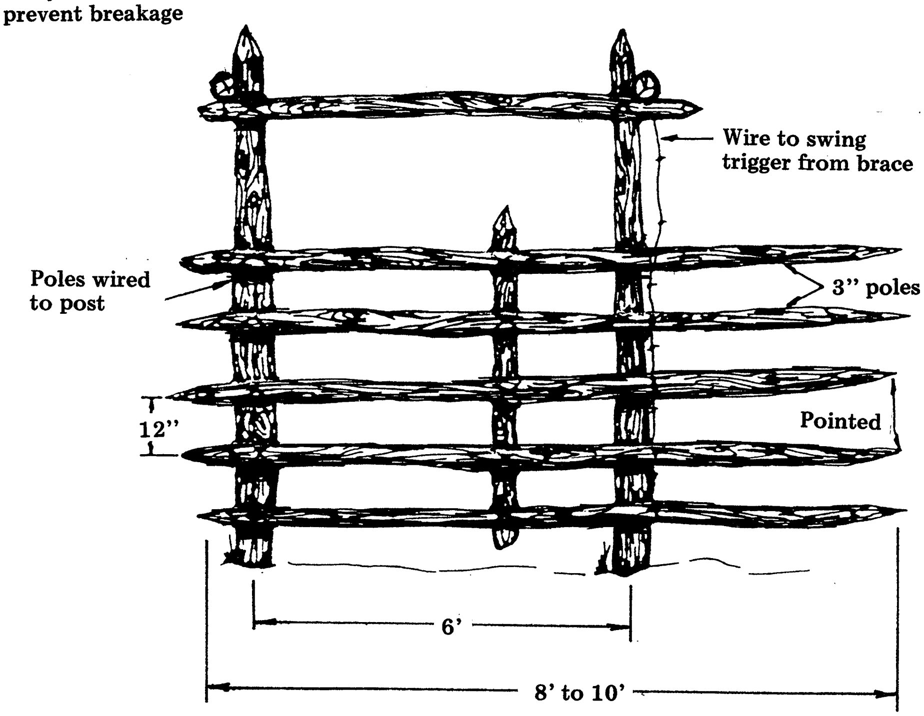


SECTION A—A

TRIGGER GATE:

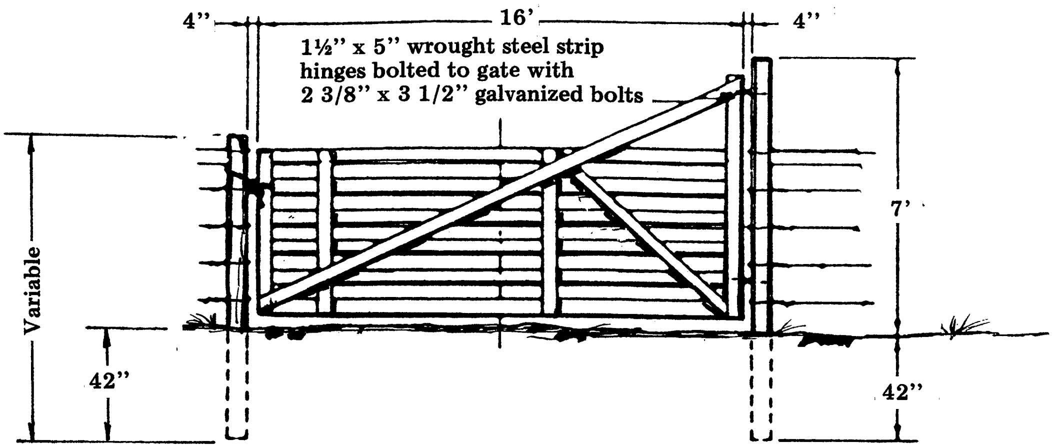


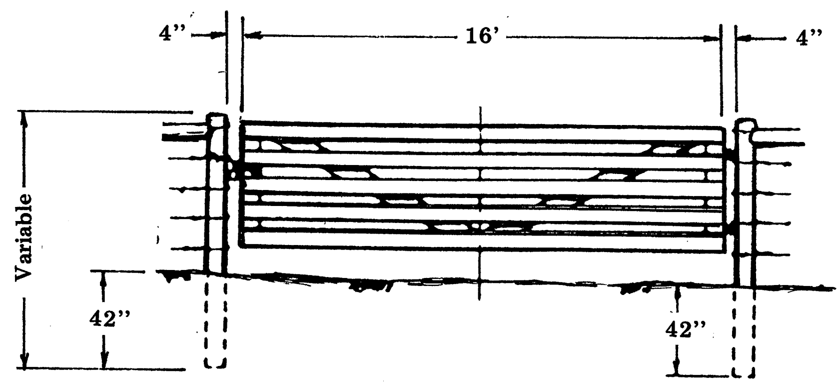
Note: Triggers should be fairly limber to prevent breakage

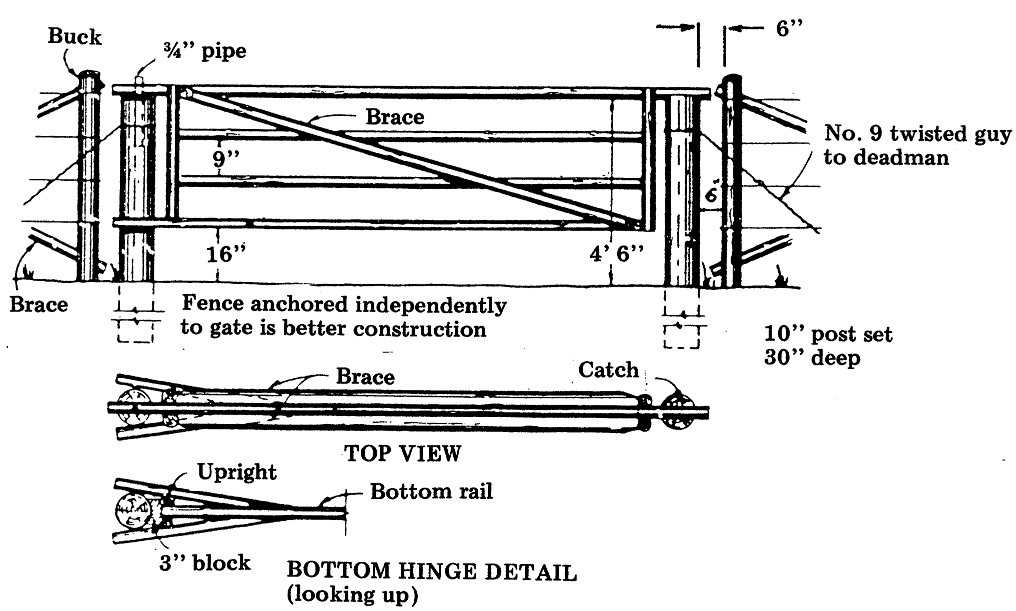


View of trigger

EXAMPLES OF 16-FOOT WOODEN GATES:

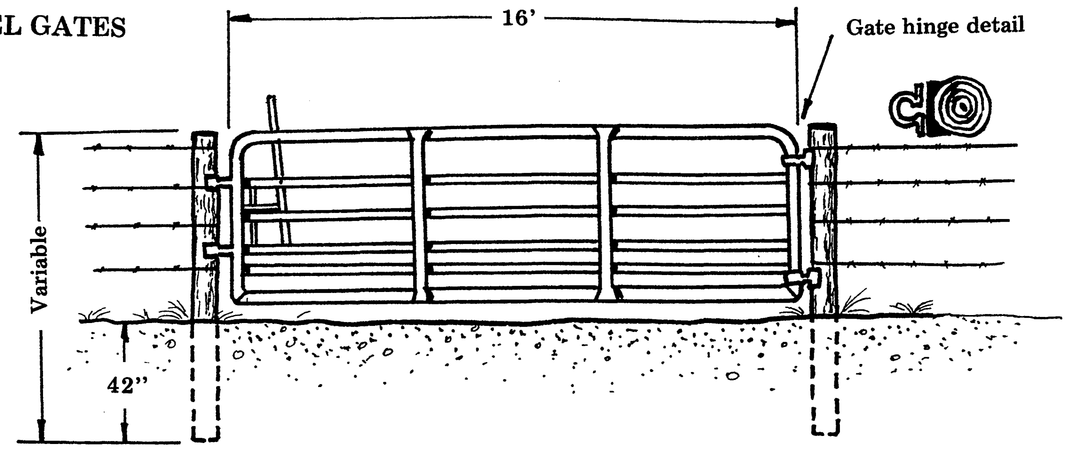


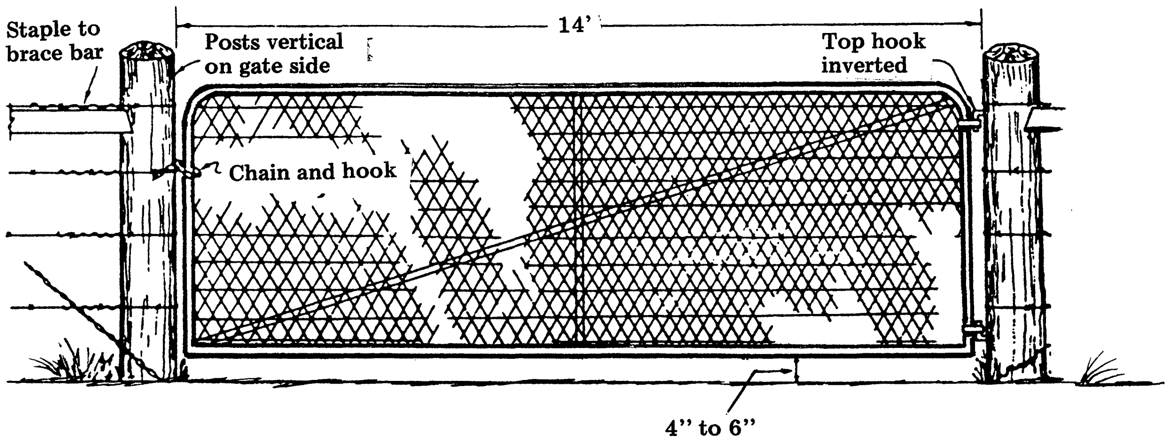




Metal Swinging Gates

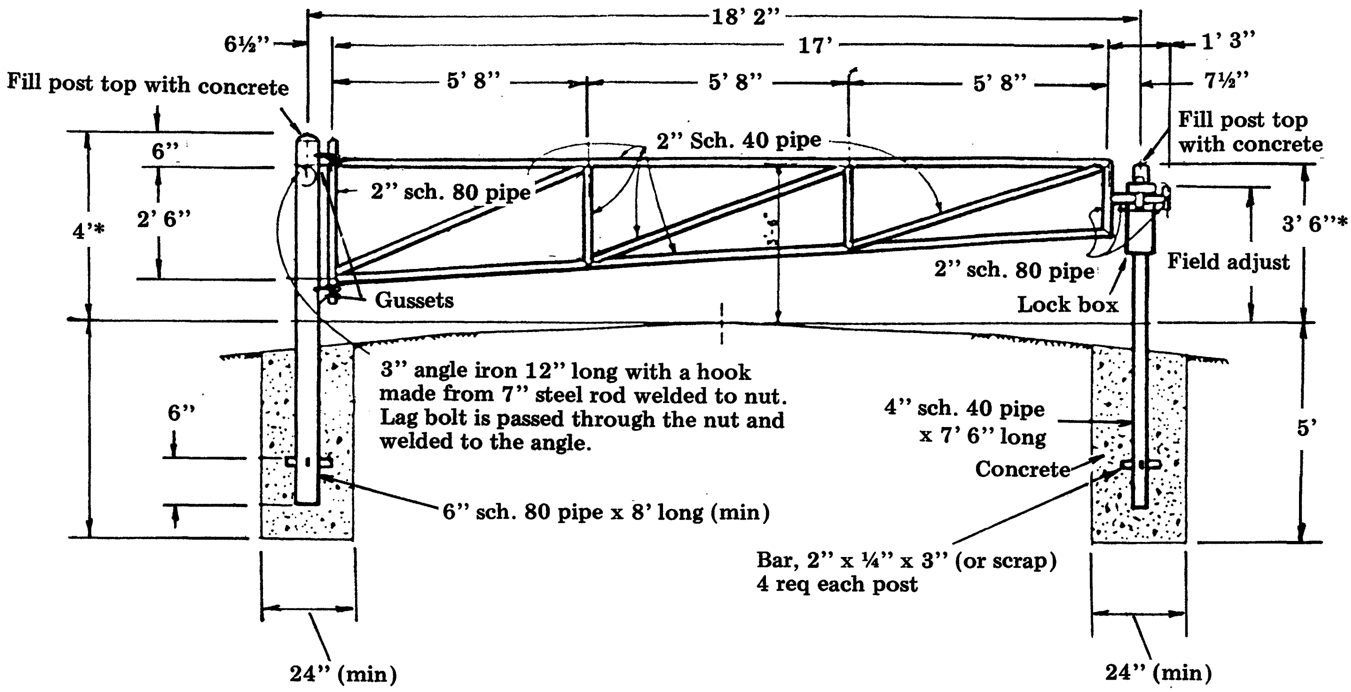
TUBULAR STEEL GATES



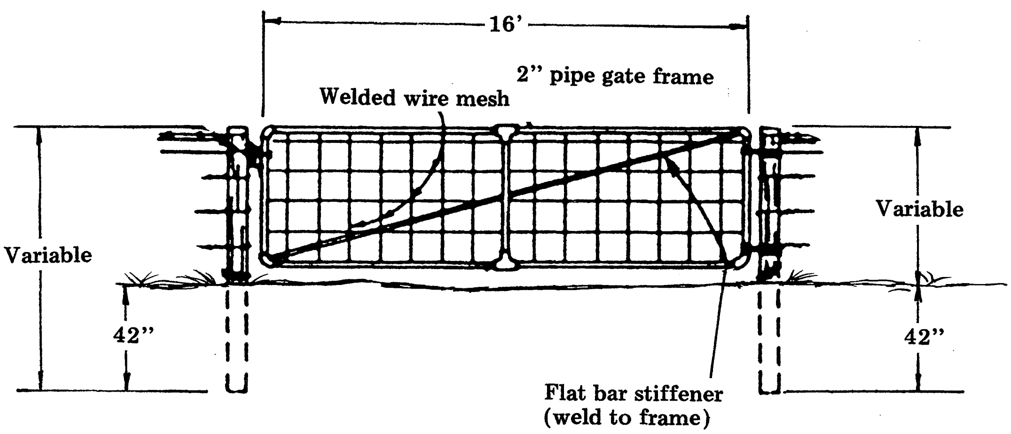


Metal swinging gate.

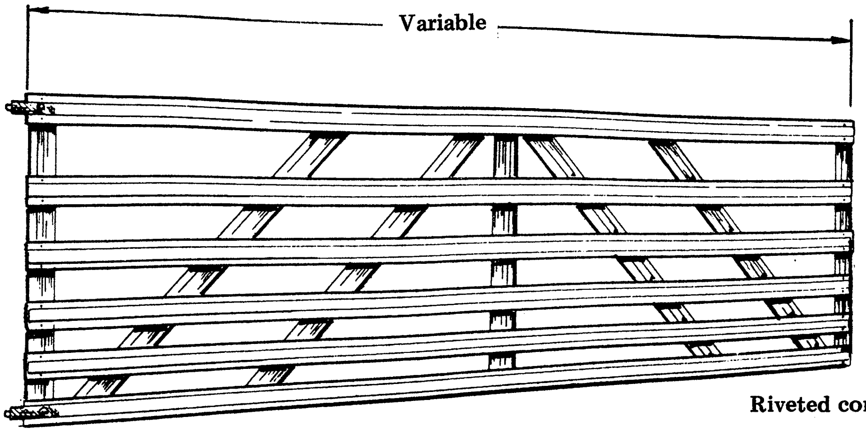
PIPE FRAME GATES:



Notes: *: hold these dimensions when setting posts
Welded construction
Exposed surface of concrete shall be crowned to shed water



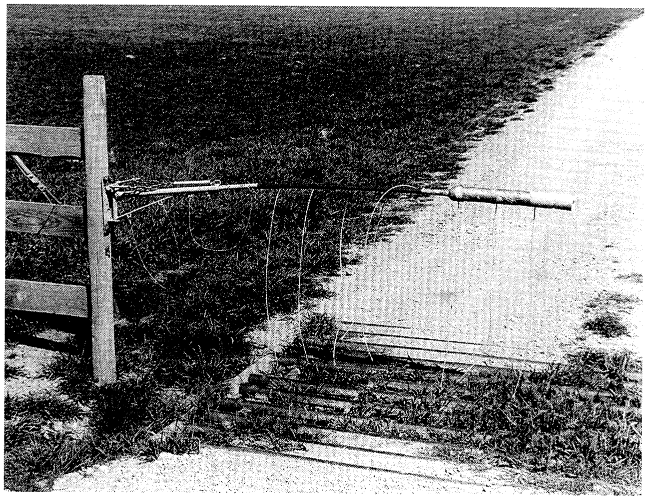
ALUMINUM GATES:



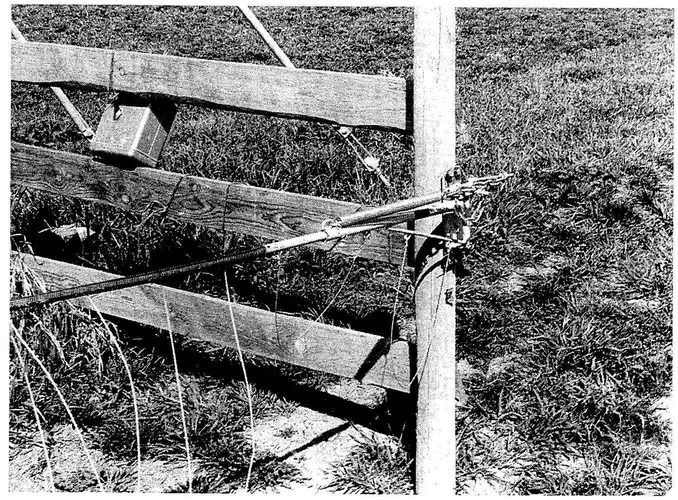
Aluminum gates are commercially available and may be purchased in a variety of lengths

Aluminum gate.

SPRING-LOADED FIBERGLASS ROD DRIVE-THROUGH GATE:

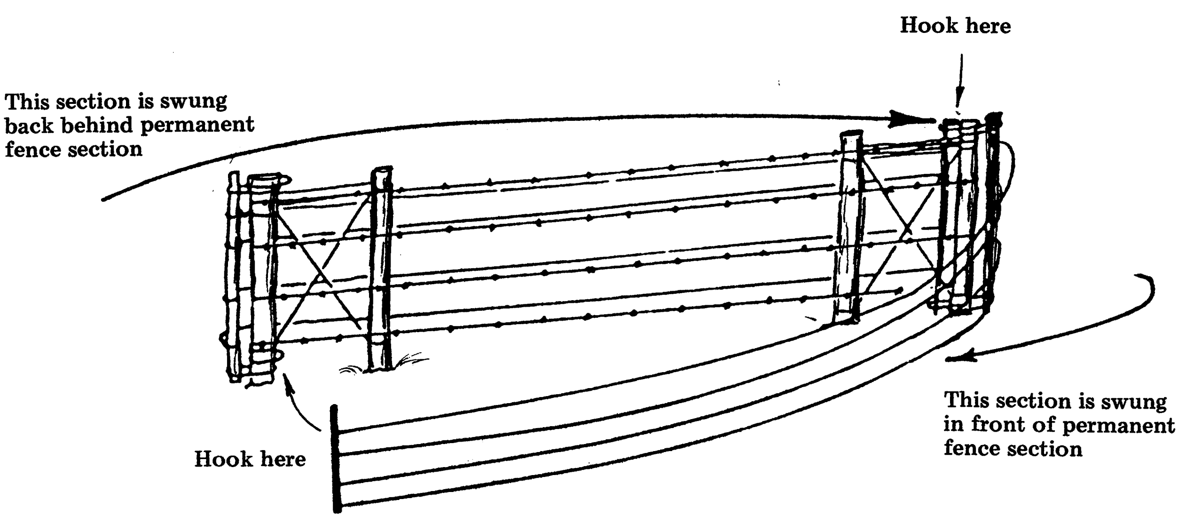


Spring-loaded fiberglass rod drive-through gate.



Drive-through gate detail.

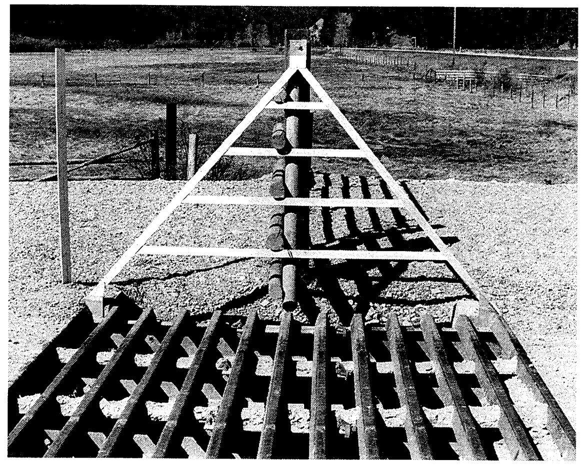
The swing-back fence is designed as a large gate. Large segments of a fence can be swung out of the way for wildlife movement.



Cattleguards

Cattleguards are similar to gates in that they both allow access to either side of a fence. There are differences however. A cattleguard does not have to be opened or closed, but does effectively prohibit livestock from crossing a fence line. Cattleguards are more expensive to build or buy than gates; they usually require digging to install; and they require frequent cleaning. And, to allow livestock to pass, a gate should be installed adjacent to a cattleguard. This additional expense should be weighed against the convenience of the cattleguard.

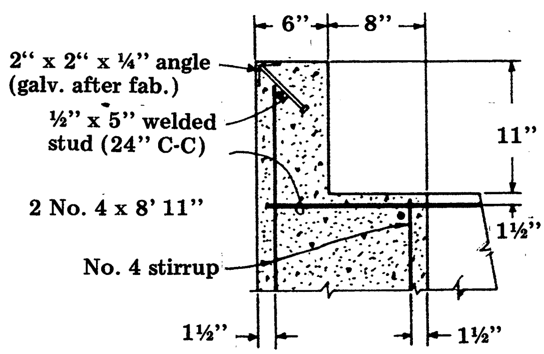
Examples of appropriate designs are illustrated:

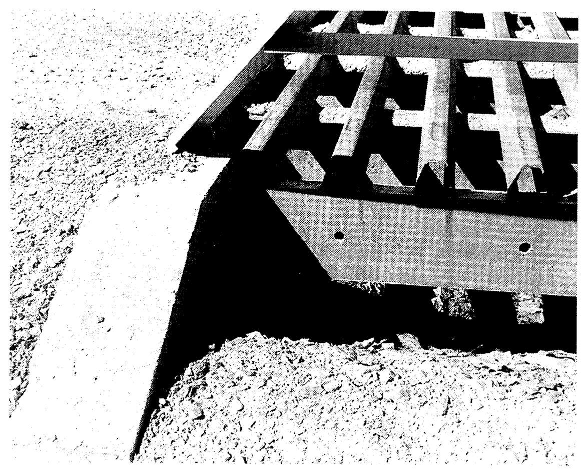


Concrete foundation cattleguard.

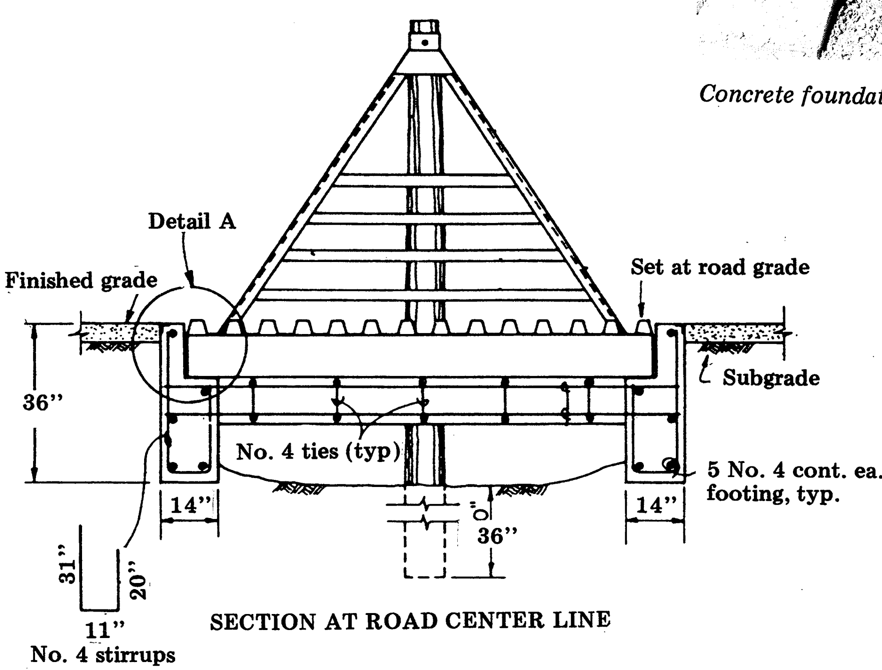
CONCRETE FOUNDATION

DETAIL A





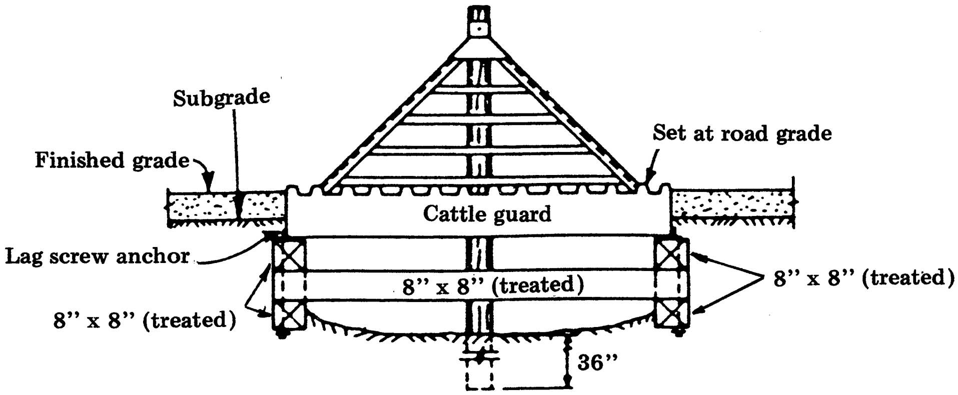
Concrete foundation cattleguard (detail).



SECTION AT ROAD CENTER LINE

	Cattleguard width	14'	16'	24'	28'	32'
MATERIALS REQUIRED	Concrete	3.3 c.y.	3.7 c. y.	5.4 c. y.	6.3 c. y.	7.1 c. y.
	No. 4 reinforcing steel	324 l. f.	355 l. f.	486 l. f.	547 l. f.	618 l. f.
	2" x 2" x ¼" steel angle	28 l. f.	32 l. f.	48 l. f.	56 l. f.	64 l. f.

TIMBER FOUNDATION



SECTION AT ROAD CENTER LINE
(with grid and wings in place)

Notes: Cattleguard anchor angles with ¾" x 6" lag screws with standard washer to be furnished with each single grid

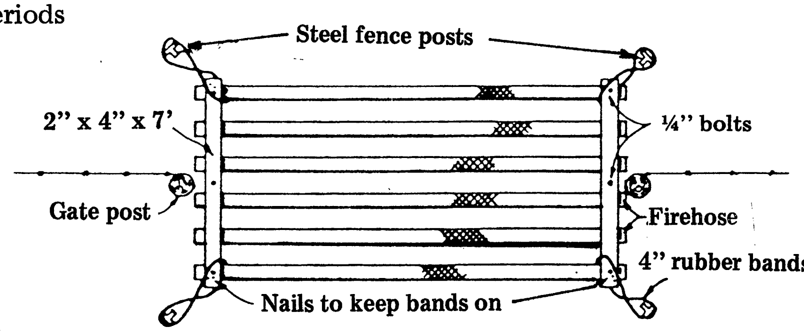
On earth-surfaced roads, set top of cattleguard 8" above subgrade unless plans or stakes indicated another elevation. Taper fill back from cattleguard approximately 50 feet in both directions.

TEMPORARY CATTLEGUARD

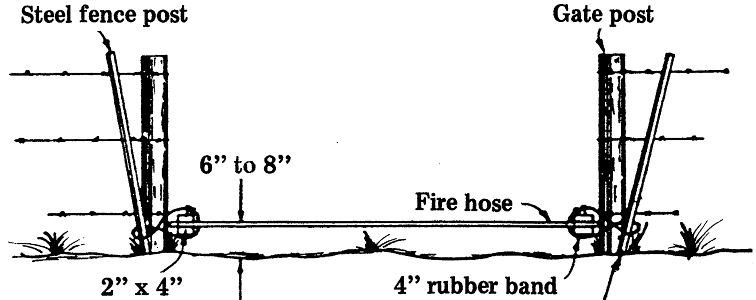
Temporary cattleguards are cheap and effective where vehicular traffice is heavy for short periods such as during timber sales.

Materials:

4— 2" x 4" x 7' lumber
6— ¼" x 4" machine bolts
12—5/16" washers
44—16d nails
150' 1½" cottonjacket firehose (yellow if available) (cut into 14' lengths)
2—innertubes (cut into 4" bands)
4—5' steel fence posts
30' baling wire (to close in ends)
4—1½" sections of split firehose (to mount on steel post to keep post from cutting rubberbands when guard is mounted)



TOP VIEW

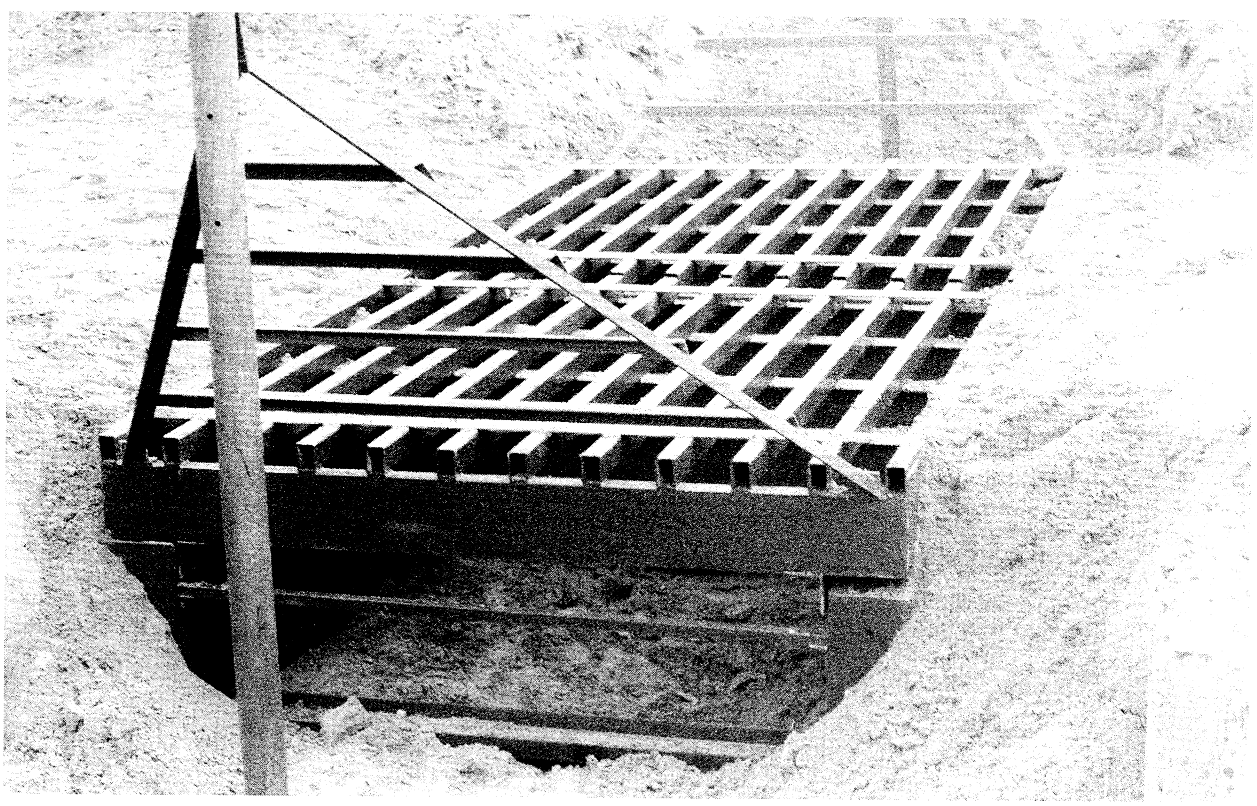


SIDE VIEW

Temporary firehose cattleguard

STEEL FOUNDATION

Typical steel foundation cattleguard under construction.



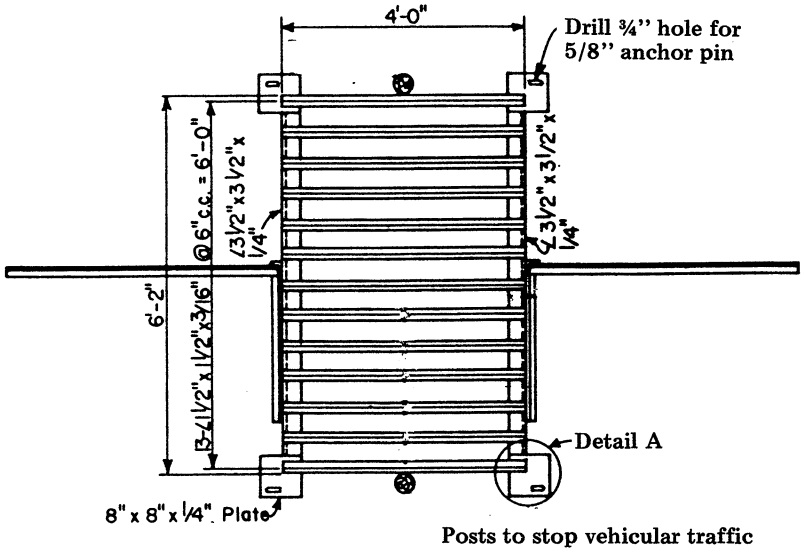
Steel foundation cattleguard.

A well-constructed cattleguard of railroad iron should be set in a concrete foundation. Only the inner edge of the cattleguard lies on the boundary line to allow removal for cleaning. Note that drainage is easily provided that does not conflict with the fence line.

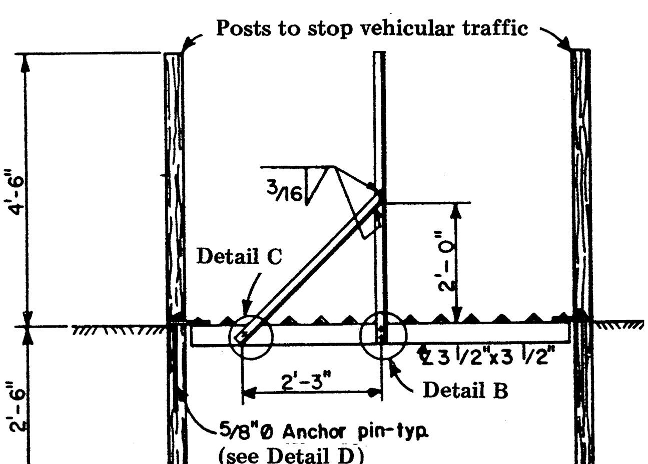
If you construct guards in heavy traffic, you must consult an engineer.

Pass structures are small cattleguards that prevent livestock movement but allow antelope a break in the fence line. For cattle, sheep, and antelope a 6-foot by 8-foot pass is recommended. Corner location of these passes is recommended.

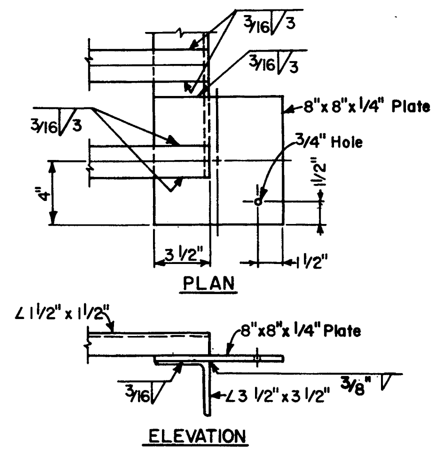
ANTELOPE PASS



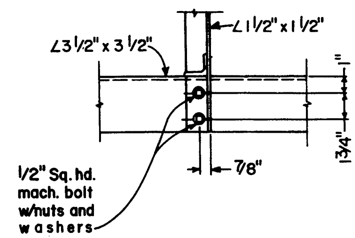
TOP VIEW



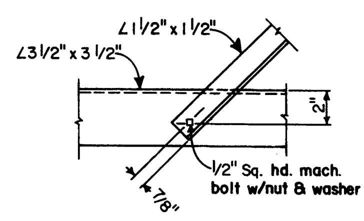
SIDE VIEW



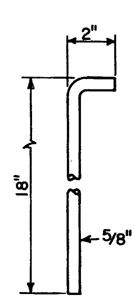
DETAIL A



DETAIL B



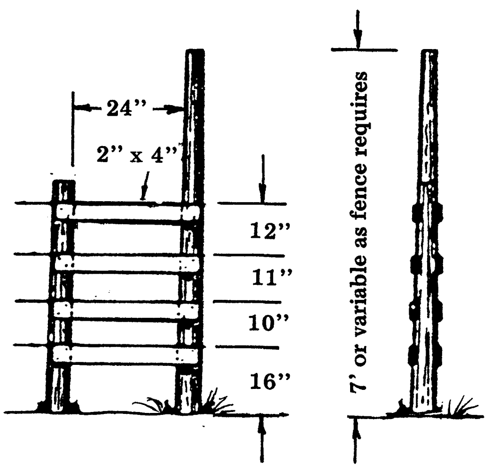
DETAIL C



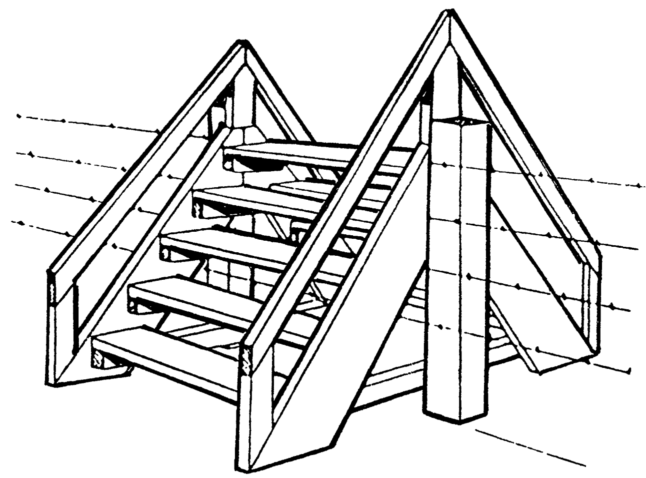
DETAIL D

People Access

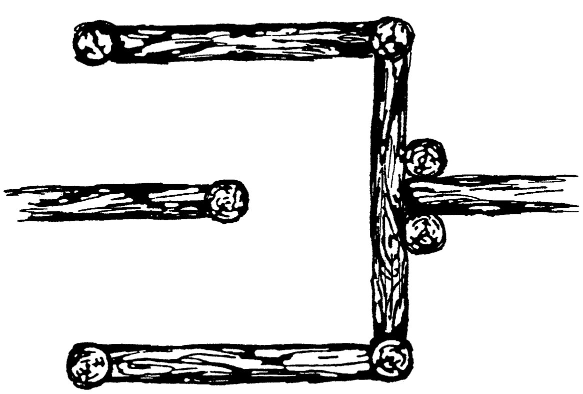
Fences control livestock, wildlife, and people. Controlling people effectively requires planned access. Gates are, of course, the most common access, but stiles, ladders and walk-throughs exclude livestock and wildlife while allowing people to move safely from one side of a fence to the other. These structures must be strong and durable. They must be constructed with safety as a major consideration. Treated lumber will prolong the life of the structure. Controlling where people cross a fence will save a great deal in maintenance and replacement costs.



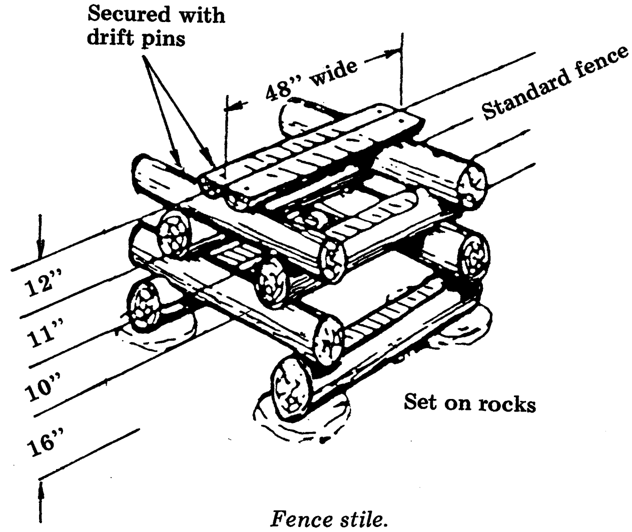
Standard fence post



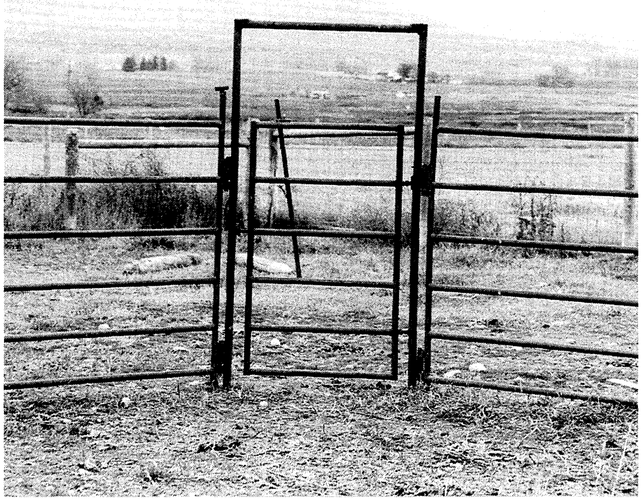
Fence stile.



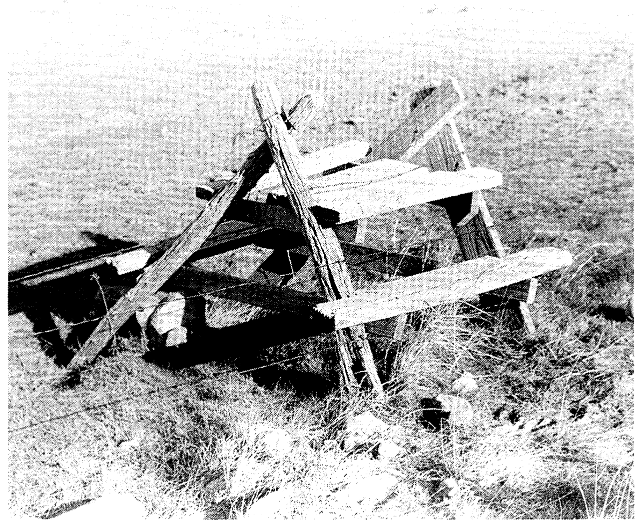
Walk-through gate.
(Excludes livestock & wildlife.)



Fence stile.



Typical steel access gate.



Fence stile.

Materials

Recommended post and brace sizes are:

Wood Posts and Brace Members

Member	Top Diameter *Square Inches*	Minimum Length *Feet*
Corner post	6	8
End post	5	8
Gate post	5 or 6	8
First corner brace post	5	8
Other brace post	4	8
Horizontal brace member	4	8
Diagonal brace member	4	10

Steel Posts and Brace Members

Member	Pipe Diameter *Inches*	Angle Measure *Inches*	Minimum Length *Feet*
Corner post	2½	2½ x 2½ x ¼	8
End post	2½	2½ x 2½ x ¼	8
Gate post	2½	2½ x 2½ x ¼	8
First brace post	2½	2½ x 2½ x ¼	8
Other brace post	2½	2½ x 2½ x ¼	8
Horizontal brace member	2	2½ x 2½ x ¼	8
Diagonal brace member	2	2½ x 2½ x ¼	10

Posts, rails, and other wood members contacting the ground should be treated with a preservative. Wood can be preserved by controlling the moisture content, using wood naturally resistent to the pests, or by chemicals. Mechanical barriers are sometimes used, but are usually ineffective. This handbook discusses chemical preservatives.

Sap wood and soft wood accept wood preservatives much better than heart wood or hard woods do. If possible, choose sap wood from a soft wood species for your wood components.

Wood preservatives fall into three catagories: creasote and creasote solutions, oil-based preservatives, and water-based preservatives. The following table shows the advantages and disadvantages of the three general types of preservatives.

Advantages and Disadvantages of Preservatives

Preservative Type	Advantages	Disadvantages
Creasote and Creasote Solutions	Toxic to wood-destroying fungi, insects, and some marine borers; low volatility; insoluable in water; easy to handle and apply.	Dark color; strong odor; oily, unpaintable surface, tendency to bleed or exude from the wood surface; should not be used in homes or other living areas because of toxic fumes.
Water-based	No hazard from fire or explosion; the surface is left clean, paintable, and free of objectionable odors; safe for interior use and treatment of playground equipment; leach resistent.	Unless re-dried after treatment, the wood is subject to warping and cracking; does not protect wood from excessive weathering.
Oil-based	Toxic to fungi, insects, and mold; can be dissolved in oils having a wide range of viscosity, vapor pressure, and color; low solubility; can be glued, depending on the dilutant or carrier; easy to handle and use.	Can leave an oily, unpaintable surface, depending on the carrier; some applications provide less physical protection to wood than creosote; should not be used in homes or other living areas because of toxic fumes; it is toxic and irritating to plants, animals, and humans.

There are two basic methods of applying wood preservative.

Pressure treating is the most common practice for commercial companies treating wood. Pressure treating offers the following advantages: a deeper and more uniform penetration; better control over retention; wood can be preconditioned in the chamber; and it can comply with safety code regulations and engineered specifications.

However, once a treated member has been cut, insects and decay can enter through the non-protected area of the cut. For this reason, it is best to precut the members before treating.

Non-pressurized treatment is a cold soaking technique that can be used to treat wood members. When treated, wood should be peeled, seasoned, and unglazed. If wood is glazed, pound it with an incising hammer to allow the preservative to penetrate. Soak the poles until the preservative has evenly penetrated ½-inch into the wood. This may take from several hours to several days. Soak a sample pole and inspect cuttings at regular intervals to establish the time needed to treat the poles. A recipe for preservative is:

1 to 1½ cups boiled linseed oil

1 ounce melted paraffin wax (Melt over a double burner only; do not melt over direct flame)

19 ounces copper-8-quinolinoate

Add enough solvent (mineral spirits, paint thinner, or turpentine) to make 1 gallon

A typical corral fence would require 25 to 30 gallons of preservative. Fill a 55-gallon barrel half full with preservative. Load posts or other wood to be treated into the barrel. If the preservative does not then fill the barrel, add solution to the top.

There are three major wood preservatives classified by the Environmental Protection Agency: creosote, inorganic arsenicals, and pentachlorophenol. Restricted use was based on toxicity due to exposure over a long period of time.

Exposure can come through handling and mixing the chemicals, entering pressure-treating cylinders, working around spraying or dipping operations, handling freshly treated wood, cleaning or servicing equipment, or disposing of waste preservatives. Reducing the exposure received reduces the level or risk of toxicity. Exposure can be reduced by following the guidelines listed below:

1. Don't eat, drink, or use tobacco products in the work area.

2. Wash hands often.

3. Remove gloves to handle paper work, phones, or equipment that other people may touch.

4. Eye protection, long-sleeved shirts, rubber gloves, long pants, respirators, and rubber or heavy boots should be worn when working with a preservative on freshly treated wood.

5. Wash clothes separately.

A single or short-term exposure of the three restricted preservatives can cause the following sypmtoms:

Creosote:

Can cause skin irritation; vapors and fumes are irritating to the eyes and respiratory tract; prolonged and repeated exposure may lead to dermatitis.

Pentachlorophenol:

Irritating to eyes, skin, and respiratory tract.

Ingestion of penta solutions, inhalation of concentrated vapors, or excessive skin contact may lead to fever, headache, weakness, dizziness, nausea, and profuse sweating. In extreme cases, coordination loss and convulsion may occur. High levels of exposure can be fatal.

Prolonged exposure can lead to an acne-like skin condition or other skin disorders, and may cause damage to the liver, kidneys, or nervous system.

Inorganic arsenicals:

Exposure to high concentrations of arsenical compounds can cause nausea, headache, diarrhea and abdominal pain (if material was swallowed); extreme symptoms can progress to dizziness, muscle spasms, delirium, and convulsion.

Prolonged exposure can produce chronic, persistent symptoms of headache, abdominal distress, salivation, low-grade fever, and upper respiratory irritation.

Long term effects can include liver damage, loss of hair and fingernails, anemia and skin disorders.

In case of exposure, follow these procedures:

If skin has been exposed, first remove contaminated clothing. Immediately wash the affected areas with mild soap and water. Don't irritate the skin with vigorous scrubbing. Later, if you notice inflammed skin, redness, or itching in the affected area, consult a doctor.

In cases of eye contact, immediately flush the eyes with running water. Lift the upper and lower eyelids for complete irrigation and continue for fifteen minutes, then see a doctor.

If accidental inhalation has occurred, move the victim to fresh air and apply artificial respiration as needed. Get medical help immediately.

If chemical preservative has been swallowed, call medical help immediately:

*If creosote or penta was swallowed, first give one or two glasses of water, induce vomiting, then administer two tablespoons of 'USP Drug Grade' activated charcoal in water.

*If an arsenical chemical has been swallowed, drink large quantities of water, or milk if available. Get professional medical help immediately.

Never attempt to give anything by mouth to an unconscious person.

Never induce vomiting in an unconscious person.

The product label and consumer data sheets supplied by the chemical companies also provide emergency treatment recommendations.

Use extreme care when using wood preservatives or wood treated with a preservative. When working with wood treated with one of the restricted preservatives, consult the Environmental Protection Agency or your County Extension Agent.

Brace Wire—Used to put tension on the brace in the opposite direction of the fence line tension. A standard brace wire is soft No. 9 gauge wire wrapped around the posts two times or it may be two strands of twisted No. 12½ gauge wire wrapped around the posts once. A single strand of 12½ gauge high tensile wire wrapped twice around the posts is equal to the twisted wire.

Life expectancy of wire depends on the kind and thickness of the protective coating. The most common coating is zinc. Galvanized or zinc-coated wire is measured by the amount of zinc per-square-meter or square-foot. Fence manufacturers and the American Society for Testing Materials have established classes of zinc coating—Class 1 has the lightest coating and Class 3 the heaviest. Life expectancy of Classes 1 and 3 coatings to protect wire from rusting under various climatic conditions are shown in the following table.

Copper is much more effective than zinc in resisting rust. However, once the copper coating is nicked enough to expose the steel wire, corrosion occurs at a faster rate than on galvanized wire. Aluminum coating has at least 3 to 5 times greater corrosion resistance than zinc coating. Aluminum coating also resists heat up to 1,650° F. It is therefore more suited for areas where burning under fences is common. Some manufacturers add copper to steel, but tests by the American Society for Testing Materials show no additional value in this process. Most manufacturers use a medium-hard steel in their fencing wire to allow spring action through tension curves. These tension curves are partially straightened when the fence is stretched. During summer heat they take up slack as the fence lengthens and they allow the fence to contract in winter. Barbed wire does not have the advantage of tension curves, so a wire stretched on a hot summer day may break or pull a brace assembly out of position during the winter. Small wire must be made of harder steel to provide adequate pulling strength. A fencing wire made of soft steel will not have adequate strength to hold up to the tension applied when the wire is stretched.

Galvanized Wire Rust Expectancy

Wire Size	Climatic Condition: Dry Class 1	Dry Class 3	Humid Class 1	Humid Class 3	Coastal & Industrial Class 1	Coastal & Industrial Class 3
	Years till rust appears					
9	15	30	8	13	3	6
11	11	30	6	13	2	6
12½	11	30	6	13	2	6
14½	7	23	5	10	1½	4½

Nails and Staples—Galvanized 40d common nails are sometimes used to hold the compression member in place. The most common galvanized staple is 1½-inches long. In extremely hard wood, a 3/4-inch long galvanized staple may be preferred.

Rod or Stick—Any strong rod-resistant material can serve as a twist stick to set the tension of the brace wire. Such materials are a 3/8-inch bridge spike, a piece of steel rod, a treated piece of wood around 1½ x 2-inch x 2-foot in size. Be sure these twist sticks are placed so they will not unwind.

Steel Dowel Pins—Used in place of notching the brace posts to hold the compression members. Ideally, a 3/8-inch galvanized carbon steel rod 4 to 10 inches long is preferred.

Compression Sleeves—Splice brace wires and fence wires together and eliminate the need to tie the wire off.

Lightning Protection—Steel posts give some fences the lightning protection they need. Fence posts of other materials need lightning protection added at every brace and on both sides of a gate. A 5/8-inch galvanized steel rod 6 feet long is commonly used as the ground rod and a galvanized screw clamp connects the fence ground wire to the rod.

Tools

The following tools are needed to construct braces and corners:

- Post hole digger
- Tamping tool
- Saw—carpenter or chain
- Chisel, wood—1-inch or larger
- Brace and bits—various bit sizes and expansion bit
- Rule—12-foot in a metal case
- Crayon marker
- Crimper
- Plumb bob
- Post driver
- Axe—single or double
- File—flat and/or chain
- Hammer—claw and 4-pound
- Carpenter's level
- Carpenter's square
- Nail apron
- Ball of cord or twine

Various kinds of equipment are available for placing posts:

Two-handled hand digger—Works well in areas where there is little rock.

Shovel and bar—Best in rocky ground.

Tractor-mounted auger—Some are rigidly mounted and some free swinging to allow you to drill straight regardless of slope. Tractor-mounted augers are not well adapted to steep or rocky ground.

Portable self-contained power augers—Commercially available.

Chain saw augers—Have power take-off and attachments. They work well in spring and early summer on ground that is not too rocky or hard.

Carpenter's level—Helps set brace posts vertically.

Carpenter's rule—Measures post, sets depths, positions compression members, and measures wire spacing.

Carpenter's square—Aligns the notch to be chiseled out of the brace posts.

Crayon marker—Marks post depth, notches, position of compression members, and positions of wire.

Nail apron—Holds nails and staples.

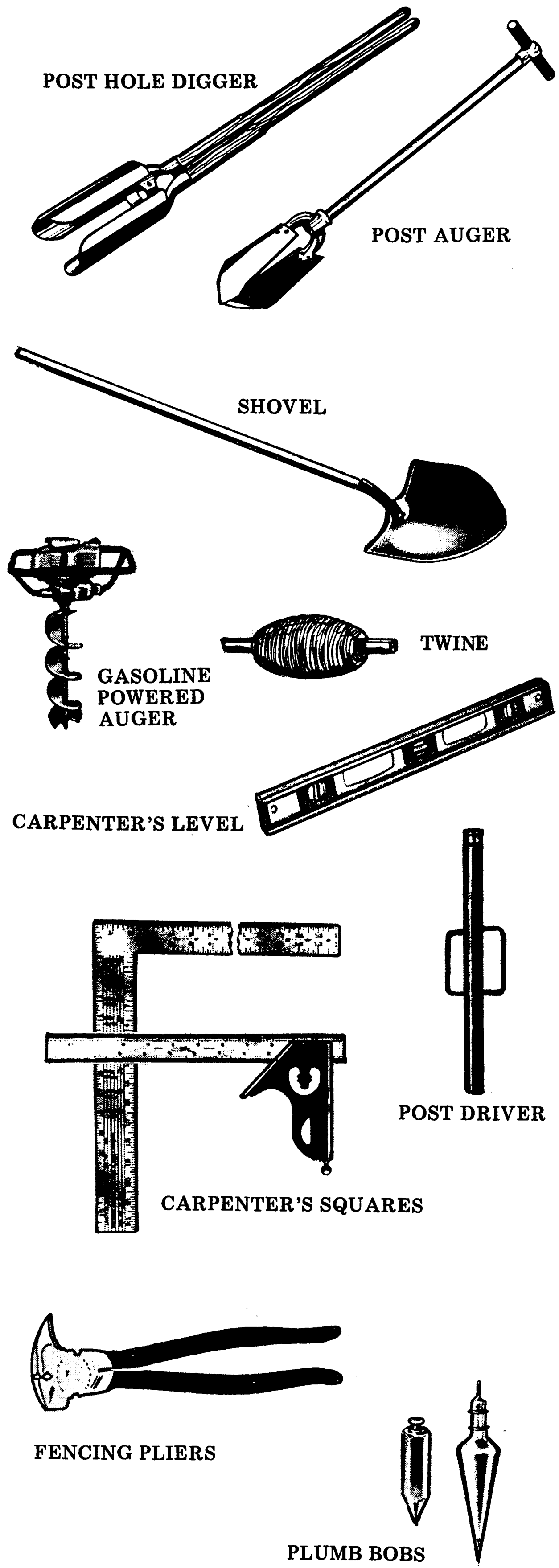
Crimper—Ties off wire.

Ball of cord or twine—Measures the length of brace wire for the brace and marks the straight line between braces.

Plumb bob—To set the 1- and 2-inch lean on anchor and/or brace posts.

Post drivers—Hand-operated post drivers may be purchased or built. The heavier two-person drivers are best for rocky ground.

Mechanical post drivers—Can be mounted on tractors, trailers, or skids. They need a crew of two or three to operate.



Tamping tools—The most common tool is a digging bar with a round tamping head on the other end or handle end. A 1-inch galvanized pipe about 6 or 7 feet long with a cap or short tee-joint works well. In sandy or loam soil a fire rake or shovel handle with the end cut off square makes a good tool. In other types of soil you need to put a 2-foot length of pipe with a cap on one end on the wooden handle to give the tamping tools enough weight. Wooden handles are less tiring to workers than metal handles.

Axes—Single- or double-bit axes shape compression members to fit notches in brace posts.

Saws—Carpenter's or chain saws shape compression members to fit notches on brace posts and cut ends off posts.

Files—Sharpen axes or chain saws.

Chisels—Shape notch in brace posts.

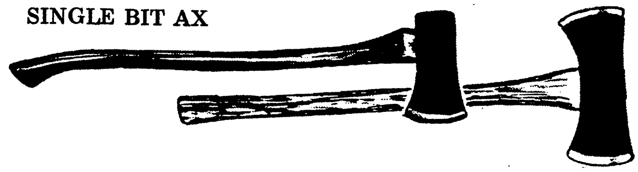
Hammers—Claw and 4-pound hammers are used in chiseling notch in brace posts, driving in steel dowels, setting nails, and staples.

Brace and bits—Makes holes for steel dowels.

DIGGING BAR

TAMPING TOOL

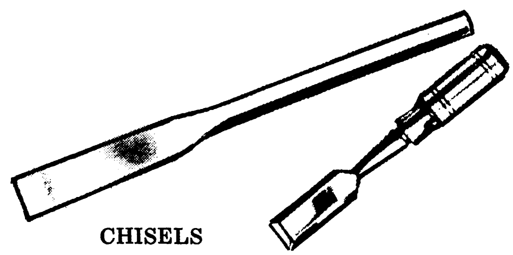
SINGLE BIT AX



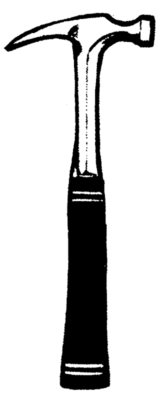
DOUBLE BIT AXE

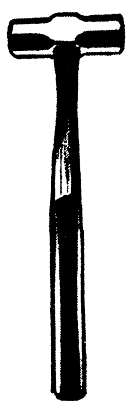
SAW

FILES



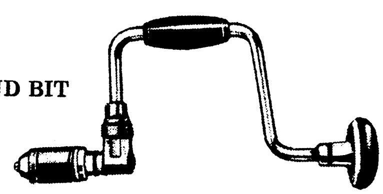
CHISELS



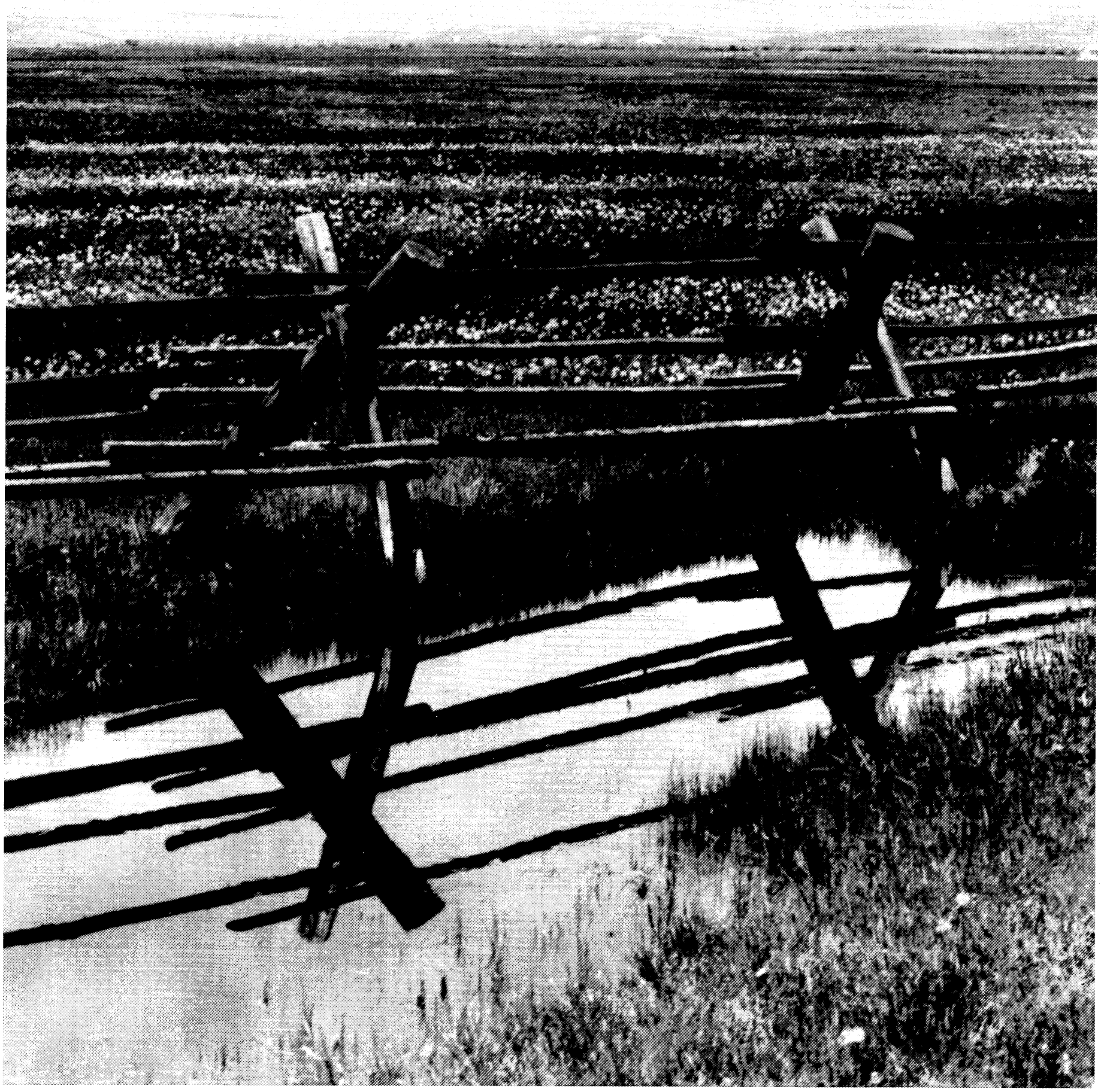


CLAW HAMMER 4-POUND HAMMER

BRACE AND BIT



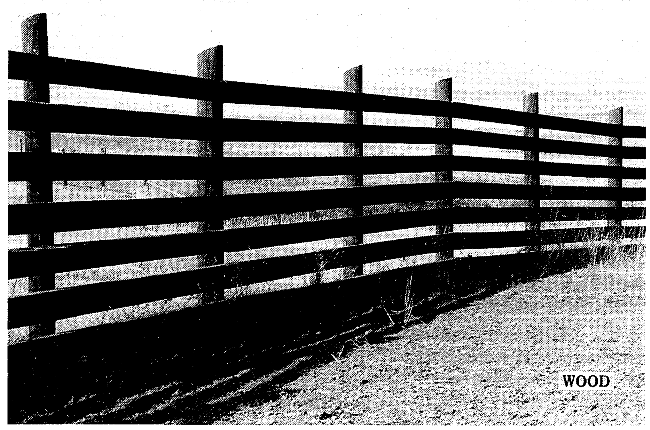
PORTABLE DRILL



Fence Options

Three major fencing options are presented in this handbook—electric, wire, and wood. There are a multitude of choices within those major categories. You may, for example, choose smooth, barbed, or woven wire or choose between temporary or permanent fencing. To help you make your decisions, we have described the advantages and disadvantages of the most common fences, and have included cost comparisons, construction techniques, tools and materials.

Barbed wire is the most common fence built. A conventional four-strand barbed wire fence provides a strong physical deterrent, but is moderately costly to build and maintain. Smooth high tensile wire reduces injuries to livestock caused by barbed wire and is a good alternative for interior fences. It has a lower construction and maintenance cost than conventional barbed wire. Permanent electric fencing is rapidly replacing both barbed wire and high tensile wire fencing. Permanent electric fencing is rapidly replacing both barbed wire and high tensile wire fencing. Permanent electric fencing is more a psychological barrier rather than a physical barrier and therefore has lower labor and material costs. It is relatively easy to install and has a long service life. Wood fences are more expensive to construct. They are more visible than most other fences; however, they are often the most esthetically pleasing.



Examples of fences.

Electric Fences

Electric fences have been viewed as temporary structures, but with recent innovations they are now permanent. High tensile electric fencing is inexpensive; easy to construct; has less animal damage; is less restrictive to wildlife movement; requires less maintenance; and, if properly constructed, has a longer life span than conventional fences. To be effective, electricity must be constant. The fence must be frequently inspected and animals must be trained to respect it.

The old standard U.S. manufactured energizers could electrify up to 6 miles of wire that had a useful life of up to 4 years. New Zealand energizers can effectively electrify over 75 miles of wire with a useful life of 10 to 15 years.

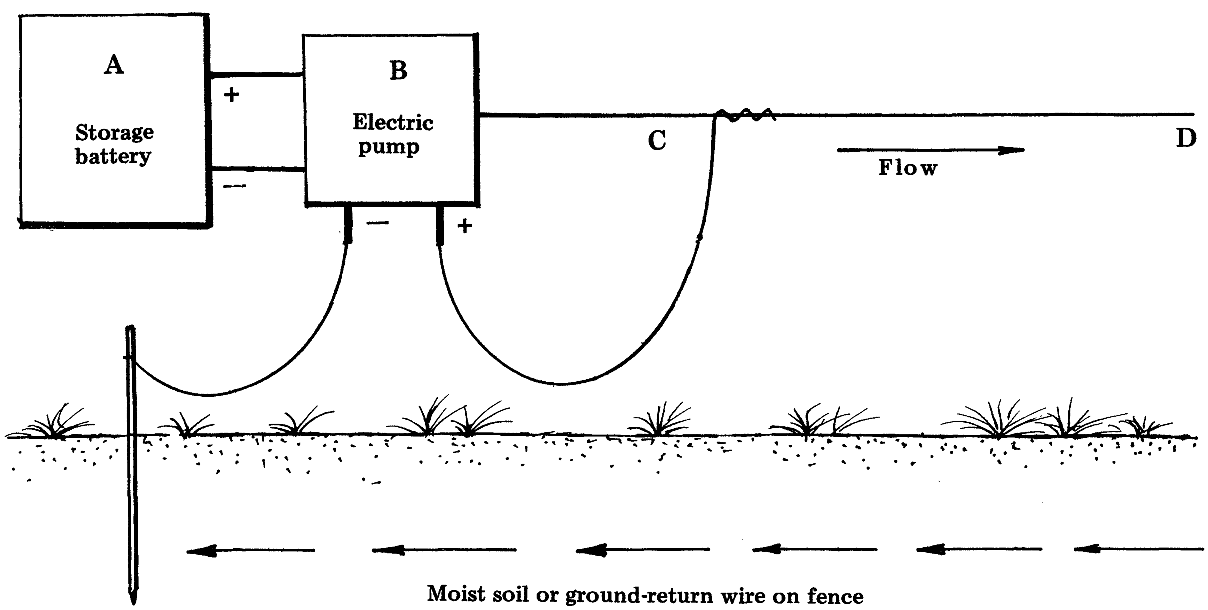
An electric fence is a wire that carries intermittent electrical charges that shock when the wire is touched. To be effective, a shock of at least 1,000 volts must be delivered to cattle, 2,000 volts to sheep, and 2,500 to 3,000 volts to deer, dogs, and coyotes. Electric fences are more of a psychological barrier than a physical barrier and may not need as much material as standard fences. This may result in a 25 to 50 percent saving in labor and material costs.

The effectiveness of the electric fence depends on six factors:

1. the power of the energizer
2. the wire carrying the current
3. the insulators carrying the charged wire
4. the conductive nature of the ground
5. the earth peg or earth-return wire
6. the type of animal being controlled

A definition of electrical terms is included for your convenience.

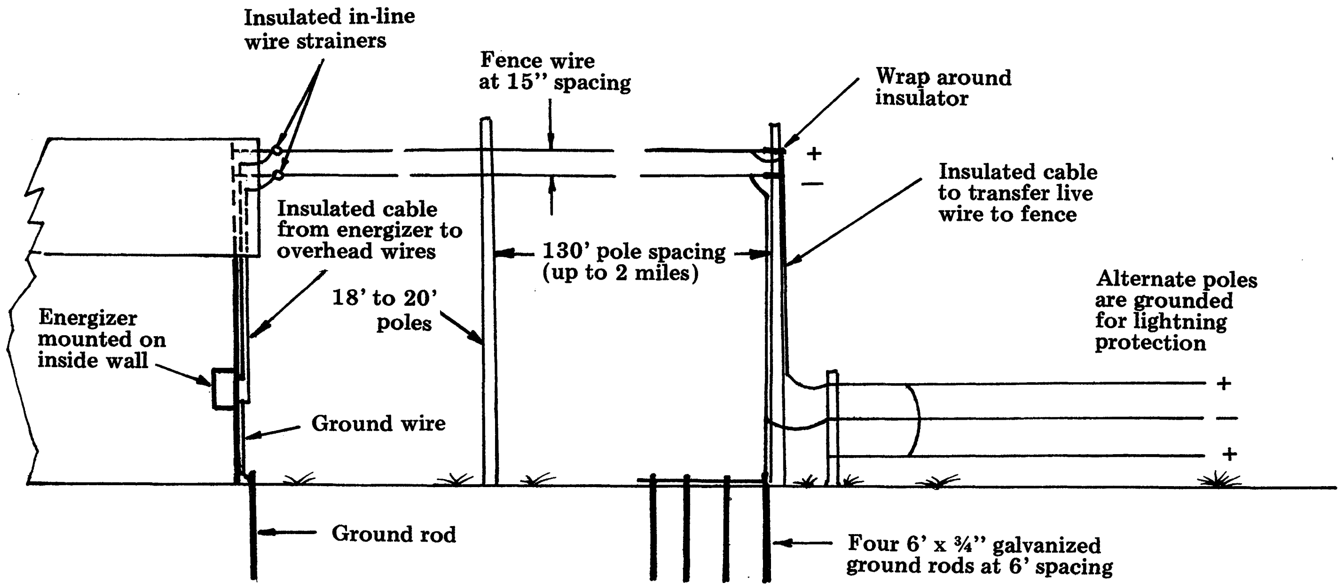
Electricity from either the main lines or a storage battery (A) is forced by an electric pump or energizer (B) along the wire from C to D. In an electric system, a ground-to-earth or ground-return wire back to the energizer must be provided to complete the circuit or the current will not flow. The rate of flow is measured in amperes per second and the pressure in volts. The total power imput and output of the energizer is expressed in watts (amps times volts).



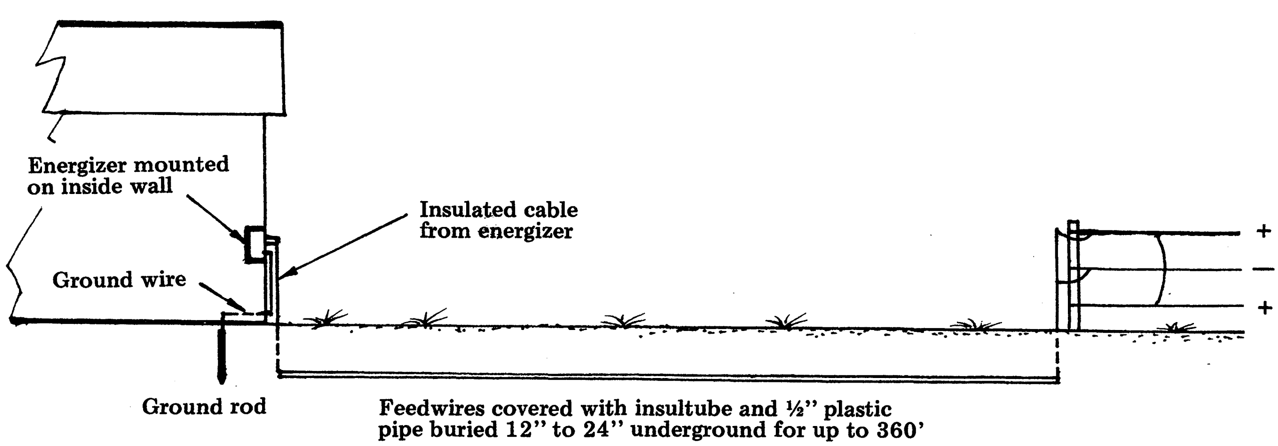
Resistor:	An electrical component which, due to its material and or shape, offers resistance or restriction to the flow of electricity. The degree of restriction is measured in electrical units called ohms. The amount of resistance that will limit the flow to 1 amp when a pressure of 1 volt is applied = 1 ohm. Volts/amps = ohms.
Conductor:	A substance that allows electrons to flow freely. The less resistance, the better the conductor. The unit of conductance is called Mho (ohm spelled backwards), this unit is the exact reciprocal of the ohm. Amps/volts = Mhos.
Insulator:	A substance that will not allow any electron flow and is used to stop electricity from leaking. Most insulating materials have a critical pressure for a given thickness, above which the material suddenly punctures.
Leaks:	Refers to low conductance (high resistance) paths from the fenceline back to the energizer earth terminal, caused by: Cracked insulators, foliage entangled in the live wire, a length of live wire on the ground, animals touching the live wire.
Shorts:	Refers to a high conductance (low resistance) path between the live wire and either a dead wire or an earth return wire. Commonly known as a wire-to-wire short. Such a condition constitutes the largest threat to the reliability and effectiveness of an electric fence line.
Volts:	Units of electrical pressure, just as lb/square-inch are units of physical pressure. One volt is the force necessary to cause a current of 1 amp to flow through a resistance of 1 ohm, i.e. ohms x amps - volts.
Amps:	Units of electrical rate of flow, just as gallons per hour are units of rate of physical flow. One amp is a flow rate of 6,280,000,000,000,000,000, i.e. 6.28 x 10^{18} electrons per second. One amp is the rate of electron flow that results when a pressure of 1 volt is applied across a resistance of 1 ohm, i.e. volts/ohms = amps.
Ohms:	Units of electrical resistance or restriction to the flow of electrons, just as a long, thin pipe causes physical resistance or friction to the flow of water through it. One ohm is the amount of resistance that will limit the flow rate to 1 amp when a pressure of 1 volt is applied, i.e. volts/amps = ohms.
Coulombs:	Units of electrical quantity, just as 1 gallon is a specific quantity. One coulomb is 6.28 x 10^{18} electrons, i.e. a flow rate of 1 amp for 1 second. Amps x seconds = coulombs.
Watts:	Units of electrical rate of doing work, i.e. power, just as horsepower is a physical rate of doing work. One horsepower can lift 1 lb vertically at the rate of 550 feet per second, or heat 1 lb of water at the rate of 0.7 degrees fahrenheit (0.39°C) per second. 746 watts = 1 horsepower, and can therefore lift 1 lb at the rate of 550 feet per second, or heat 1 lb of water at the rate of 0.7 degrees fahrenheit per seond. A flow rate of 1 amp at a pressure of 1 volt produces watt, i.e. amps x volts = watts.
Joules:	Units of electrical energy, just as 550 foot lbs (1 horsepower for 1 second) is a specific amount of physical energy, i.e., 746 joules = 550 foot lbs. One joule is the amount of energy required to do approximately 0.74 foot lbs of work. One joule is the energy required to produce 1 watt for 1 second, i.e. watts x second = joules.
Energy:	The capacity or ability to complete a particular amount of work (see joules). It is largely the quantity of joules released by an energizer during each pulse, which determines its effective power. 3,600,000 joules = 1 kilowatt-Hour.
Capacitor:	An electrical component capable of storing and releasing electrical energy, and approximating a reservoir, the volume of which is stated in electrical units called Farads (micro farads). If 1 amp flows into a capacitor for 1 second and this causes a rise in pressure of 1 volt, then the volume of the capacitor = 1 Farad. Amps x seconds/volts rise = farads.

If the mainline power source is over 2 miles from the fence, a battery-powered energizer should be used. Most battery-powered energizers can be hung from one of the upper wires on the fence with a wing nut, or fastened to a fence post with rust-proof screws. Energizers should be located where they cannot be damaged by livestock or machines, and they should be located in an enclosure to prevent theft or vandalism. If possible, a mainline plug-in energizer should be installed inside a building to protect it and permit frequent inspection. Plug-in energizers can also be installed outdoors on a fence post or a separate post, but never on a power pole.

Installed indoors, the power input should be from a properly fused and grounded electrical outlet designed to receive a thee-pronged plug for 110 volt or a three-pronged plug for 220 volt operation. For indoor installations, the high-voltage feedwires from the energizer to the outside of the building can be No. 12 two-wire double-insulated copper electrical cable attached to two strands of galvanized high tensile wire strung overhead or buried underground. In either case, the ends of the copper wires should be "tinned" before attaching them to the galvanized wires and the underground wires should be protected with insultube and ½-inch plastic pipe. A separate ground wire should be connected from the ground terminal on the energizer to a ground rod driven just outside of the building.

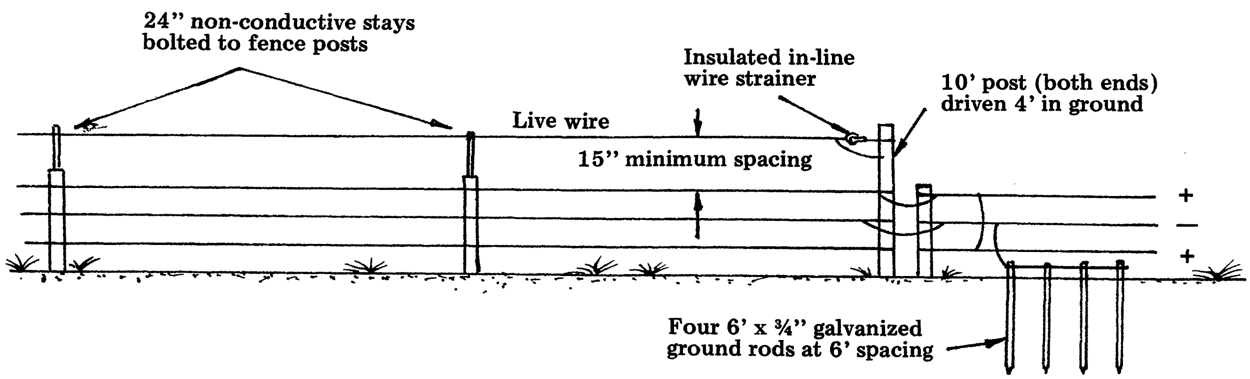


Overhead transmission from energizer to fence.



Underground transmission from energizer to fence.

If carrying the power overhead or underground to the fence to be electrified is impractical, it is possible to simply string a live wire on 24-inch nonconductive stays bolted to the tops of the existing fence posts and use one of the wires on the fence for a ground-return wire.



Transmission using existing fence.

Components

Energizers

In the mid 1960's, new energizers were developed in New Zealand. These units, and others based on them, are of solid-state construction and release high voltage electrical charges. Their useful life is at least 15 years. These chargers can release 5,000 volts under no-load conditions and can effectively charge between 30 and 75 miles of fence, depending on the type of energizer and the number of wires charged. For example, a very powerful mainline-operated energizer can supply 60 miles of a single-strand fence, but can charge only 20 miles of a fence containing three hot wires (20 miles x 3 strands = 60 miles of charged line). Charges are released at a rate of 35 to 65 per minute, approximately 3/10,000 of a second in duration, and are less than 300 mAmps in intensity.

Many energizers will give a 5,000 volt reading with a voltmeter, but this is no indication of their ability to deliver a charge when subjected to varying loads caused by such things as dry or wet vegetation. Specifications detailing the energy (joules) and force (volts) produced by energizers under light to extreme resistances (ohms) are available from most energizer manufacturers and suppliers. The greater the joule and voltage output at a given resistance, the longer stretch of fence it will power and the greater its ability to power through vegetation.

Perhaps the most important part of high tensile electric fencing is the selection of the energizer. A permanent high tensile electric fence must be powered by energizers meeting the following specifications:

1. High-impact self-insulating plastic cases resistant to weather and corrosion.

2. Indicator lights that show the energizer and the fence are functioning properly.

3. Snap-in service modules for fast field repair.

4. Safety pace fuse to prevent over-pulsing.

5. Choice of output—on all 110 and 220 volt units, half power and full power output terminals should be available. On 12-volt models a variable speed switch is necessary to increase battery life.

6. Automatic output control to add power as needed.

7. Solid-state circuitry with 5,000 to 6,000 volts peak output.

Solid-state energizers have advantages when compared to standard U.S. manufactured energizers:

1. A stronger pulse that lasts a shorter period of time.

2. Less internal resistance.

3. Greater capacity to drive a charge through vegetation or other leakage sources.

4. Substantially less tendency to arc, which reduces fire danger.

5. Longer life because of solid-state design.

6. Removable circuit boards that can be easily replaced.

New Zealand energizers may be operated by mainline power or by wet or dry cell batteries. Solar and wind powered energizers have been developed. Mainline-operated units eliminate maintaining and replacing batteries and they provide a more consistent and cheaper supply of power. Most models will consume $1 or less of kilowatt-hours per month when operated 24 hours a day. Since transmission wires must be strung to the fence, these units should be located within 2 miles of a power source. As a result, mainline energizers are used primarily for permanent electric fences in nonintensive livestock operations. Mainline units may be connected to either 110 or 220 volt power sources.

Wet cell batteries are rechargable and power either 12-, 24-, or 32-volt energizers. The 24- or 32-volt units are capable of a similar voltage output as mainline units, but batteries must be continually recharged by a generating plant. Twelve-volt units are capable of one-quarter to one-half the voltage output of mainline units and can power between 5 and 25 miles of fence wire. Manufacturers' claims of battery life are based on ideal conditions seldom duplicated in the field. Some manufacturers suggest that conventional 12-volt automobile or tractor batteries can power their energizers. Experience has shown that this is not feasible.

Dry cell energizers are more expensive in the long run and do not electrify as much fence (up to 2 miles) as wet cell batteries. Dry cell batteries are non-rechargable and generally last from 1 to 6 months. They may be used for temporary summer grazing and then discarded.

Solar-powered energizers are particularly suited to remote, little visited areas. Solar panels are usually placed on a mounting unit and produce enough wattage (up to 32 watts) to charge 12-volt batteries. Depending on the storage device employed, between 5 and 14 days of energy can be stored for later use on nights and cloudy days. Models can supply between 2 and 30 miles of fence material and are reported to have an average life expectancy of 8 to 10 years. They may be used for either temporary or permanent fences. These energizers eliminate running long lead-outs from a mainline and require little maintenance other than adding water to the batteries once or twice a year.

Wind-chargers may also charge 12-volt batteries. Such a charger was effective for 3 years in Australia and charged 7 to 9 miles of fence. Wind chargers are more costly than solar panels and have wearing points. They are susceptible to an intermittent power source. There is greater chance of a discharged battery and of frost damage.

Choose an energizer based on the following factors:

1. The power output required to control the animals to be worked with.

2. Length of fencing material to be electrified—both the number and distance of hot wires.

3. Protection against dust or corrosion if the energizer will be outdoors.

4. Expected future needs for energizer.

5. Power available—mainline, battery.

6. Reliability of brand.

7. Permanent fence or frequently moved temporary fence.

8. Type of soil and its prevalent moisture content.

9. Rated and actual outputs of various units.

10. Initial and operating costs.

11. Flasher to tell if unit is producing pulses.

12. High-low switch to regulate power according to the moisture content of the soil or to train livestock.

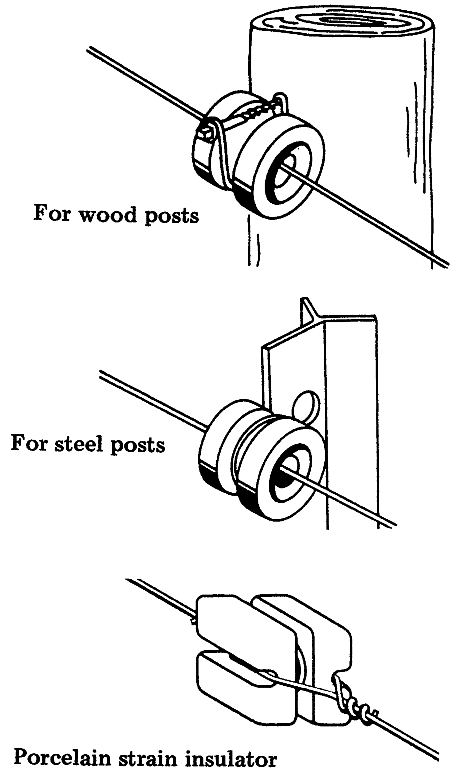
13. Provision for easy mounting of portable units.

14. Built-in lightning resistor.

Energizers meeting the requirements for electric fencing are commercially available.

The efficiency of an energizer is affected by the amount of leakage from the wires and a wet or dry climate. It is more effective to power a few short fence lines radiating from a central point than one long fence line.

Pulsing sequences differ. Some energizers may produce uniform electrical charges between 35 to 65 times per minute. Some energizers produce pulses up to 15 seconds apart. A 15-second interval effectively controls trained sheep. The greater interval greatly reduces power requirements and extends battery life. A new design incorporates a random pulsing sequence. This design emits a series of random charges that are more intimidating to livestock. A significant "off time" period follows the shocks and allows the animal to be released from the wires.

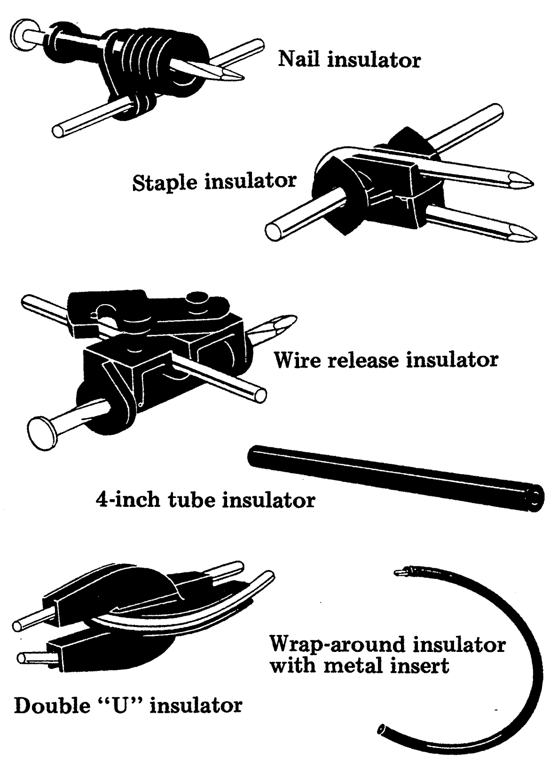


Ceramic insulators.

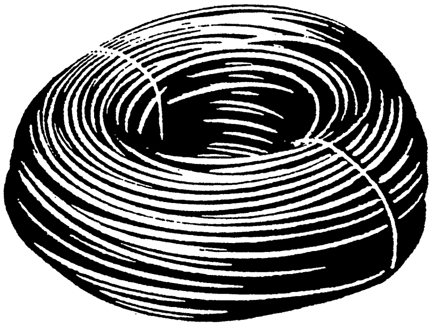
Insulators

Insulators are constructed of either porcelain or plastic and may be attached to posts by wire clips, nails, staples, screws, or wrap-around tubes. Both porcelain and plastic types will deteriorate under extreme climate conditions. Porcelain insulators are strong and durable and resist fire damage. These insulators are very reliable in high strain positions at ends and corners. They are subject to frost damage, however, and can develop fine cracks in the glaze.

Most insulators are designed to withstand ultra-violet light and up to 2,200 pounds of strain. Black insulators resist ultraviolet breakdown, but plastic insulators are less efficient than porcelain when dirty. They will stand stress, but have a low impact value. Plastic insulators should have a large flash plate to prevent arcing to the post. Tube insulators with metal inserts are quite durable. Tube insulators have been found to collect dirt and nesting insects, which can cause electrical leaks.

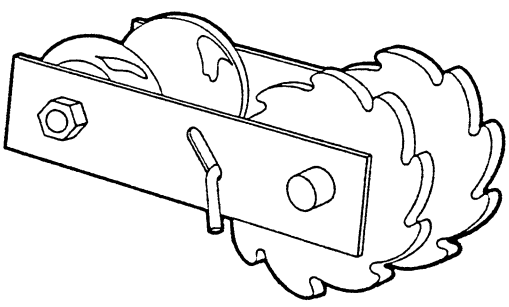


Plastic insulators.



For insulating overhead and underground feedwires. Available in small and large coils

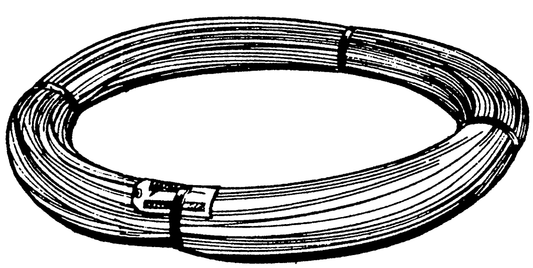
Insultube.



Insulated adjustable in-line wire strainer.

Wire

Twelve-and-a-half gauge smooth high tensile wire has proved most effective at the least cost.

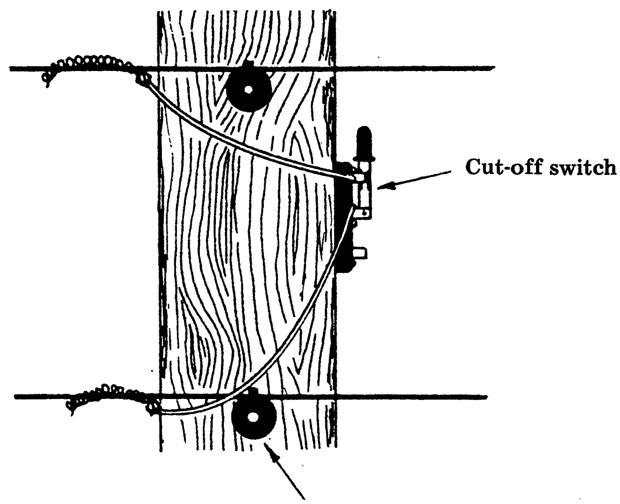


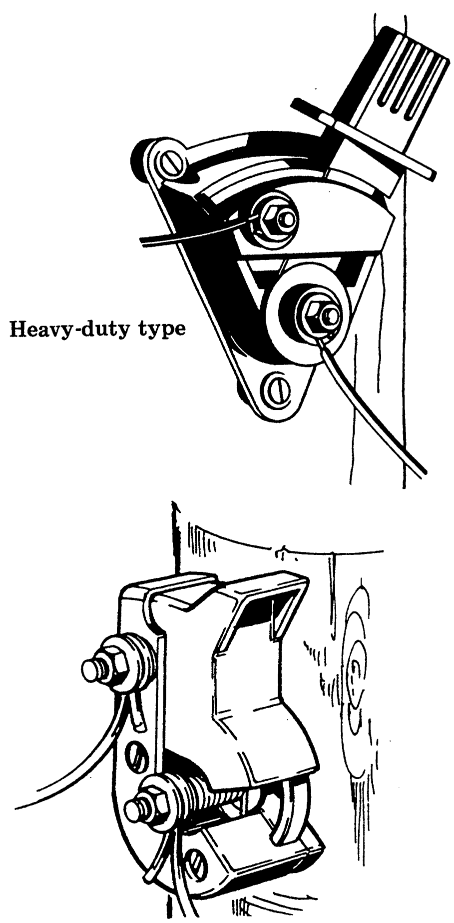
12½ gauge smooth high tensile wire.

Heavier gauge wire may be required on extremely long fence lines because of its lower resistance. Heavier gauge wire is also used for leadouts when the main power source is far away from the fence line. Lighter gauge wire (14, 14½, and 15) may be used for temporary electric fences. Its higher resistance is not appropriate for permanent electric fences.

Cut-off Switches

Cut-off switches can be installed at intervals along fences to isolate sections for repairs and also can cut power to sections not in use.

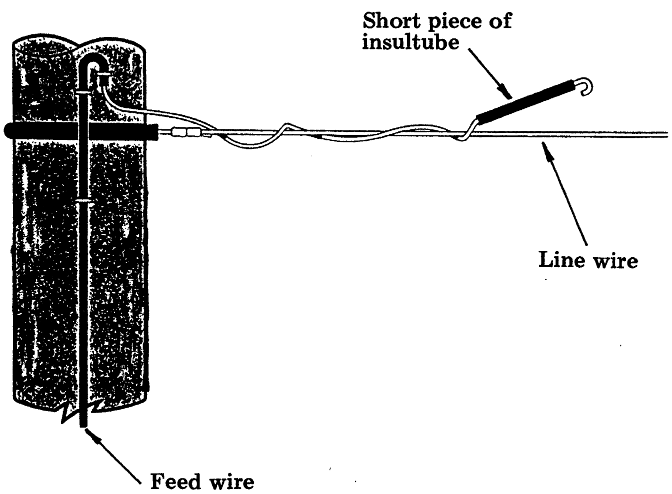




Typical cut-off switches.

Tapping

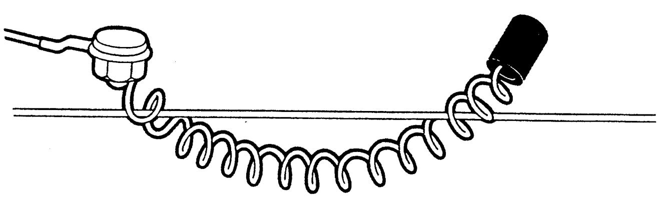
Tapping feedwires onto line wires on the fence, or connecting ground wires onto ground-return wires on the fence, can be accomplished using short segments of the same wire used on the fence. This method requires no fittings and, when part of the wire is covered with a short piece of insultube, the tap can be connected and disconnected without switching off the electricity.



Tapping feedwire onto line wire.

Spring Connectors

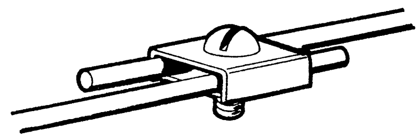
Flexible spring connectors attach to feedwires or ground wires as shown. Spring wire taps can easily be fastened to line wires without tools. Fitted with short lengths of plastic tubing, these can be connected and disconnected without switching off the current.



Flexible spring connector.

Line Clamps

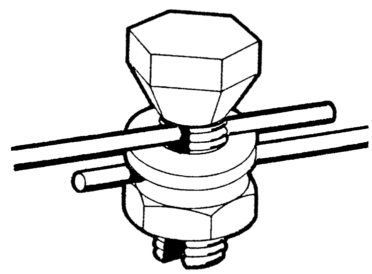
Screw-type line clamps are economical and can be installed with only a screwdriver. These galvanized clamps provide a quick and easy method for tapping feed or ground wires into line wires already strung and stapled on the fence.



Screw-type line clamp.

Connectors

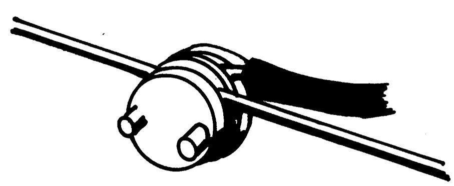
Solderless connectors are installed with a small wrench or pliers. Solderless connectors provide another means of tapping feed or ground wires onto line wires already installed on the fence.



Solderless connector.

Joint Clamps

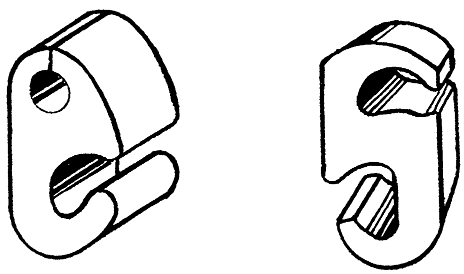
Wire joint clamps are a bolt-type clamp that installs easily with a screw driver and pliers for tapping feed or ground wires onto existing fence wires.



Wire joint clamp.

Nicotap Sleeves

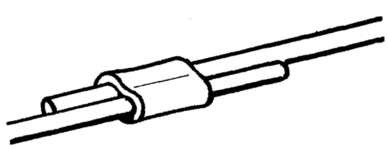
Nicotap sleeves are economical fittings for permanently tapping feed and ground wires onto line wires. These sleeves allow connecting new wires to existing wires without cutting or splicing.



Nicotap sleeves.

Nicopress Sleeves

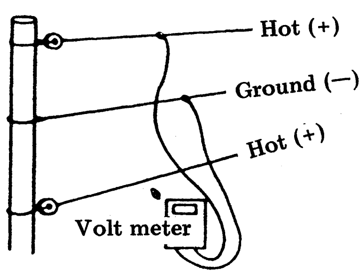
Nicopress sleeves are economical fittings for permanently tapping feed and ground wires into line wires. Sleeves must be threaded onto the line wires and moved to the exact location where they will be fastened before tying off and stapling the line wires. They must be crimped with a crimping tool and cannot be removed once installed. They are available in various sizes to accommodate different gauges of wire.



Nicopress sleeve.

Volt Meter

A volt meter is the single most important tool one can have to properly install and maintain an electric fence. It allows effective monitoring of the voltage. If the voltage falls below 2,000 volts, disconnect the fence and attach the volt meter to the energizer. If the voltage is normal, then the problem is in the fence.

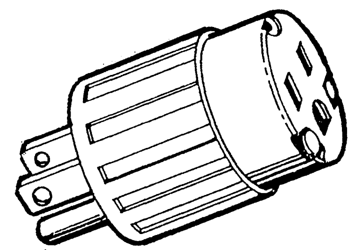


Shockstop

A shockstop is an electronic cut-off switch that allows you to switch the power on and off anywhere along the fence by transmitting a signal back to the control unit with the hand unit. The control unit is connected to the main power energizer, which allows you to easily move or work on the fence.

Voltage Spike Protector

A voltage spike protector protects the energizer from power voltage surges and is recommended for rural areas where power fluctuations are common.



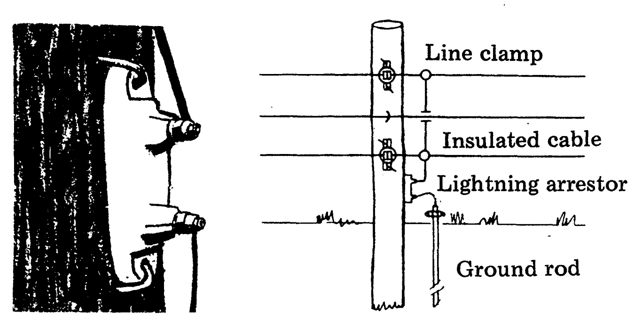
Voltage spike protector.

Voltage Alarm

A fence voltage alarm is an electronic monitoring device that can monitor 110-, 220-, or 12-volt energized fences. It features both audible and visual indicators for showing interrupted power. It also has a 12-volt output terminal that can be attached to a horn or flashing light. It can be powered by either two 6-volt batteries (inside the case) or the same 12-volt battery that powers the energizer.

Lightning Arrestor

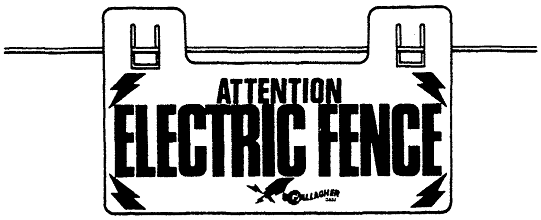
A lightning arrestor allows a spark gap in the porcelain base to let lightning go to the ground before it can reach the energizer.



Lightning arrestor.

Warning Signs

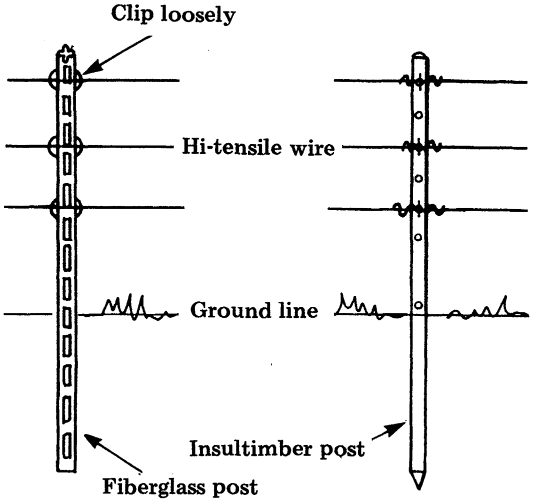
Warning signs are required on electric fences where people may contact them. The interval for these warning signs should not exceed 300 feet.



Warning sign.

Posts

Posts and braces for electric fences are the same as those for standard wire fences. High density wood posts are reported to be nonconductive. Density is sometimes enhanced by pressure treating with creosote. There is some electrical leakage with these posts during wet periods.



Posts.

Electroplastic Twine (Temporary)

Electroplastic Twine has a variety of stainless steel filaments (3 to 9) intertwined with ultra-violet stabilized polyethylene/polypropolene cord. The stainless steel filaments are loosely looped throughout the poly-cord, which exposes them to animals that contact the twine.

Electroplastic twine.

Advantages are:

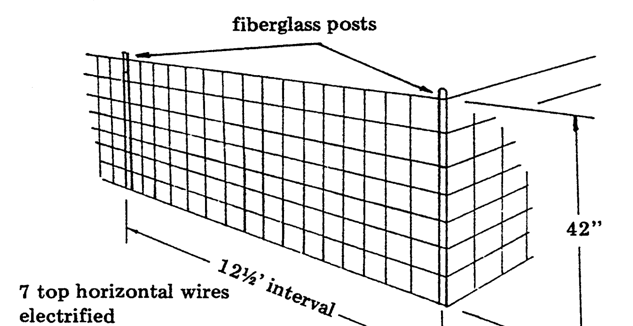
1. It is very lightweight.
2. It is fairly elastic.
3. It is easily knotted.
4. It requires only hand tightening.
5. Its breaking strength is over 190 pounds.
6. As the number of filaments increase, the electric resistance lowers.

Disadvantages are:

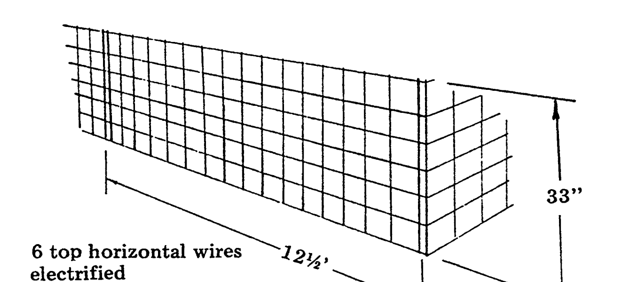
1. It weathers poorly.
2. If the filaments break and the poly-cord does not, it is hard to find the break.
3. Capabilities of the energizer are lowered because of high wire resistance. To join two electroplastic twines, tie a double overhand knot.

Electroplastic Netting (Temporary)

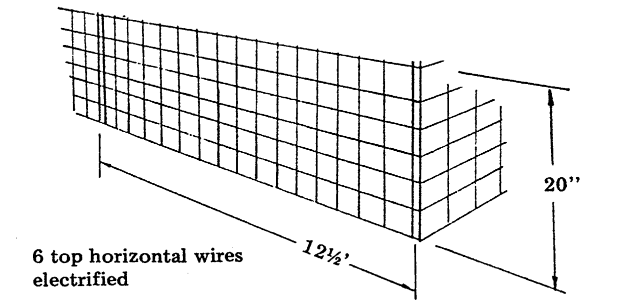
Electroplastic netting is constructed of the same material as the electroplastic twine. Only the top strands contain the stainless steel filaments that carry the electric charge. The bottom horizontal and all vertical strands are made up of only ulta-violet stabilized polyethylene/polypropolene cord, which cannot carry an electric charge. The netting comes in various sizes from 20 inches to 42 inches high and the number of electrified wires varies from 6 to 7. The netting is supported at 12½-foot intervals with fiberglass posts. The netting comes in lengths of 150 feet and weighs between 8 and 10 pounds. It has all the advantages and disadvantages of electroplastic twine. However, because the netting contains more electrical conductors, it carries an electric charge twice as far as electro-plastic twine.



HORSE AND GOAT FENCE



SHEEP AND HOG FENCE



RABBIT AND RODENT FENCE

Electroplastic Tape

Electroplastic tape is ½-inch wide with five strands of stainless steel filament running through it. Its advantages are:

1. Its light weight,
2. Its high visibility,
3. It is fairly elastic,
4. It joins with a simple knot,
5. It requires only hand tightening.

Its disadvantages are:

1. Breaks in the conductive filaments are hard to find if the tape is not broken.
2. The capabilities of the energizer are reduced because of high wire resistance.
3. It weathers poorly.

The tape may be held in place with special insulated pig-tail stakes. Other posts may also be used as long as the tape is held at the desired height and properly insulated. Good electrical connections are made with a double overhand knot.

A plastic ribbon coated with conductive aluminum carries the electric charge. The aluminum coating is highly visible. The ribbon is twisted as it flips off the roll. This provides a reflective surface that flickers in the wind and attracts animals. The ribbon has a high resistance to electrical flow that reduces the capacity of the energizer. This is an effective material for temporary fences.

Permanent Tape

For large areas, 14-gauge steel wire with an alumigel coating can be used. Once this fence is erected, a roll of ¼-inch yellow polypropolene tape is wrapped around the individual wires, two to three wraps every 16 feet, to give the wire high visibility.

Advantages are:

1. It provides the high visibility desired to attract animals to the wire and, once trained, to avoid it.

2. If the tape deteriorates or is damaged, it can be easily replaced with new tape.

3. It conducts the electrical current better.

4. It is stronger than electroplastic twines or tapes and is less susceptible to damage.

5. Repairs are made either with standard electrical wire knots or crimping sleeves for 14-gauge wire.

Disadvantages are:

1. It is heavier than electroplastic twines or tapes.

2. It is more difficult to roll up than electroplastic twines and tapes.

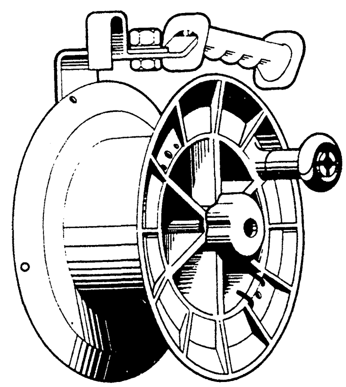
3. It requires extra wrapping for visibility.

Portable Reels

There are a variety of reels to roll up and hold any of the wire used in temporary electric fencing. These reels easily unwind and rewind the wire they hold for easy transportation. The reels have brakes that hold tension on the wire when it is strung out in a fence line.

The maximum length of single strand electroplastic twine on each reel is 1,980 feet. The maximum length of three strands of electroplastic twine on one reel is 660 feet.

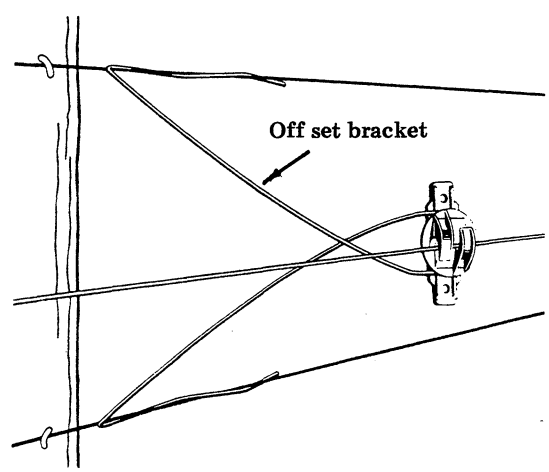
These reels can be attached to various types of posts or to the wires of an adjoining fence line. Some posts may need extra bracing to withstand the strain of the wire tension.



Portable reel.

Off Set Brackets:

There are various types of off set brackets that can be used to renovate old fence lines.



Off set bracket.

Safety

Anyone constructing electric fences should insure that these measures are adhered to:

1. Do not allow guide or line wires to contact any power lines.

2. Do not erect wires or ground wires near overhead power lines, telephone wires, or radio antennas. This not only prevents broken power lines from contacting fence wires, but it avoids interference.

3. Install mainline energizers inside a building or a structure free from risk of damage if possible. The energizer must not be attached to a power pole. All 110-volt or 220-volt supply lines for mainline energizers should be installed according to local electrical codes by a competent electrician. The energizer should be installed out of reach of children in a location free from risk of mechanical damage and flammable material.

4. The earth terminal on the fence energizer must be connected to grounding rods. Never connect the fence energizer earth terminal to any other grounding device. Establish one for it alone. At the same time, make sure that fence energizer grounding rods are at least 6 feet (2 meters) away from any other grounding rods for other purposes.

5. Under no circumstances should more than one energizer be connected to the same electric fence. Maintain at least 6-foot (2 meter) spacing between fence wires connected to different energizers.

6. Where the public may contact an electric fence, approved warning signs should appear at intervals not exceeding 300 feet (100 meters). These warning signs normally state "Electric Fence" or "Live Wires".

7. Where an electric fence crosses a public pathway, install a non-electrified gate or a safe crossing.

8. Where an electric fence wire crosses a public highway, maintain at least 15 feet (5 meters) between the wire and the surface of the highway.

9. Do not install any portion of an electric fence or make repairs or adjust wire tensions with the current on. Disconnect the feedwires to the segment of fence to be worked on.

10. When testing an electric fence with a voltmeter, wear rubber gloves or rubber-soled shoes to minimize electric shocks. Wear a non-metallic hard hat. Any electrical shock is intensified if the hands and feet and clothing are wet from rain or perspiration.

11. If testing a fence without a voltmeter or test light, place the palm of one hand on the soil and slide a blade of green grass forward gradually against a live wire. A trickle of current indicates the current is "on".

12. Never grasp a wire on an electric fence. Even if the current is off, test a live wire first with the back of your fingers. In the event of a shock, the reflex will pull fingers away from the wire.

13. In areas with dry grass, reduce the output of the energizer to minimize the risk of fire.

14. Keep all metallic farm implements away from electric fences. Do not tether livestock with chains near electric fences.

15. Warn all children that a fence is electrified and instruct several responsible persons on how to switch off or disconnect the current.

16. Do not attempt to repair or modify any electric fence energizer. Return it to the authorized dealer for service.

17. Do not construct or repair electric fences during thunderstorms.

18. Install proper ground connections on power poles or buildings to protect them from lightning.

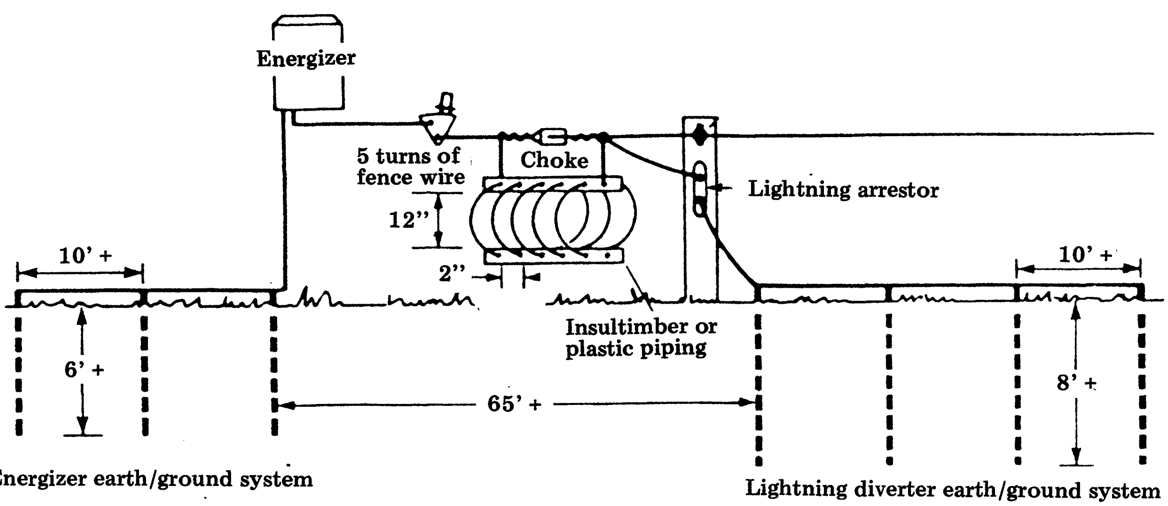
Most modern electric fence energizers have some form of lightning protection built into them by the manufacturer. Nothing totally protects from lightning. Several of the solid-state energizers have modules that are quickly replaced. Some users of electric fences advocate shutting off the supply of electricity to the fence during electric storms, others contend that no human or animal is likely to contact the wires during a lightning strike. It is wise to keep humans and animals away from electric fences during electrical storms.

A lightning arrestor is an important accessory on an electric fence. The spark gap in the porcelain base lets lightning go to the ground before it can reach the energizer. For maximum protection, the lightning arrestor should be installed between the energizer and the fence or on the fence as close as possible to the energizer. However, the grounding rods for the lightning arrestor must be at least 40 feet (20 meters) from the energizer's grounding rods.

All hot wires are attached to the fence terminal on the lightning arrestor with insulated cable and the ground terminal is attached to the ground rod with high tensile wire. Three lightning arrestors should be installed on each fence.

A choke assembly can also be constructed and used in combination with the lightning arrestor. The choke causes a blocking effect for the extremely high voltage of the lightning, so it jumps the carbon discs inside the lightning arrestor and disperses into the ground.

For total protection of the energizer during storms, unplug it and disconnect the earth and fence terminals from the energizer. In bad lightning areas, the top wire of the fence can be an earth one, grounded every 1,100 yards in damp areas to act as a lightning rod for the fence line.



Choke assembly.

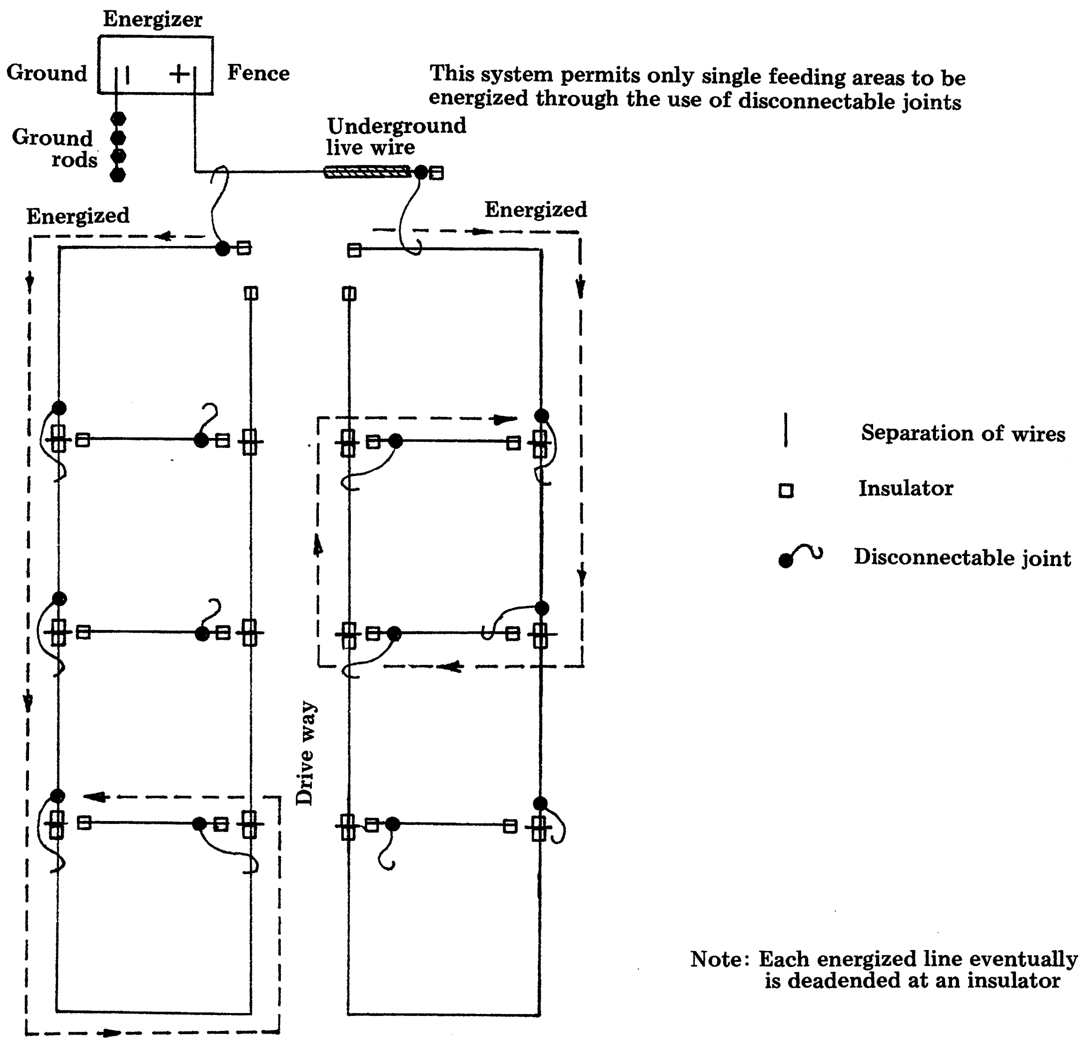
Construction

Laying The Line

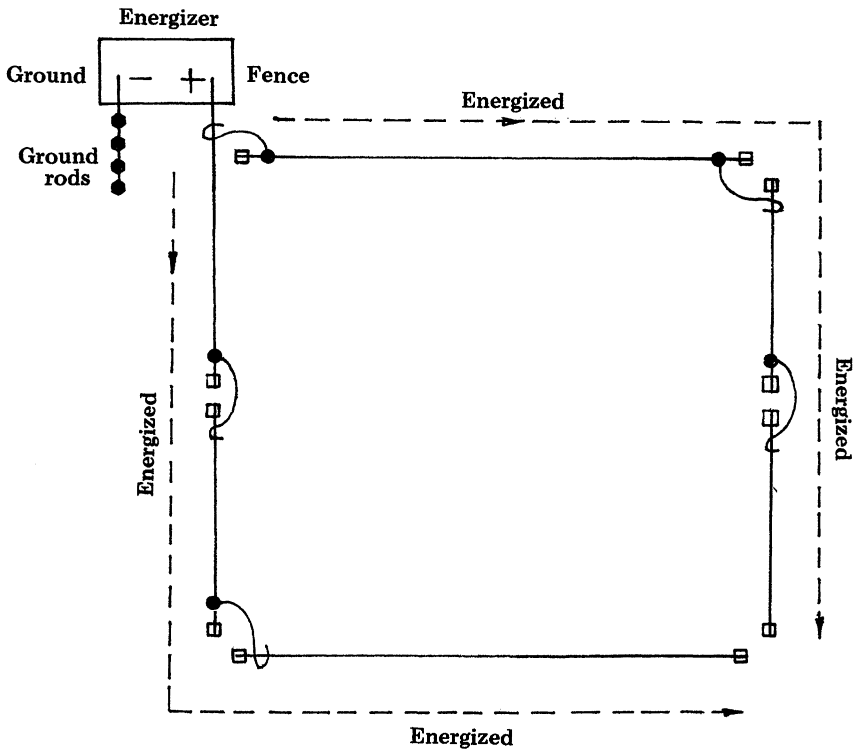
Laying out lines for electric fences requires more care than laying out nonelectric fences. Because lighter posts are often used, special attention must be paid to posts in curves, on corners, and over uneven terrain. Take special care to clear the fence line. This is especially important if live wires are to be placed at low levels on the posts. Remove all underbrush and debris along the entire line. Grade off humps and mow weeds and grass.

Plan the placement of disconnectable joints on the feed wires and the subdivisional wires. There can be only one connection from the energizer to the feeder lines and joints to enable a person to disconnect each feed wire and the associated subdivisional wires individually. Only one end of a subdivisional wire should be connected to a feed wire. The other end simply terminates at the strain insulator.

The following examples illustrate how disconnectable electric joints can be used to energize different areas as they are needed or for finding faults that occur somewhere in the system.



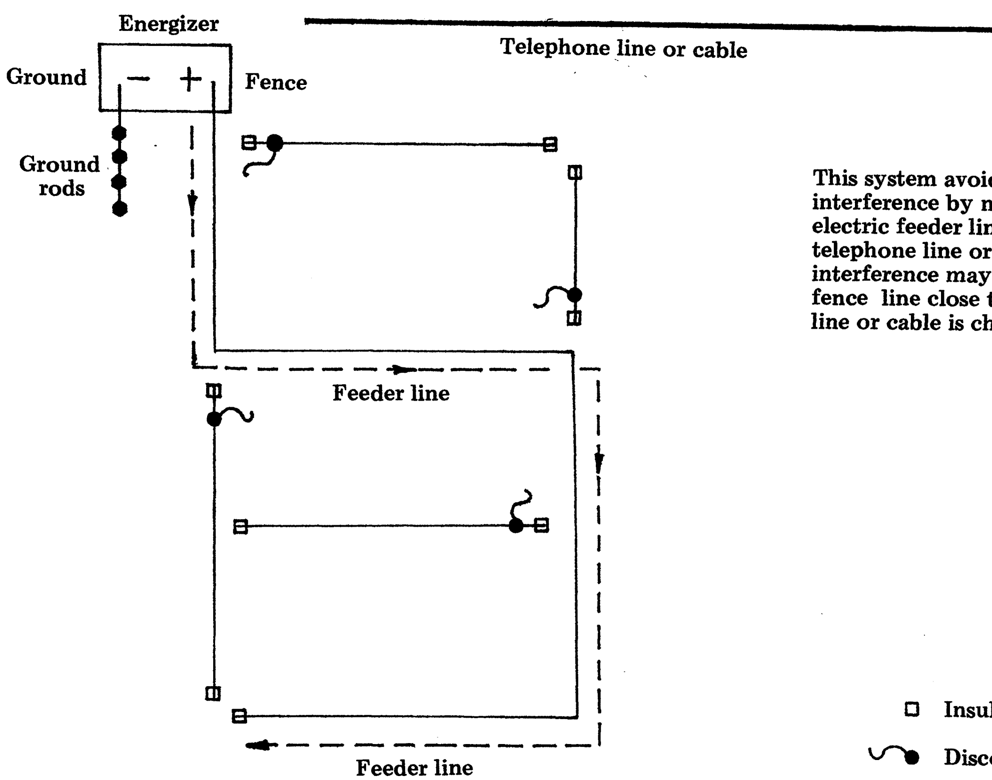
Disconnectable electric joints.



This system encloses one large area. Disconnectable joints are used in strategic locations in the fence to facilitate fault finding.

Insulator

Disconnectable joint



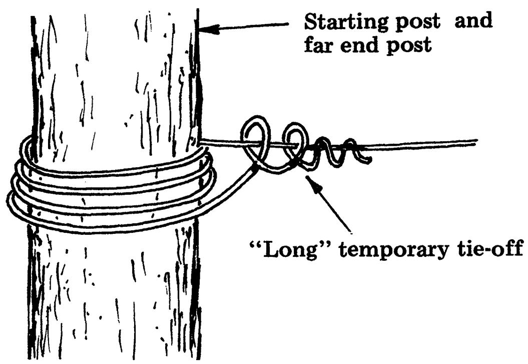
This system avoids telephone interference by not running the electric feeder line close to the telephone line or cable. Telephone interference may occur when the fence line close to the telephone line or cable is charged.

Insulator

Disconnectable joint

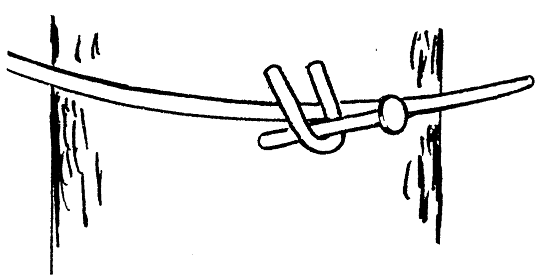
Disconnectable electric joints.

Special considerations apply when constructing electric fences. Stringing the guide wire is the key to properly locating the line posts for electric fences. The guide wire is the lowest permanent wire on the fence. Depending on whether it is a ground-return wire or a live or neutral wire, allowances must be made for fasteners and insulators for later connections and tying off. There are several means of doing this. The least expensive method requires making a "long" temporary tie-off on the starting post and on the far end post. A long tie-off is made simply by wrapping the end of the wire two to four times around the starting post before tying it off with an end post knot. A similar long tie-off should be made at the far end post.



"Long" temporary tie-off.

If uneven terrain requires one or more posts in rises or dips, relieve the tension on the guide wire enough to fasten it to all rise and dip posts. If the guide wire is to be electrified using tube insulators and sleeves, it should be temporarily fastened to the rise and dip posts with a staple and nail. For threading the tubes, simply remove the nails and, after all tubes are in position, drive another staple downward or upward.



Temporary fastening of live wires to dip post.

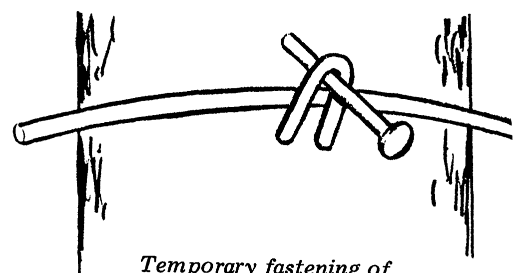
Remember:

1. Tension the guide wire so it retains its alignment.

2. All round posts in curves and corners should be driven so the guide wire is outside the posts.

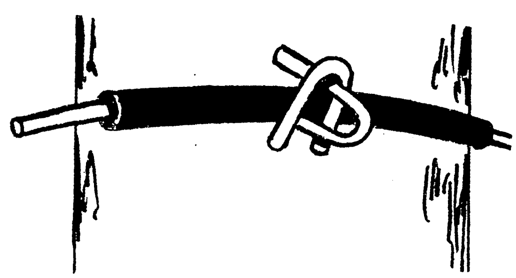
3. Posts should be driven with a 2-inch to 4-inch lean to counteract the pull of the wires.

4. If the posts have a natural taper, they should be positioned ½-inch to 3/4-inch away from the guide wire so it does not touch the wire after being driven. Posts that do not taper should be placed as close as possible to the guide wire without touching it. All posts should be marked to their maximum driving depth in the soil before driving them.



Temporary fastening of live wires to rise post.

Permanent fastening of live wires to dip post.



Permanent fastening of live wires to rise post.

Except for installing insulators and providing for the electrical connections, the procedures for stringing the line wires on electric fences erected in straight lines over level terrain are similar to those for stringing the wire on high tensile wire fences.

Choose one of the following procedures for installing electric fences:

1. On short fences, 1,000 feet or less with up to four additional wires, pay out the line wires one at a time from alternate ends of the fence. This requires at least two payout reels.

On longer fences with five or more additional wires, use a multi-reeled wire payout mechanism.

2. If the fence is to have only one or two live wires, provide for all electrical connections wire by wire. If it is to have several additional live wires and ground-return wires, string all wires and make long, temporary tie-offs at the ends. Perform all electrical work at each end post later before making permanent tie-offs.

3. If the fence has relatively few live wires and round posts, use insulators and line taps that can be used after the wires are strung and permanently tied off. Or, use insulators and line taps that must be threaded onto the wires before they are permanently tied off.

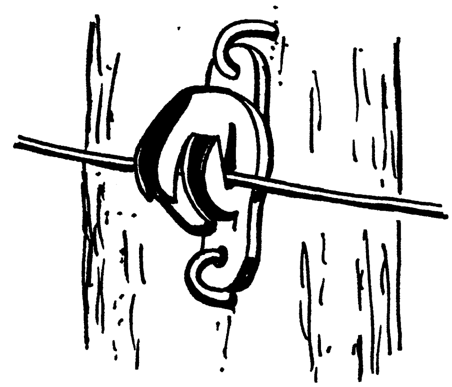
4. On short fences, 600 feet or less, thread insulators and sleeves from one end of the fence to the other. On longer fences, thread insulators from each end toward the midpost.

5. If the fence has one or more posts in rises or dips, when paying out the line wires, fasten all the wires to each rise and dip post before paying them out and tying them off.

To permit later unfastening, live wires can be fastened to rise and dip posts as shown on opposite page.

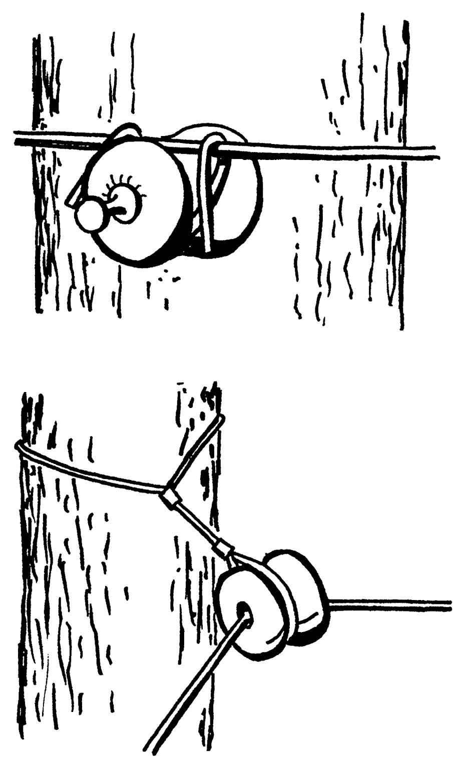
For threading tubes or other thread-on insulators, remove the nails and drive another staple downward or upward, as needed, for the site.

Plastic insulators can be attached any time, since they have a detachable wire system.



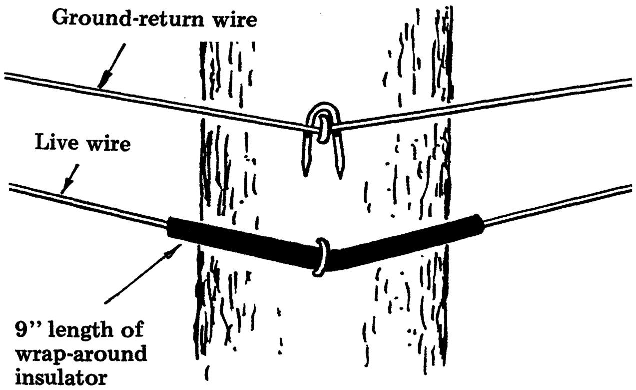
Typical plastic insulator.

Top quality porcelain insulators may be used on rise and dip posts also.



Porcelain insulators.

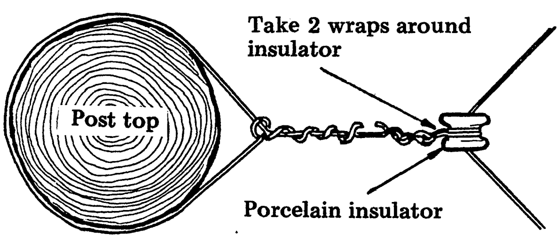
If any round post becomes the common post in a 90°-corner, string all wires continuously around the outside of that post as well as around the outside of all posts in the brace assemblies.



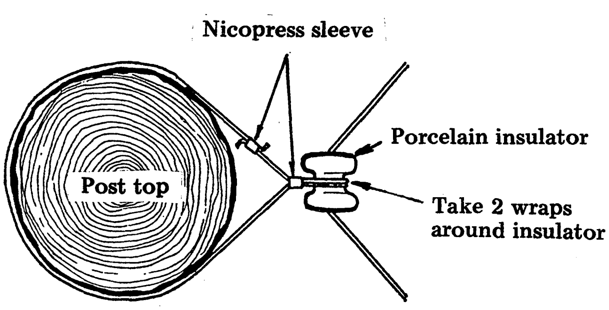
Method of wiring round common post at a 90° corner.

For tying on inside corners and not using press sleeves, the New Zealand knot for strain posts is used. Then take two wraps around the donut insulator and tie off. Keep the insulator as close to the posts as possible.

Nicopress sleeves can also be used.



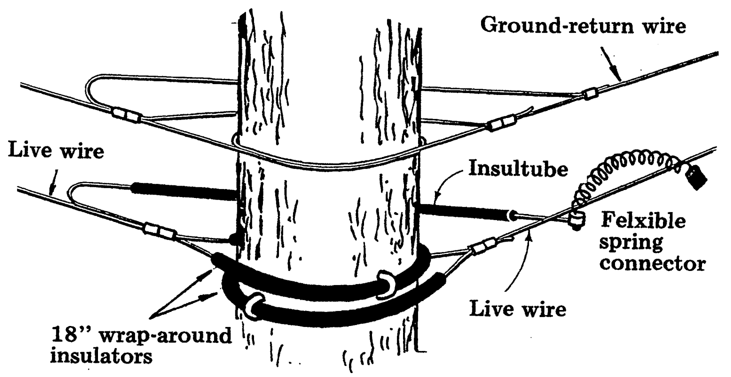
Tying on inside corner using New Zealand knot.



Tying on inside corner using Nicopress sleeves.

A continuous wire around a corner does not allow disconnecting the current to the new direction of the fence line. This may be done by tying off the live wire and the ground wire. A long tie-off on a live wire from one direction provides a live but disconnectable jumper to the live wire at equal height on the new direction of the fence line. This allows you to check each line separately for electrical faults. The ground-return wire may be continuous:

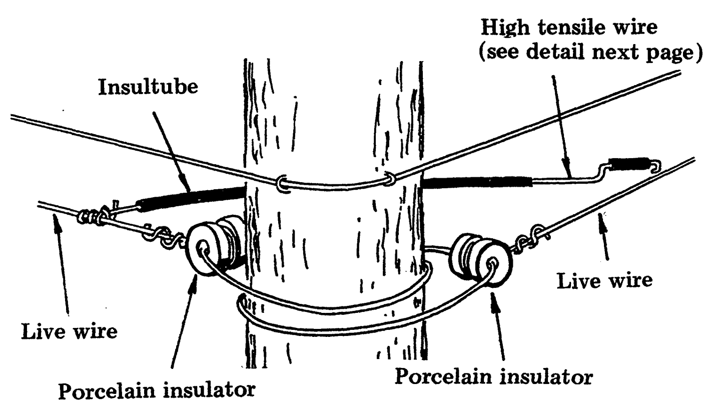
1. Wrap-around insulators, insultube, and flexible spring connectors.



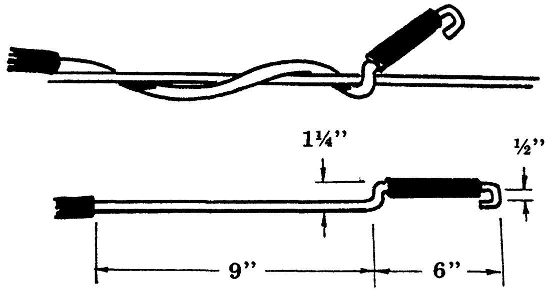
Wiring corner post with disconnectable live wire.

2. Porcelain insulators, insultube, and a high tensile wire joint.

This simple and disconnectable joint can be made from 12½ gauge high tensile wire. A simple insulated handle can be made from high density insultube. When constructing the disconnectable joint, it is important to follow these dimensions to insure a good tight joint.



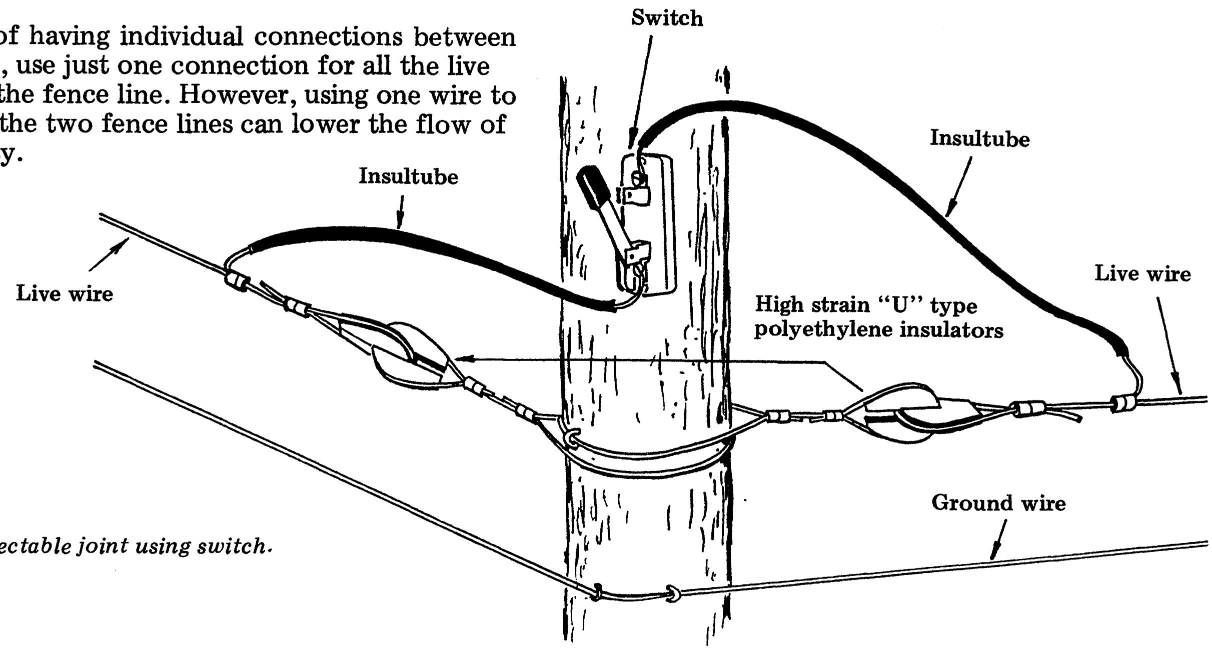
Disconnectable joint.



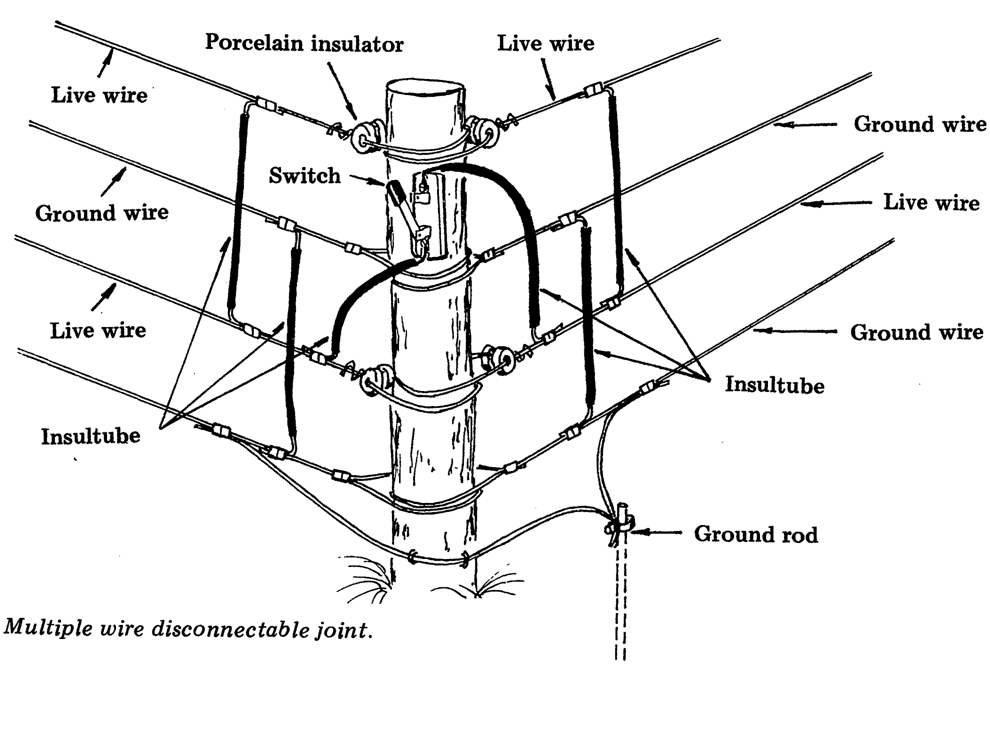
Disconnectable joint detail.

3. Switches can also be used on individual lines.

Instead of having individual connections between each line, use just one connection for all the live wires in the fence line. However, using one wire to connect the two fence lines can lower the flow of electricity.

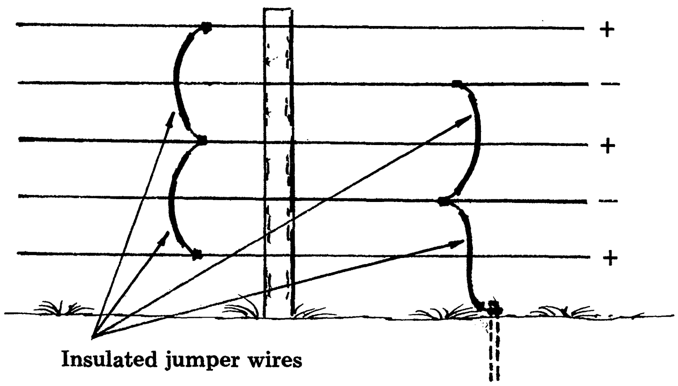


Disconnectable joint using switch.



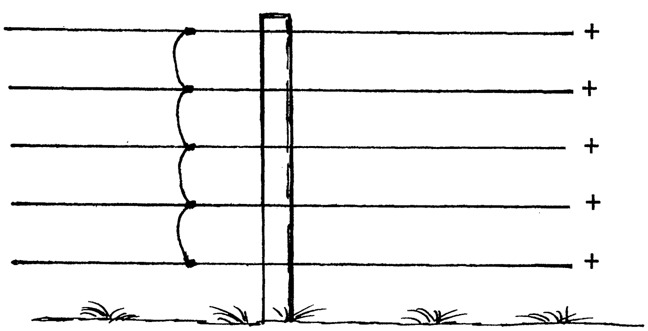
Multiple wire disconnectable joint.

On long fence lines, live and ground-return wires should be joined to themselves with insulated jumper wires at intervals not exceeding 1 mile.



Joining live and ground-return wire on long fence lines.

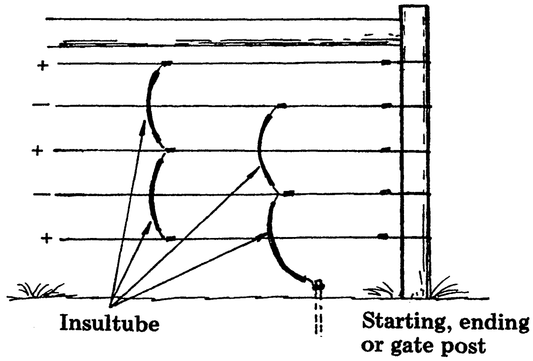
If the fence consists of all live wires, one continuous uninsulated jumper wire should be installed at intervals not exceeding 1 mile.



Joining live wires on long fence lines.

In these locations, a nicopress sleeve will be needed. Mark such locations on a counting guide with an "S" for nicopress sleeve. Also mark each post where a ground rod will be located—1,500 feet of fence for dry areas and 3,000 feet in wet areas. A nicopress sleeve will be threaded on for these locations. Following is a sample counting guide:

All live wires and all ground wires on electric fences should be joined to themselves with a continuous jumper wire. These connections should be made near each starting, ending, and gate post. Use insultube to insulate the wires from each other.



Join live and ground wires near starting, ending and gate posts.

The procedure for threading tube insulators and nicopress sleeves:

1. Having driven all the line posts, mark each round post with the height of each wire. Begin at the starting post and work to the fartherest end post where the wires are to be permanently tied off.

2. While one person is doing Step 1, another person walks the fence line and writes down the number of each round wood post in sequence, beginning with number 1 at the starting post.

END POST ↓ ... STARTING POST ↓

16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

On very long fences, or on those with large numbers of round wood posts, one may prefer to locate and mark the midpost. Then count the other portion of the fence line from the far end, starting again with number 1.

End Post ↓ ... Mid Post ↓↓ ... Starting Post ↓

1 2 3 4 5 6 7 8 9 10 11 (12)(11) 10 9 8 7 6 5 4 3 2 1

Same Post

R = Rise Post	END POST					SAME POST ↓↓							SAME POST ↓↓											STARTING POST
D = Dip Post																								
C = Corner Post	1	2	3	4	5	(6)	(7)	6	5	4	3	2	(1)	(11)	10	9	8	7	6	5	4	3	2	1
M = Mid-point Post	S				D	M	M	R					C	C					R		D			S
S = Nicopress Sleeve													S	S										

It does not matter that the midpost might not have the same number, as long as you know exactly how many round wood posts are to the left and right of it.

3. While counting the round wood posts, mark the specific number of each post where the guide wire changes direction off a straight line (such as on rises, dips, corners, or curves). Each post in such locations requires threading a wrap-around insulator tube on each live and neutral wire. Wrap-around insulator tube contains an internal metal reinforcement strip that keeps the wire from cutting through the insulator tube. These tubes are 18 inches long. Only at end posts, where the wire is to be permanently tied, is the full 18 inches needed. At other points, the tube can be cut to the length required—9 inches for curves, up to a 90° corner where the live wire is to be continuous, and 6 inches for rise and dip locations.

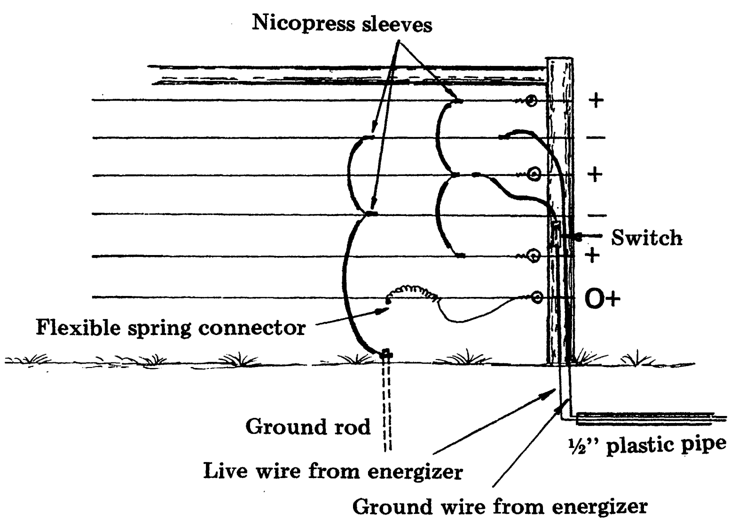
4. Make a sketch or diagram of the electrical connections to be made on the wires at the starting point, at any 90° corners, and at the far end post. Carefully note which kind of insulator and fastener will be used. The following example shows a six-wire fence with a neutral bottom wire and with alternating live and ground-return wires from there up. All wires are strung simultaneously with temporary long tie-offs.

It is particularly important that if permanent electrical connections are to be made with nicopress sleeves, the sleeves should not be crimped until the lines have been tensioned.

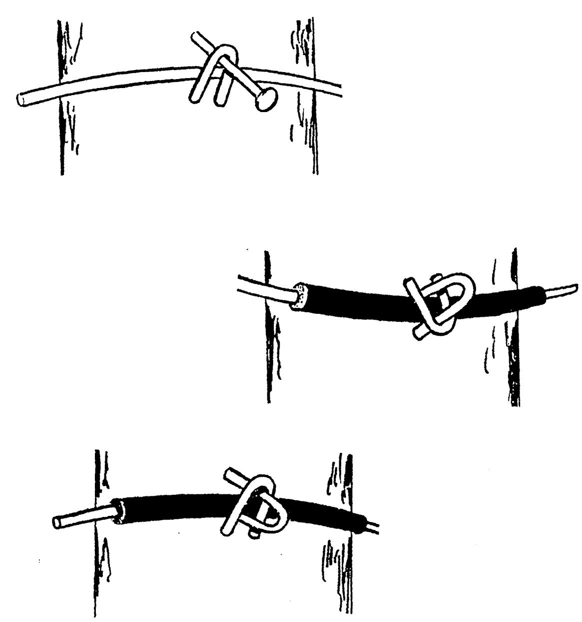
5. Load five coils of high tensile fence wire onto a multi-reeled payout mechanism. Working from the second wire up, tie off all remaining wires at their premarked heights by wrapping each wire two to four times around the post and tying it off with an end post knot. Be sure to start wrapping each wire from the livestock side of the post.

6. Having temporarily tied off all line wires, start the tractor and drive at a slow even speed down the fence line on the wire side of the posts. Pay out the wires as close as possible to the posts. Maintain enough tension on the wires to prevent loops that could become kinks under tension. Be careful to stop all reels if the tractor is stopped. Remember that the wires must be strung around the outsides of all posts in corners and curves. It is all right to drive over the guide wire, but be sure to return to the livestock side of all line posts in straight lines.

7. Stop at each rise and dip post and at the midpost. Working from the top wire down, temporarily fasten all wires at their proper height marks with staples.



Typical diagram of electrical connections.



Temporary wire stapling.

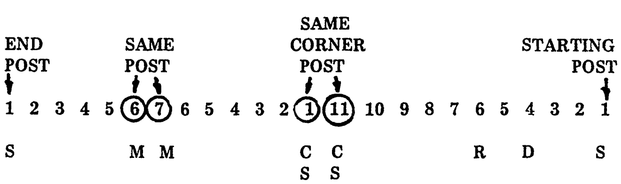
8. At 90° corners, if the wires are not to be tied off, keep all wires to the outside of all posts in the brace assemblies and return to the livestock side only at the first line post. If the wires are to be tied off, stay on the livestock side of the posts at the far end brace assembly.

9. Resume paying out the wires to a point about 6 feet beyond the far end post. Stop the tractor and the payout reels to maintain sufficient tension on the wires and keep them separated and off the ground.

10. Working from the second wire up, cut each wire off its reel. Allow at least 3 feet to wrap it at least twice from the livestock side around the end post and tie it off with an end post knot. Each wrap around a 6-inch diameter post requires about 20 inches of wire. The number of wraps, depends on how long the jumper must be to reach the next higher live wire.

Installing Insulators and Nicropress Sleeves

Having strung and temporarily stapled all the line wires to rise and dip posts and the midpost, return to the starting end post and, with the number post data and wiring diagram in hand, install the insulators.



R = Rise Post

D = Dip Post

C = Corner Post

M = Mid-point Post

S = Nicopress Sleeve

Wiring diagram.

1. Make sure there is almost no tension on the lowest wire. Untie the end post knot and cut off that portion twisted for the knot to eliminate the kinked wire. Unwrap the wire from the post. Following the numbered list of posts, thread all 4-inch tube insulators and wrap-around insulators onto the bottom wire. Count from the corner post backwards, including all posts in the brace assembly. As the insulators and nicopress sleeves are added to the wire, push them towards the corner post.

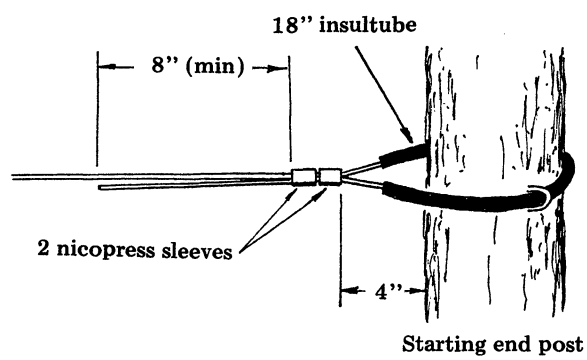
2. Using the corner post diagram, number post data, and the beginning post diagram, figure the number, type, and placement of insulators and nicopress sleeves.

Place them on the bottom wire in the following order:

One 18-inch wrap-around insulator
Two nicopress sleeves
Four 4-inch tube insulators
One 6-inch wrap-around insulator
One 4-inch tube insulator
One 6-inch wrap-around insulator
Two 4-inch tube insulators
Two nicopress sleeves
One 18-inch wrap-around insulator

3. Tie off the bottom wire.

Wrap the insulated wire around the starting end post. Be sure that the metal insert in the wrap-around insulator faces toward the post to prevent the wire from cutting through the tube insulation. Insert the wire through the two sleeves. Push the sleeves back onto both wires to within 4 inches of the post. Be sure that the surplus end of the wire beyond the sleeves is at least 8 inches long. Crimp the sleeves.



Bottom wire tie off.

Thread all the other lines with insulators and sleeves as needed. Then, all of the insulators and sleeeves can be installed in one process as they are worked toward the corner post. The other nicopress sleeves should not be crimped on the wires until the lines have been fully tensioned.

4. Use the numbered post data sheet and the end post diagrams to place the second wire. Start with the corner post and work back to the starting end post. Additional tube insulators are needed to prevent shorting out the live wire with the diagonal brace wire. The surplus end of the wire beyond the sleeves must be long enough to provide a continuous insulated jumper wire to the fourth wire, which is also a live wire. Position all insulators on the posts so that no bare portion of the wire touches the post. Secure the insulator by driving one staple over the tubing. Do not drive the staple into the tubing.

The procedures for installing the second wire are:

One 18-inch wrap-around insulator
Two nicopress sleeves
Five 4-inch tube insulators
One 6-inch wrap-around insulator
One 4-inch tube insulator
One 6-inch wrap-around insulator
Three 4-inch tube insulators
Two nicopress sleeves
One 18-inch wrap-around insulator

Once the insulators and sleeves have been placed on the second wire, tie off in the same manner as the bottom wire, except that the surplus end of the wire must be long enough to reach the fourth wire, which forms the continuous jumper wire.

5. Refer to the numbered post data and end post diagram and place the third wire. Start at the corner post and work back to the starting end post. This is a ground-return wire and will not require insulators. Since the wires are being broken and tensioned at the corner post, three nicopress sleeves will be needed there—one for the ground-rod wire. The surplus end of the wire at the corner post will have to be long enough to reach the wire at the same height going in the other direction.

To install the third wire, follow these procedures:

Six nicopress sleeves.

6. The fourth wire is also a live wire and has the same insulation requirements as the second wire. However, since the cut-off switches and insulated jumper wires are attached to this line, more sleeves are required.

One 18-inch wrap-around insulator
Four nicopress sleeves
Five 4-inch tube insulators
One 6-inch wrap-around insulator
One 4-inch tube insulator
One 6-inch wrap-around insulator
Three 4-inch tube insulators
Four nicopress sleeves
One 18-inch wrap-around insulator

Once the insulators and sleeves have been threaded on the fourth wire, it is ready to be tied off. Be sure the surplus end of the wire is long enough to provide a live jumper line to the sixth wire.

7. The fifth wire is a ground-return wire like the third wire. However, it has one additional sleeve for attaching the ground wire.

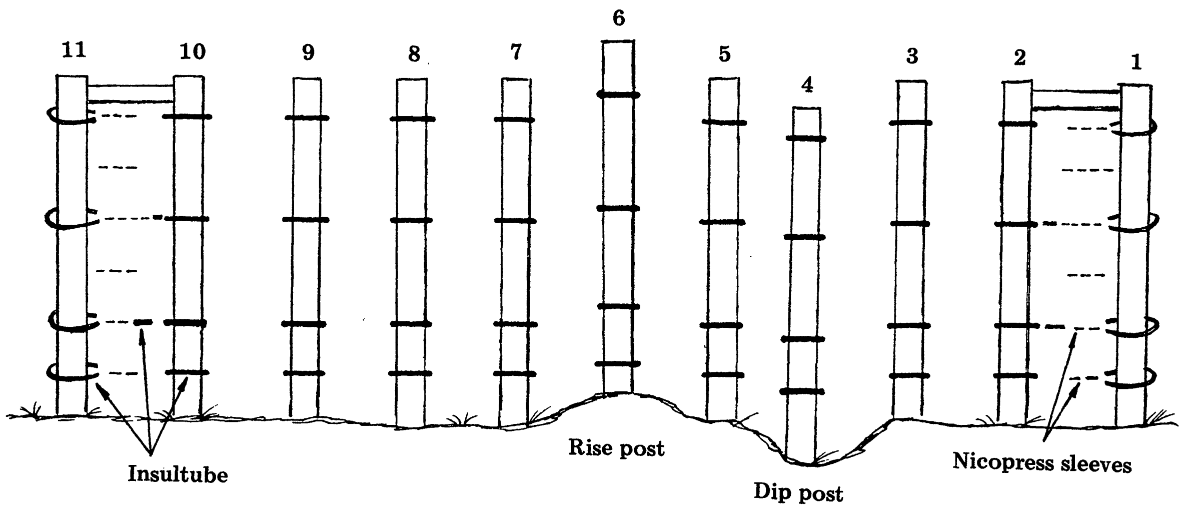
Seven nicopress sleeves.

The sixth wire is the top live wire and it has the same insulation requirements as the bottom wire. If it does come in contact with the diagonal brace wire, a piece of tube insulation will be needed for those locations. Be sure that live wires do not contact the ground. Always provide adequate insulation. Additional sleeves will have to be added to secure the continuous jumper wires from the fourth wire. Refer to the numbered post data and the post diagrams to install the insulator and sleeve needs for the sixth wire.

One 18-inch wrap-around insulator
Three nicopress sleeves
Four 4-inch tube insulators
One 6-inch wrap-around insulator
One 4-inch tube insulator
One 6-inch wrap-around insulator
Two 4-inch tube insulators
Three nicopress sleeves
One 18-inch wrap-around insulator

After the insulator and sleeves have been placed on the sixth wire, tie it off in the same manner as all the other wires, except the excess wire should be cut short.

Now, before the wires can be tensioned, the insulators and sleeves threaded on the wires need to be pushed down the lines and placed at their appropriate locations.



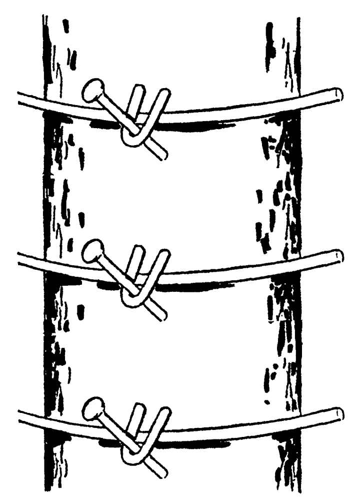
Typical wiring diagram.

The rise and dip posts have had fence wires temporarily fastened. These are the locations that will have the insulators permanently attached to the posts before tensioning.

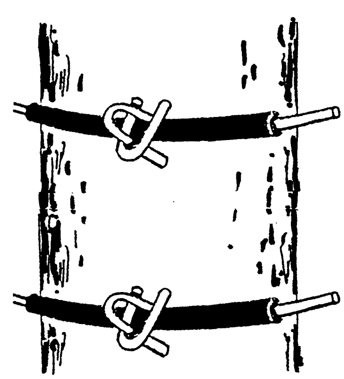
Starting with the top wire, the sixth wire, push all of the insulators and sleeves not needed between the starting end post and the second post past the second post. Do not crimp any sleeves at this time. Place the last insultube near post No. 2, where it will be secured after the wires have been tensioned. Go to wire No. 5 and push the three sleeves not needed here past the second post. Go to wire No. 4 and push all the insulators and sleeves not needed between the starting end post and post No. 2. Leave the last two insultubes near post No. 2 where they will be secured after tensioning. Continue this procedure down to the bottom wire. Then work all of the items that are past post No. 2 down the lines to post No. 3. Leave the last insultube on the live wires near post No. 3 where it will be attached after tensioning the wires. Continue working the rest of the insulators and sleeves on all the wires to post No. 4. Since post No. 4 is at the bottom of a slope, the wires are pulling upwards at this point and have been temporarily attached to the post.

Pull the nails that are acting as locks and work the insulators and sleeves past this post. The last insulator should be a 6-inch wrap-around type. Place the insulators so the metal insert is on the top of the tube. It will then bear the upward pressure of the wire. Otherwise, the upward pressure of the wire will gradually cut through the unprotected insulator tube.

Secure the wrap-around insulators in place.



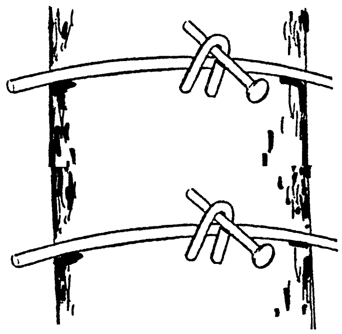
Temporary wire attachment to post no. 4 (dip post).



Final wire attachment to post no. 4.

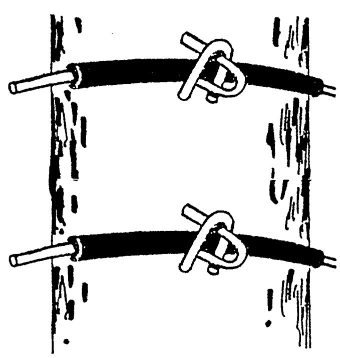
After all the wrap-around insulators have been attached to post No. 4, work the remaining insulators and sleeves past post No. 5, leaving the last insultube on the live wires near post No. 5, where they will be attached after tensioning of the wires.

Continue working the remaining insulators and sleeves up to post No. 6, which is at the top of the slope and has downward wire pressure. The wires have been temporarily fastened to the post.



Temporary wire attachment to post no. 6 (rise post).

Pull the nails and work the insulators and sleeves past post No. 6. The last insulator should be a 6-inch wrap-around type. Place the insulators so the metal insert is on the bottom of the tube. It will then bear the downward wire pressure.



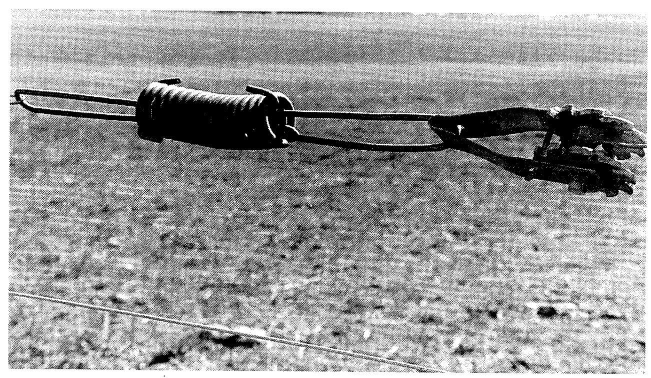
Final wire attachment to post no. 6.

Continue working the insulators and sleeves to the end of the fence line, leaving the tube insulators at the appropriate posts.

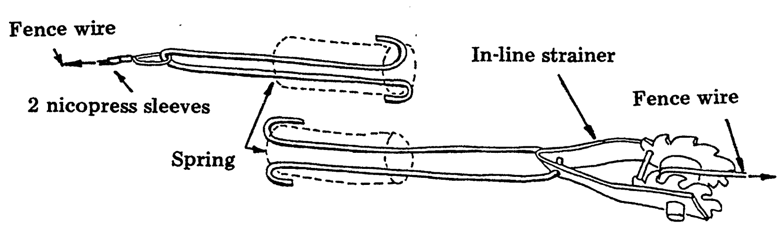
Using the corner post diagram, tie off the fence wires. The fence wires will be slack since the in-line wire strainers and a tension indicator spring will be added later to set the correct wire tension. The tie-off is done in the same manner as on the starting end post, except that the length of surplus wire past the nicopress sleeves will vary.

Locating and Installing In-Line Adjustable Wire Strainers

Once both ends of the fence line have been permanently tied off, the in-line strainers need to be installed. Installing in-line adjustable wire strainers on electric fences is essentially the same as for nonelectric fences. For fences over 600 feet long, in-line strainers should be installed near the midpost in the fence. Only uninsulated strainers can be used, since live wires must remain live on both sides of the strainers. Insulated strainers are available, but their use is limited to near a gate or end post where they can eliminate either a wrap-around, a porcelain donut, or a double "U" insulator per live wire. However, since the strainers tend to move forward several inches in the direction from which wire is being taken up on the drum, they must be installed with the drum facing the direction away from the post. The strainers should also be located away from the post so they will not contact the post as they move forward.



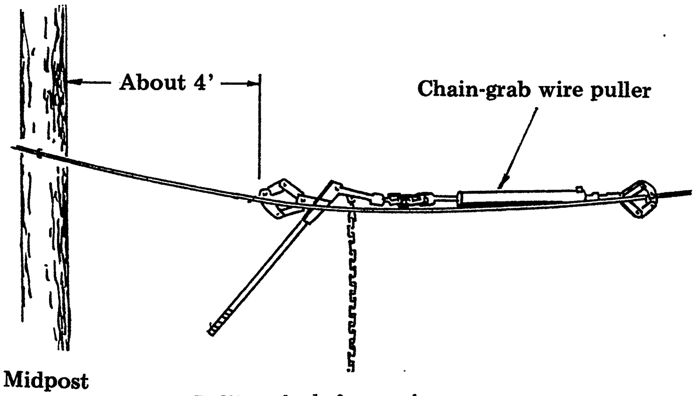
In-line strainer.



Installing in-line adjustable wire strainer.

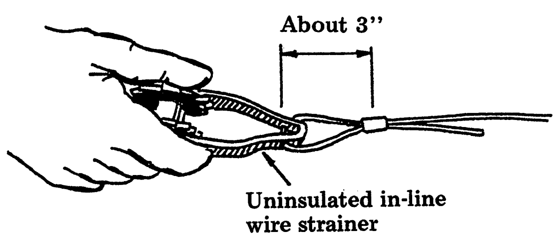
1. Before attempting to install in-line adjustable wire strainers, all wires must be permanently fastened at their proper heights on the midpost, to all rise and dip posts, and to all posts in corners and curves. Remove the retaining nails. Center the insulator under or over the existing staple. Drive another staple upward or downward, depending on whether the post is in a rise or dip. Do not drive the staple too deep. The wire should be free to run. On corner posts, or those in curves, only one staple should be required to hold the insulator in position.

2. At midpoint in the fence, where the line wires have been permanently stapled, and working from the top wire down, attach a chain-grab wire puller about 4 feet away from the midpost and pull all slack out of the wire. A tension indicator may be attached.



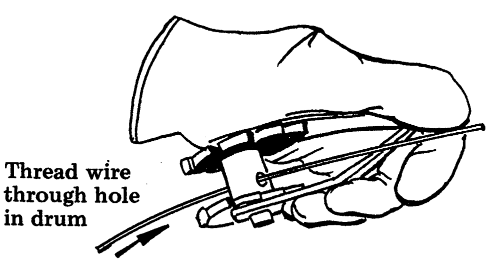
Pulling slack from wire.

3. Cut the wire at about midpoint in the slack between the jaws of the wire puller and install an uninsulated in-line wire strainer. Thread two nicopress sleeves onto the wire nearest the midpost. Slide them back 12 inches and thread the wire through the holes in the shank of the strainer about 6 inches. Bend the end of the wire back onto itself. Slide the sleeves forward about 3 inches to enclose both wires. Crimp the sleeves.

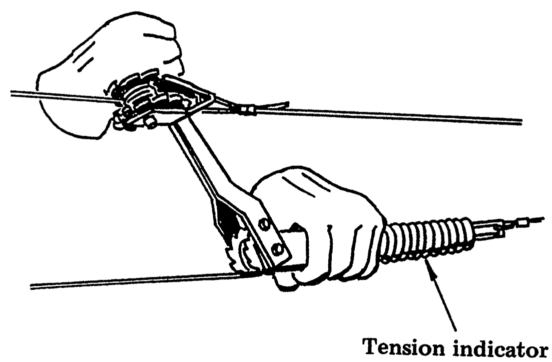


Installing in-line wire strainer.

4. Thread the other end of the wire through the hole in the drum of the strainer and cut off the surplus wire close to the drum. Attach the handle and turn the drum enough to secure the wire and insert the ratchet pin. Continue turning the drum until the wire no longer sags. Do not tension the wire more than enough to keep it horizontal. Remove the chain-grab wire puller.



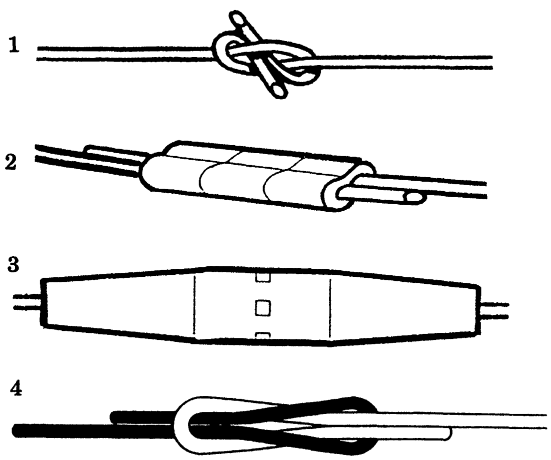
5. Attach the wire puller onto the next lower wire (the fifth) and pull out the slack. Cut the wire between the jaws of the wire puller and install an in-line wire strainer with a tension indicator spring attached as shown. Place the strainer in the same direction as the one attached earlier and tension the fifth wire the same way as the top wire. Repeat procedures 2 through 4 for installing strainers on the remaining four wires. Only one tension indicator spring is required per leg of fence. Even if the fence requires more than one strainer per wire, only one tension indicator on the second wire from the top in the middle of the fence is required. If more than one strainer per wire is required, do not take up much tension on any one strainer until the others have been installed. Defer tensioning to the recommended wire tension until all stapling has been competed.



Installing tension indicator.

Splicing Wires

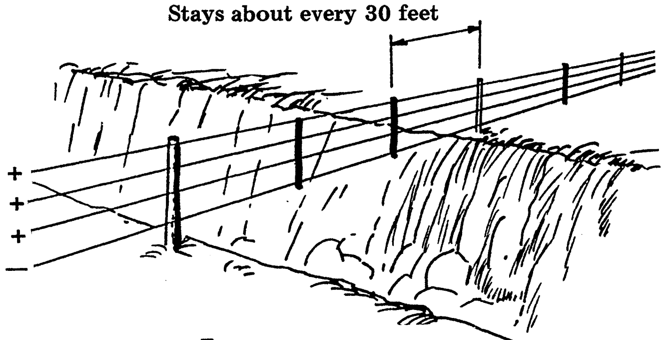
Splicing high tensile wires on electric fences can be accomplished in any of the four ways shown. The knots give only about 75 percent of the strength of the wire. Once wire is spliced, it is impossible to slide any insulators or sleeves in either direction past the splice.



Four methods of splicing high tensile wires.

It may sometimes be necessary to string electric fence wires across a wide ravine to a continuation of the electric fence on the other side. If only one live wire is used, a considerable drop in voltage will result in the remainder of the fence because of surge impedance. To prevent this, it is best to string at least as many live wires as are on the initial fence (and at least one ground return wire if appropriate) across the ravine. The same effect can be achieved by using larger diameter wire. Take care not to cross the wires; install non-conductive stays to hold the wires apart. This can be made up at ground level and then raised by gradually and evenly tensioning the wires.

Tension the wire in the same way as for nonelectric fences.



Fencing wide ravine.

Tensioning the Wire

All types of wire may break and recoil when overstretched. Use hand and eye protection when handling high tensile fence wire. As with non-electric fences, wires on electric fences should be tensioned from the top wire downward.

1. Tension the top wire until it is hand-taut and free from other wires.

2. Tension the next lower wire with the tension indicator spring behind the in-line strainer to approximately 150 pounds.

3. Return to the top wire and retension it until it feels about the same tautness as the wire with the indicator spring. Continue tensioning all the wires to the same degree of tautness, down to the bottom wire.

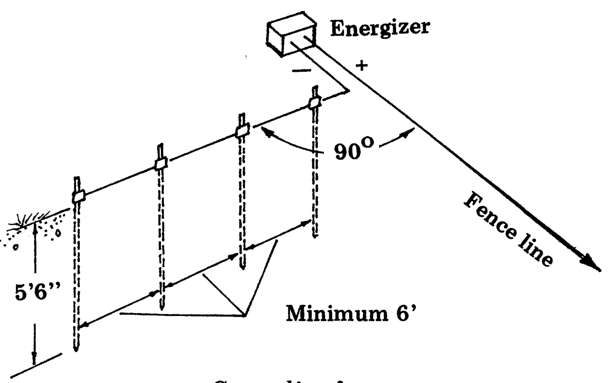
If Keppers Easy-Set Posts, insultimber posts, plastic posts, or fiberglass posts are used, be sure that the fence wires are allowed complete freedom of movement. If round wooden posts are used, staple all the fence wires to them at their proper heights. Be sure that the insulators are correctly positioned at their right location before stapling. Once all the wires have been fastened to all the posts in the fence line, increase the wire tension to that recommended by the manufacturer.

Next, correct the positions of all nicopress sleeves that will be used for continuous live jumper wires, feeder wires, and one-piece ground jumper wires. Place tube insulators on these wires to insulate them from any possibility of grounding out. Feed the wire as needed through the sleeve and crimp it in its proper position. Also position the insultubes on the live wires to protect them from shorting out on the diagonal brace wire.

After the fence wires have been tensioned to the recommended pounds and the jumper wires crimped to them, stays can be attached. All stays should be securely fastened to the wires so they maintain their position in the fence line.

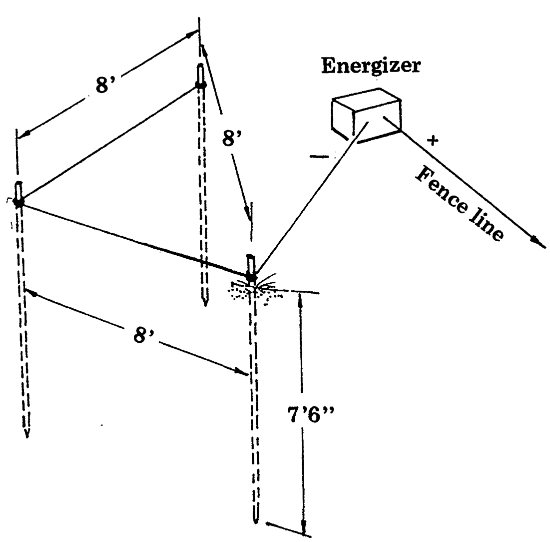
Grounding

Assuming that an electric fence has been properly wired and that an adequate energizer has been installed, perhaps 90 percent of electric fence failures are due to improper or insufficient grounding. Adequate grounding calls for driving the equivalent of 22.95 feet (7 meters) of approved ground rod or new galvanized 3/4-inch pipe into the soil near the energizer. The same results can be achieved by driving four 6-foot lengths of rod or pipe 5½ feet deep, spaced 6 feet apart and connected to a continuous ground wire from the energizer to each rod or pipe.



Grounding fence.

If 8-foot lengths are used and driven 7½ feet into the earth, only three rods or pipes are needed.



Grounding fence with 8-foot grounding rods.

The same wire used for the fence is satisfactory for connecting the ground rods. A ground clamp is required for each ground rod connection.

Ground rods must be driven into the ground near the one-piece ground jumper wires in the fence line every 1,500 feet for dry areas, 3,000 feet for wet areas, at fence ends, corners, and on both sides of a gate. The ground rods should be 3/4-inch galvanized rods, a minimum of 6 feet long, and connected to the ground jumper wire with a ground rod clamp.

For the bottom wire, which can be either a neutral wire or a live wire, a moveable tapping device must be added to the surplus wire beyond the sleeves.

Switches must be placed at the beginning post and the corner post so power can be switched on or off the fence lines.

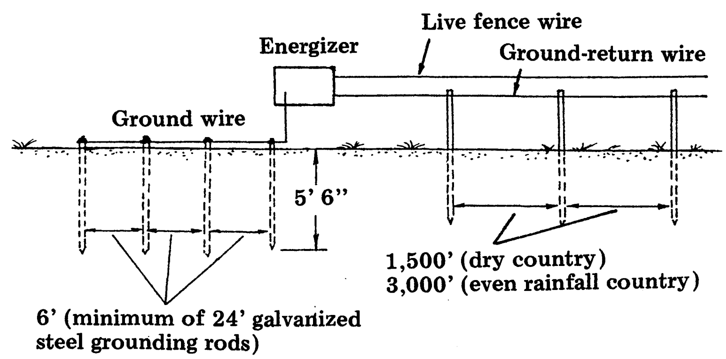
Ground rods should be driven as close as possible to the fence on the side opposite the livestock in areas where they will not be damaged by traffic or mower blades. They should be located at least 24 feet from:

1. any ground rod connected to another electrical system

2. any telephone ground rod

3. any underground metal piping system

4. any metal support or other element of a structure which rests upon or has been driven into the soil

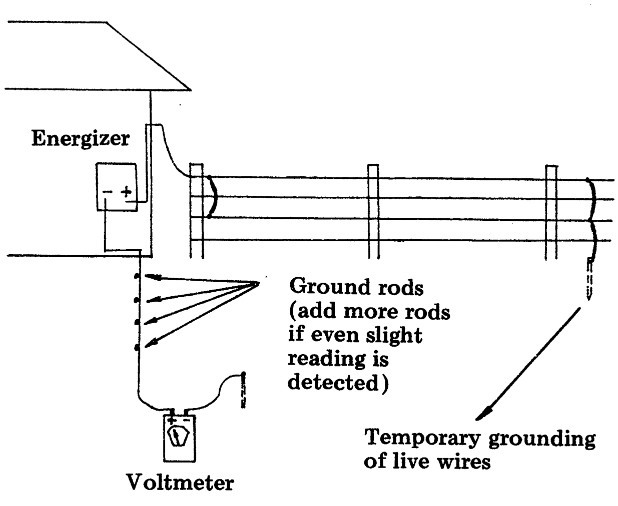


Grounding fence.

There are two methods of testing the efficiency of the ground system and these tests should be conducted under both wet and dry conditions.

1. Lay steel rods against some of the live wires at least 300 feet (100 meters) away from the *turned off* energizer. Come back to the energizer; turn it on; place the back of one hand on the fartherest grounding rod from the energizer, and with arms outstretched to get the maximum distance between the hands, work the free hand down some vegetation to the soil. If no shock is felt, dig that hand firmly into the soil. If there is no shock, the ground system is satisfactory. If you are shocked, the grounding system is inadequate and more ground rods must be added to the system

2. With the energizer *turned off*, at a distance of 300 to 400 yards from the energizer, drive a temporary ground rod into the soil. Temporarily connect one or more of the live wires on the fence to this rod. Return to the energizer and turn it on. Connect a peak-reading voltmeter to the ground rod fartherest from the energizer and connect the voltmeter's ground terminal to a metal rod or pin driven into the ground. If even a slight reading is detected on the voltmeter, additional permanent ground rods are needed on the fence. In sandy or rocky soil more grounding may be required.



Testing grounding system.

Finding Faults

Trouble-shooting to find the reason an electric fence has failed or is not operating satisfactorily is simply a process of elimination. Whether the source of current is a mainline plug-in energizer or a battery-powered model, inspection should begin with the energizer and its grounding system and proceed through progressive segments of the fence along its entire line. There are various probable causes of electric fence failure. Some are rather obvious and easy to find; others are obscure and difficult to locate without some means of testing. Most of the electrical failures are attributed to:

1. poor grounding

2. poor splices

3. extremely dry conditions

4. breakdown of insulation (cracked or dirty insulators)

5. loose or corroded connections

6. radio and telephone interference

7. electrostatic fields caused by powerlines within a 1,000-foot radius of the fence.

Testing for the most common electric fence faults can be done with a few simple and economical devices:

Voltmeter—(digital or dial)—calibrated in kilovolts and accurate to within ± 100 volts. Voltmeters test the output voltage of the energizer and the effectiveness of its grounding system as well as the voltage anywhere along the fence line between any live and groun-return wire or the soil. When testing a fence powered by one of the super high voltage energizers, they may give a high-voltage reading even with considerable leakage on the fence. Take readings progressively farther away from the energizer until a significantly lower reading is obtained. At the location of a dead short, there will be no reading on the meter, and readings beyond the fault, if any, will be significantly lower.

Multi-Bulb Electric Fence Tester—not accurate and should be regarded only as indicators of the condition of a fence. The same results can be obtained with a household light bulb socket fitted with insulated alligator clips and a few household lightbulbs of 25-, 40-, 60-, and 100-watt rating. If there is considerable leakage on a fence, even a high-voltage energizer will momentarily light a 25- or 40-watt light bulb some distance from the energizer.

Portable Transistor Radio—is another effective means of locating cracked or arcing insulators. Walk the fence line with a small battery-powered transistor radio tuned between stations. No sound will be heard until it is held near a broken or leaking insulator, which will cause an increasingly louder click or blip in the radio the closer to the fault. Spray faulty insulators with a bright-colored, water-soluble, non-metallic paint so they can easily be relocated for replacement after switching off the current.

The following table describes the most common electric fence faults, the probable causes, and the methods for correcting them.

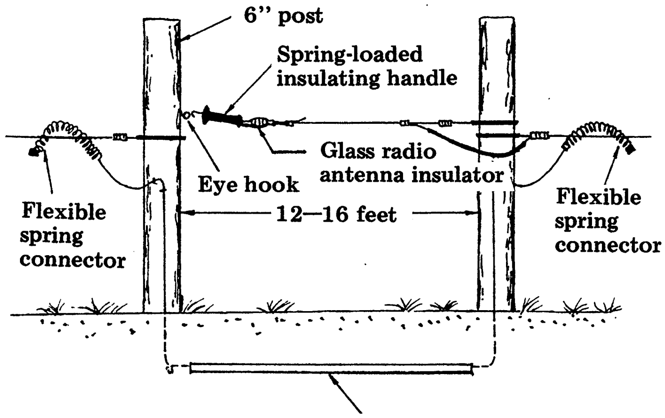
Common Electric Fence Problems

Nature of Problem	Probable Cause	Method of Correction
Energizer not on or no voltmeter reading across energizer output terminals with energizer disconnected from fence.	Mainline power outage or blown fuse on imput circuit. Energizer switched off. Dry cell batteries dead, wet cell batteries discharged. Battery terminals corroded. Energizer is faulty.	Check for power outage or blown fuse. Check energizer "on-off" switch. Recharge or replace batteries. Clean terminals. Have energizer serviced.
Energizer on but voltmeter reading is low across energizer output terminals when disconnected from fence.	Energizer switched to low setting. Weak batteries. Terminals corroded.	Check energizer output switch. Recharge or replace batteries. Clean battery terminals.
Energizer operating but no voltmeter reading on fence with energizer connected.	Ground-return wire disconnected or broken. Feedwire terminals corroded, disconnected or broken. Broken live wire or ground-return on fence. Soil dried out.	Check for broken or disconnected ground wire. Check for broken or disconnected or corroded feedwire. Check for broken, corroded, or disconnected live or ground-return wire on fence. Install ground-return wire.
Low voltmeter readings at several locations on fence.	Energizer on low setting or inadequate for length of fence. Weak batteries; terminals corroded. Ground system inadequate or deteriorated. Soil dried out.	Check high-low setting, or install more powerful unit. Recharge or replace batteries; clean terminals. Check ground system for adequacy and deterioration. Install ground-return wire.
No voltmeter reading or low reading at one location on fence.	Broken or disconnected fence wire or jumper wire. Broken or disconnected ground wire. Broken or faulty insulators. Ground rod deteriorated.	Splice broken wire or remove cause of short. Replace jumper connection. Replace faulty insulators. Repair or replace ground connection rod.
Voltmeter reading on one wire higher than another or no reading from one live wire to ground-return or soil.	Broken or disconnected fence wire or jumper wire. Broken or disconnected ground wire. Broken or faulty insulators. Ground rod deteriorated.	Splice line wire or replace jumper wire. Replace faulty ground wire. Replace faulty insulators. Repair or replace ground connection rod.
Radio, TV or telephone interference.	Ground system inadequate. Antenna too close to fence. Fence parallel with antenna wires or telephone lines.	Increase grounding capacity. Relocate antenna or telephone wires. De-electrify or relocate segment of fence parallel to or too close to antenna or wires.
Energizer not on or no voltmeter reading across energizer output terminals with energizer disconnected from fence.	Mainline power outage or blown fuse on input circuit. Energizer switched off. Dry cell batteries dead, wet cell batteries discharged. Battery terminals corroded. Energizer is faulty.	Check for power outage or blown fuse. Check energizer "on-off" switch. Recharge or replace batteries. Clean terminals. Have energizer serviced.

Electric Gates

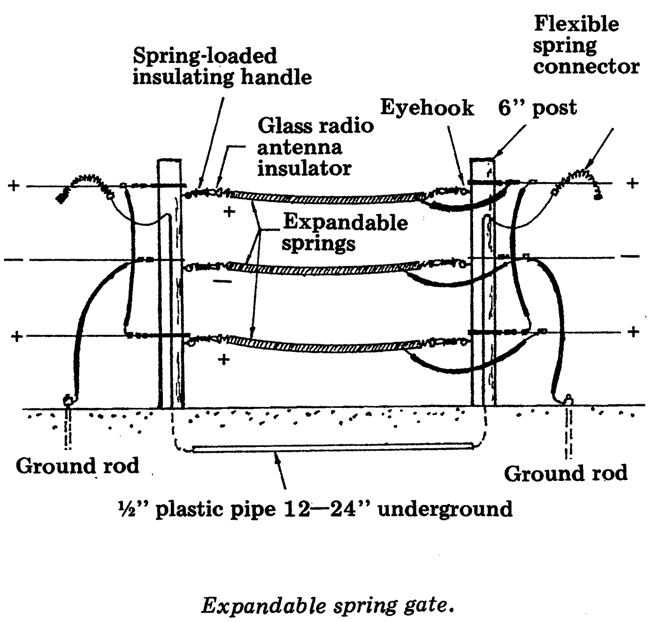
Below are several examples of gates used with electric fences:

One Wire Gate—suitable only for the one-wire cattle fence in even rainfall country.



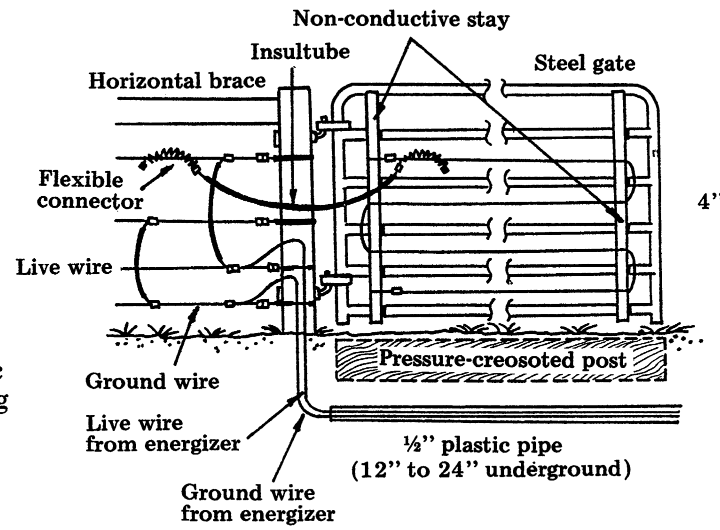
One wire gate with detachable electrified wire.

Expandable Spring Gate—a highly visible electric gate. One or more springs may be used, depending on the type of livestock being fenced.



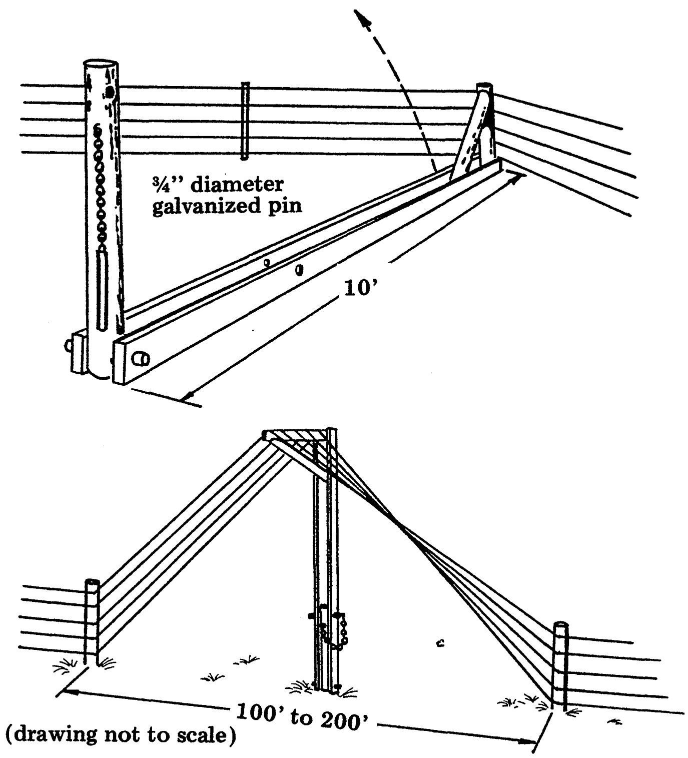
Expandable spring gate.

Electrifying a conventional gate can be easily accomplished on either a tubular steel gate, or one fabricated of pressure-creosoted lumber. Simply attach nonconductive stays vertically with galvanized U bolts about 2 feet apart across the predator side of the gate. Fit one continuous strand of high tensile wire back and forth across the nonconductive stays from top to bottom and secure with wire ties. Feedwires from the fence should be covered with insultube and connected with flexible spring connectors on the side toward which the gate swings. Feedwire for the remainder of the fence should be buried underground. Burying one or more creosoted posts horizontally under the gateway a few inches deep should discourage coyotes from digging under the gate.



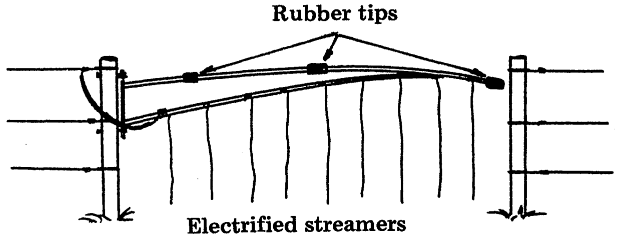
Electrified conventional gate.

Multiple Wire Lift Gate—an offset lift mechanism consisting of two pressure-creosoted planks 10 feet long x 4 inches wide x 1½ inches thick, one 8-foot x 4-inch post driven 48 inches, and one 8-foot x 4-inch post sawed in half to provide the offset post and brace. All members are fastened with 3/4-inch galvanized bolts and a removable 3/4-inch galvanized pin to hold the unit upright. Such gates would probably be practical only for fences with up to six wires, erected on one's own property, and used only occasionally for moving from one field to another.



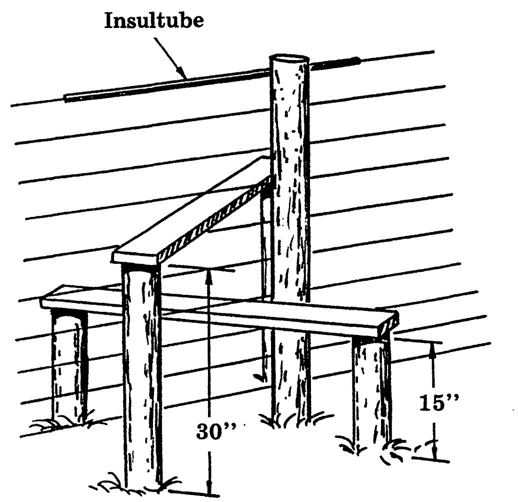
Multiple wire lift gate.

Drive-Thru Gate—fiberglass arms support electrified streamers that keep livestock from getting through. The arms are plastic-coated and have rubber tips to prevent scratching vehicles. These gates come in two sizes: One is for openings of 12 feet to 14 feet and the other for openings 14 feet to 20 feet.



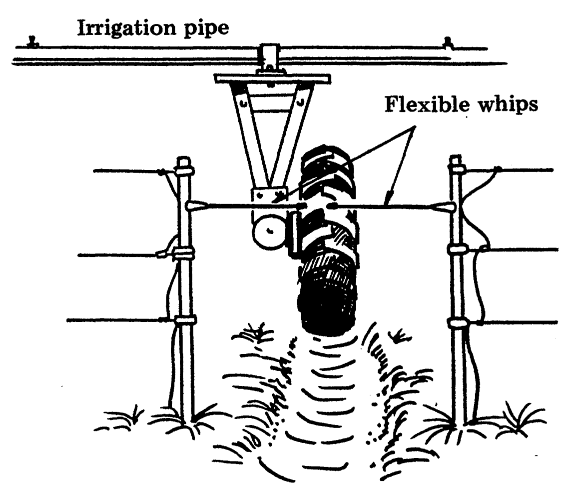
Drive-through gate.

Stiles—if access for people is required from one side of an electric fence to the other, an old-fashioned stile can be constructed. Since the top wire is usually live, remember to thread a 3-foot length of insultube on it for each stile location before tying off and stapling the top wire. In some areas it may be necessary to thread 3-foot lengths of insultube on all of the charged lines at stiles.



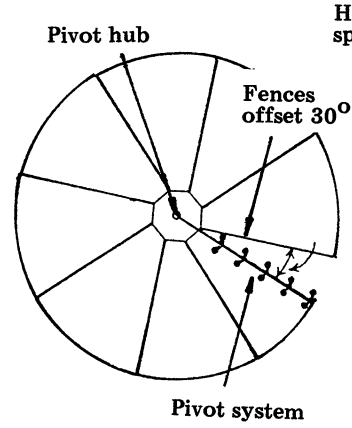
People-access stile.

Irrigation Break Through Gate—provides an opening for a pivot irrigation system. This break-through-gate has two flexible whips that open into the middle.

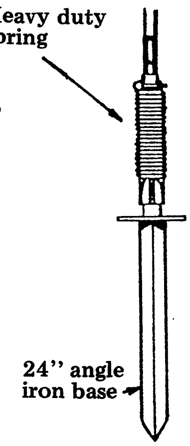


Pivot irrigation system gate.

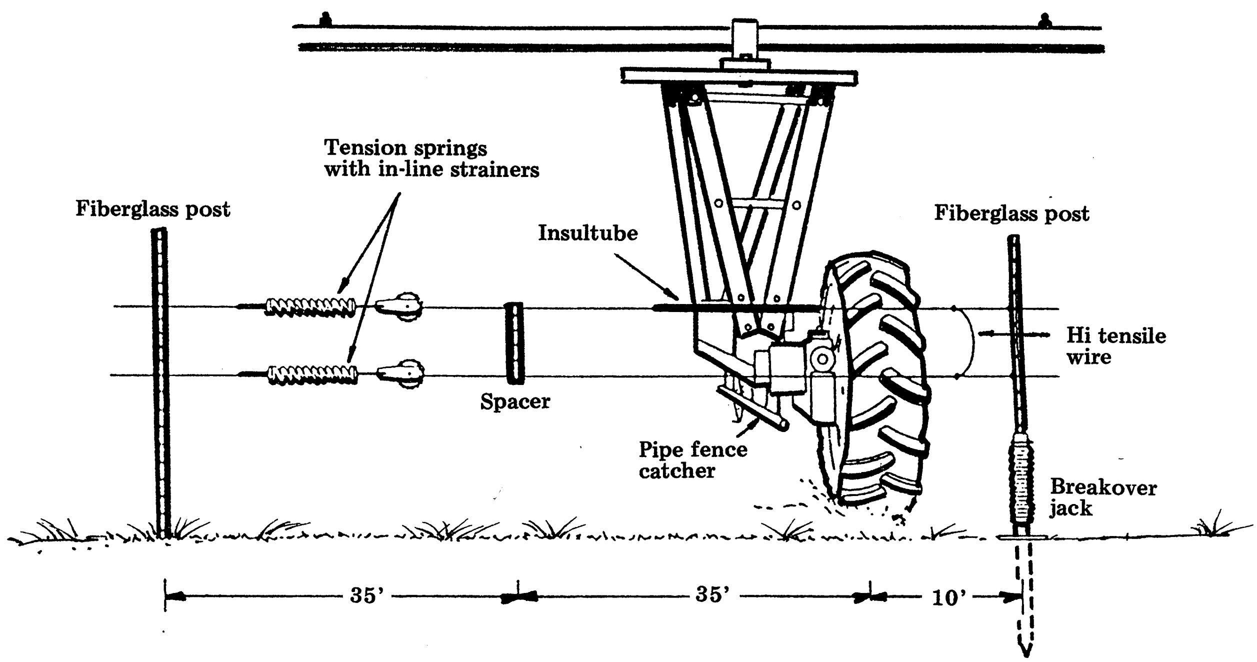
Irrigation Break-Over Fence—allows the pivot irrigation system to drive over the fence rather than travel through an opening. The break-over fence must be off-set 30 degrees or more so no more than two drive units of the pivot irrigation system are on the fence at one time. Place the break-over jacks 10 to 20 feet away from the cross-over point of the drive units. Towers that are farther apart than 130 feet will require a 48-inch fiberglass line post in the middle. Tension springs are needed on each wire to provide the needed stretch as the fence is forced down by the drive units. At the cross-over point, a short piece of high tensile wire is needed to connect the wire strands so they do not become separated by wheels driving over them.



Pivot irrigated pasture layout.

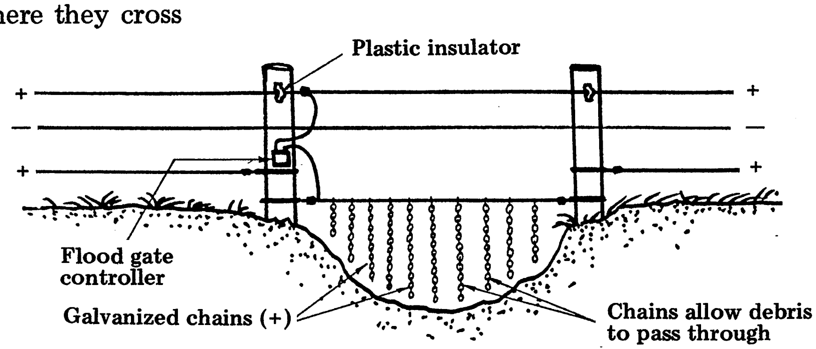


BREAKOVER JACK



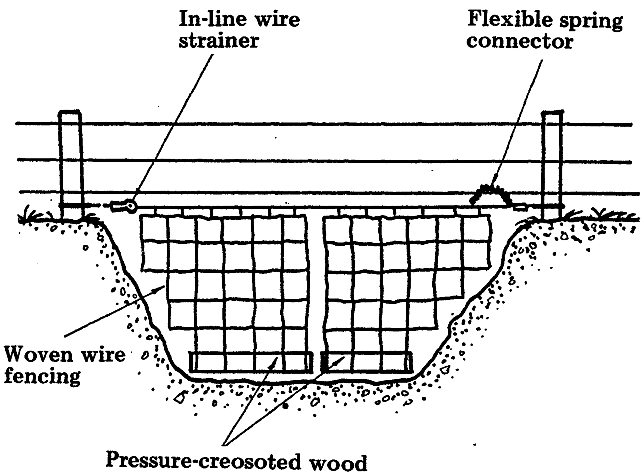
Irrigation break over fence.

Electric Flood Gates—are frequently necessary in electric high tensile wire fences where they cross small streams or wash gaps.



Electric flood gate.

One design is constructed simply by stringing a length of high tensile wire between the line posts on each side of the gap and suspending cut panels of woven wire fencing weighted with short lengths of pressure-creosoted wood. The horizontal wire is insulated from the line posts and current is supplied by a flexible spring connector to the lowest live wire on the fence. When the flood gate shorts out from run-off, the flexible spring connector must be disconnected or the system becomes ineffective.



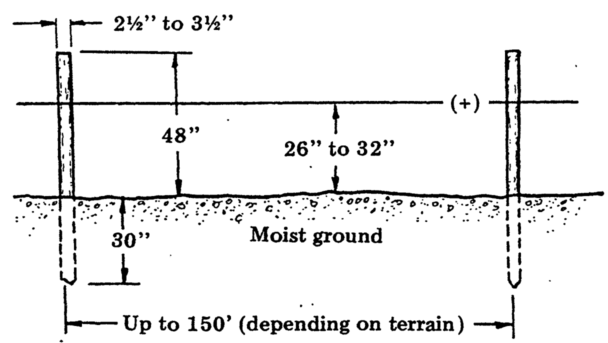
Electric flood gate.

Designs

Wire and Post Spacing

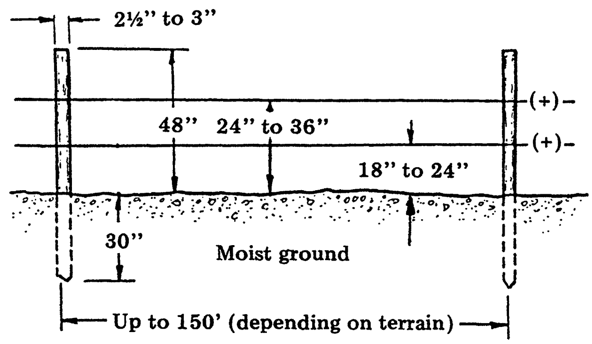
There are many electric fence designs each with a different number of wires and each using slightly different construction techniques. The following designs are a sample of the most common fences. Variance in the wire spacing is from the ground up: ground to first wire - 18 to 24 inches; first wire to second wire - 24 to 30 inches, etc. A (+) indicates a charged wire; a (-) indicates a ground wire; an (*) indicates a wire that may be charged or neutral.

ONE-WIRE FOR CATTLE IN AREAS WITH IRRIGATION OR 24 OR MORE INCHES OF RAIN ANNUALLY



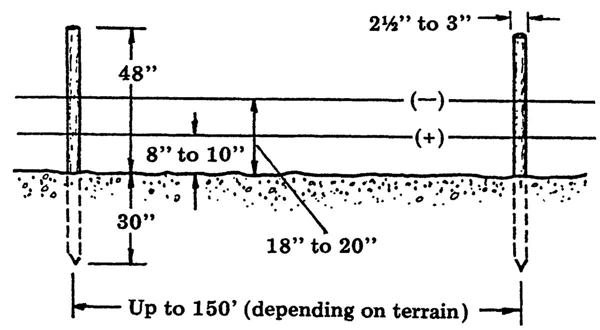
For a 12-foot or larger gate, a brace should be erected. End, gate, and 90° corner posts are 8 feet long x 6 inches in diameter and are driven 4 feet into the ground. Line posts are 6½ feet long x 2½ inches to 3½ inches in diameter are driven 30 inches into the ground.

TWO-WIRE FOR CATTLE IN AREAS WITH IRRIGATION OR 24 OR MORE INCHES OF RAIN ANNUALLY



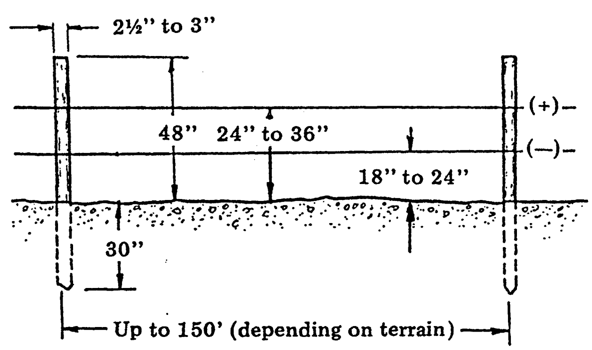
A brace assembly is required for 12-foot or larger gates. End, gate, and 90° corner posts are 8 feet long x 6 inches in diameter and are driven 4 feet into the ground. Line posts are 6½ feet long x 2½ to 3 inches in diameter and are driven 30 inches into the ground. Dip, rise, and curve posts are 8 feet long x 4 inches in diameter, and are driven 4 feet into the ground.

TWO-WIRE FOR SHEEP IN DRY AREAS



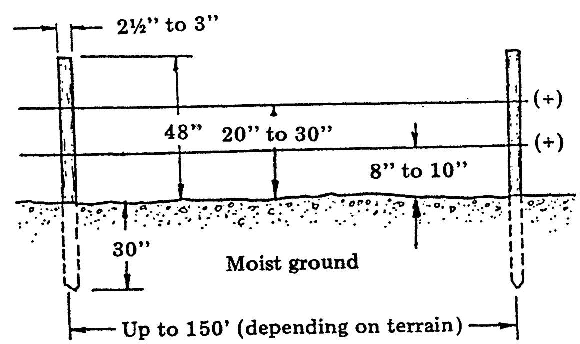
A brace assembly is required for a 12-foot or larger gate. End, gate and 90° corner posts are 8 feet long x 6 inches in diameter and are driven 4 feet into the ground. Line posts are 6½ feet long x 2½ to 3 inches in diameter and are driven 30 inches into the ground. Dip, rise, and curve posts are 8 feet long x 4 inches in diameter and are driven 4 feet into the ground.

TWO WIRE FOR CATTLE IN DRY AREAS



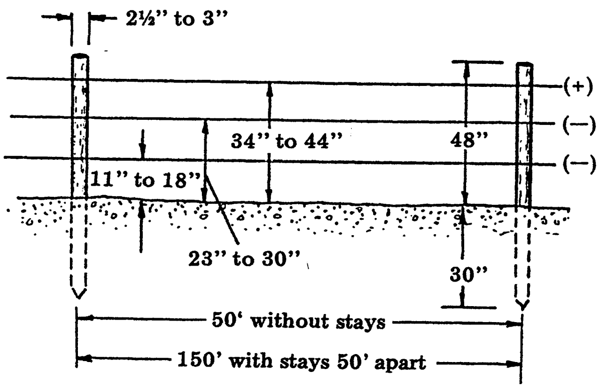
No brace assemblies are required for most soil types. Brace assembly is required for a 12-foot or larger gate. End, gate and 90° corner posts are 8 feet long x 6 inches in diameter and are driven 4 feet into the ground. Line posts are 6½ feet x 2½ to 3 inches in diameter and are driven 30 inches into the ground. Dip, rise, and curve posts are 8 feet long x 4 inches in diameter and are driven 4 feet into the ground.

TWO-WIRE FOR CATTLE WITH CALVES OR SHEEP IN AREAS WITH IRRIGATION OR 24 INCHES OF RAIN ANNUALLY



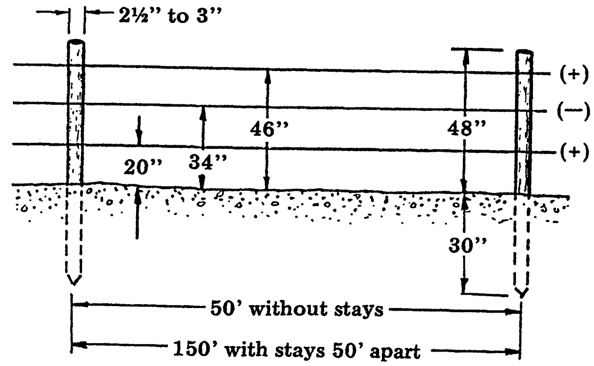
A brace assembly is required for 12 foot or longer gates. End, gate and 90° corner posts are 8 feet long x 6 inches in diameter and are driven 4 feet into the ground. Line posts are 6½ feet long x 2½ to 3 inches in diameter and are driven 30 inches into the ground. Dip, rise, and curve posts, 8 feet long x 4 inches in diameter are driven 4 feet into the ground.

THREE-WIRE FOR CATTLE WITH CALVES IN WET OR DRY COUNTRY (SUBDIVISION)



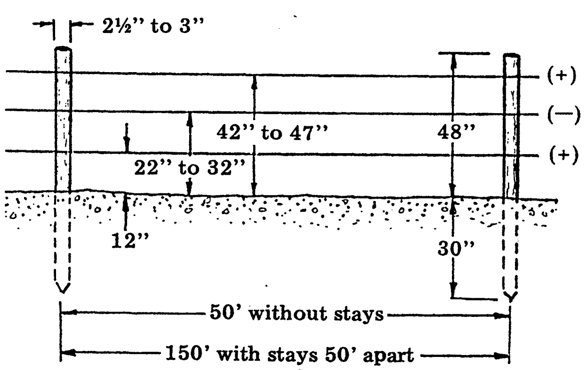
A good fence on even or uneven terrain. A single-span or equivalent brace assembly is required at fence ends, gates, and 90° corners. End, gate and 90° corner posts 8 feet long x 6 inches in diameter are driven 4 feet into the ground. Line posts, 6½ feet long x 2½ to 3 inches in diameter are driven 30 inches into the ground. Dip, rise, and curve posts, 8 feet long x 4 inches in diameter are driven 4 feet into the ground.

THREE-WIRE FOR CATTLE AND HORSES IN DRY COUNTRY



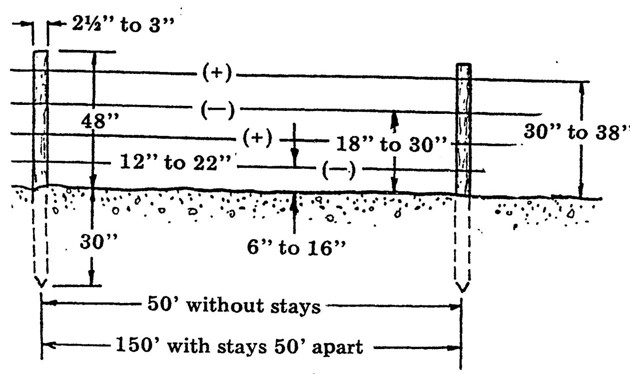
A good fence on even or uneven terrain. A single-span or equivalent brace assembly is required at fence ends, gates, and 90° corners. End, gate and 90° corner posts, 8 feet long x 6 inches in diameter are driven 4 feet into the ground. Line posts, 6½ feet long x 2½ to 3 inches in diameter are driven 30 inches into the ground. Dip, rise, and curve posts, 8 feet long x 4 inches in diameter are driven 4 feet into the ground.

THREE-WIRE FOR HORSES IN DRY COUNTRY



A good fence on even or uneven terrain. A single-span or equivalent brace assembly is required at fence ends, gates, and 90° corners. End, gate and 90° corner posts, 8 feet long x 6 inches in diameter are driven 4 feet into the ground. Line posts, 6½ feet long x 2½ to 3 inches in diameter are driven 30 inches into the ground. Dip, rise, and curve posts, 8 feet long x 4 inches in diameter are driven 4 feet into the ground.

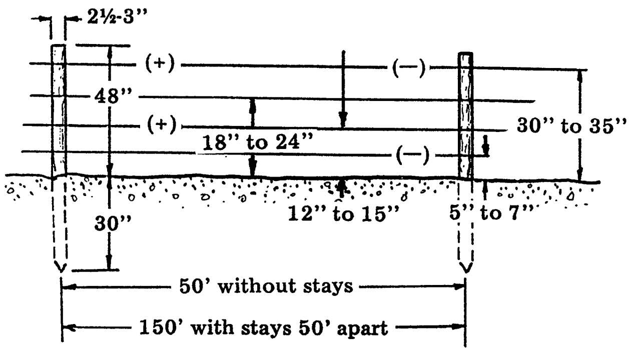
FOUR-WIRE FOR SHEEP IN WET OR DRY AREAS



A good fence on even or uneven terrain. A single-span or equivalent brace assembly is required at fence ends, gates, and 90° corners. End, gate and 90° corner posts, 8 feet long x 6 inches in diameter are driven 4 feet into the ground. Line posts, 6½ feet long x 2½ to 3 inches in diameter are driven 30 inches into the ground. Dip, rise, and curve posts, 8 feet long x 4 inches in diameter are driven 4 feet into the ground.

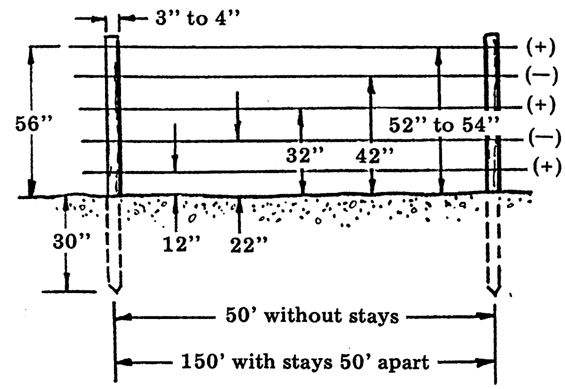
If dry conditions existed, a ground return wire would be added 2 to 6 inches below the live wire. Nonconductive spacers should be placed between these wires to prevent them from touching and grounding out the live wire.

FOUR-WIRE FOR CATTLE AND SHEEP IN DRY COUNTRY



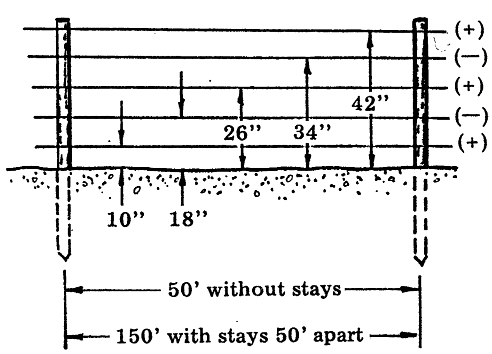
A good fence on even or uneven terrain. A single-span or equivalent brace assembly is required at fence ends, gates, and 90° corners. End, gate, and 90° corner posts, 8 feet long x 6 inches in diameter are driven 4 feet into the ground. Line posts, 6½ feet x 2½ to 3 inches in diameter are driven 30 inches into the ground. Dip, rise, and curve posts, 8 feet long x 4 inches in diameter are driven 4 feet into the ground.

FIVE-WIRE FOR HORSES IN DRY COUNTRY



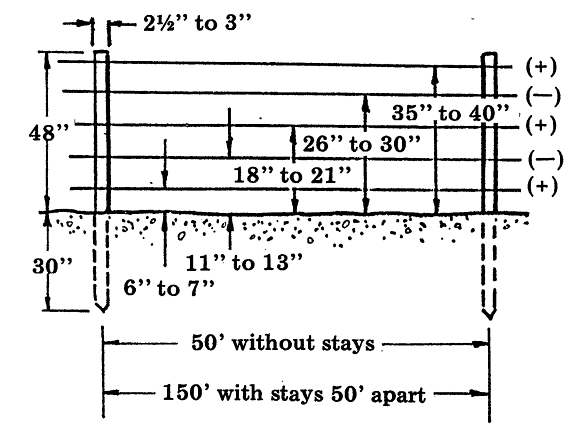
A good fence on even or uneven terrain. A single-span or equivalent brace assembly is required at fence ends, gates, and 90° corners. End, gate and 90° corner posts, 8 feet long x 6 inches in diameter are driven 4 feet into the ground. Line posts, 6½ feet long x 2½ to 3 inches in diameter are driven 30 inches into the ground. Dip, rise, and curve posts, 8 feet long x 4 inches in diameter are driven 4 feet into the ground.

FIVE-WIRE FOR CATTLE WITH CALVES IN DRY COUNTRY-SUBDIVISION



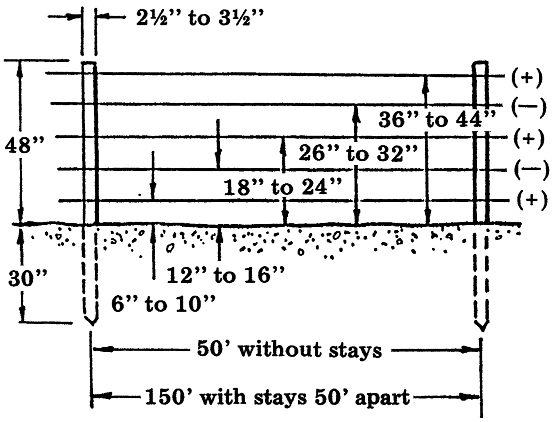
A good fence on even or uneven terrain. A single-span or equivalent brace assembly is required at fence ends, gates, and 90° corners. End, gate and 90° corner posts, 8 feet long x 6 inches in diameter are driven 4 feet into the ground. Line posts, 6½ feet long x 2½ to 3 inches in diameter are driven 30 inches into the ground. Dip, rise, and curve posts, 8 feet long x 4 inches in diameter are driven 4 feet into the ground. The bottom wire is a neutral wire. It can be left uncharged or, when necessary, tapped onto a charged line.

FIVE-WIRE FOR SHEEP WITH LAMBS IN DRY COUNTRY



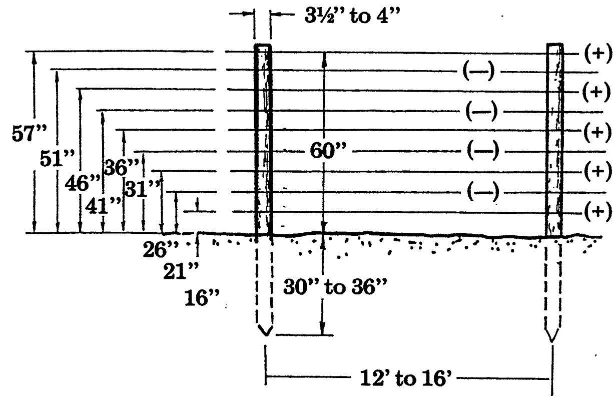
A good fence on even or uneven terrain. A single-span or equivalent brace assembly is required at fence ends, gates, and 90° corners. End, gate and 90° corner posts, 8 feet long x 6 inches in diameter are driven 4 feet into the ground. Line posts, 6½ feet long x 2½ to 3 inches in diameter are driven 30 inches into the ground. Dip, rise, and curve posts, 8 feet long x 4 inches in diameter are driven 4 feet into the ground. The bottom wire is a neutral wire. It can be left uncharged or, when necessary, tapped onto a charged line.

FIVE-WIRE FOR CATTLE WITH SHEEP IN DRY COUNTRY



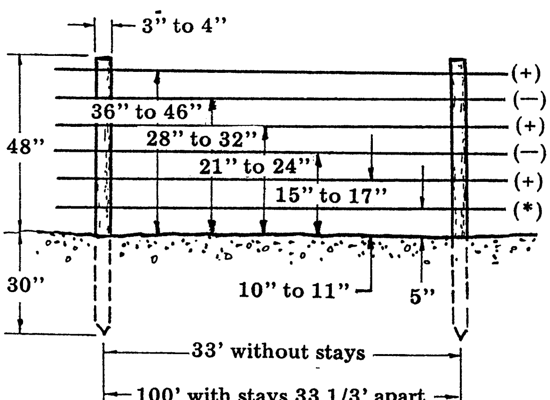
A good fence on even or uneven terrain. A single-span or equivalent brace assembly is required at fence ends, gates, and 90° corners. End, gate and 90° corner posts, 8 feet long x 6 inches in diameter are driven 4 feet into the ground. Line posts, 6½ feet long x 2½ to 3 inches in diameter are driven 30 inches into the ground. Dip, rise, and curve posts, 8 feet long x 4 inches in diameter are driven 4 feet into the ground.

NINE-WIRE FOR HORSE PASTURE



A good fence on even or uneven terrain. A double-span or equivalent brace assembly is required at fence ends, gates, and 90° corners. End, gate and 90° corner posts, 8 feet long x 6 inches in diameter are driven 4 feet into the ground. Line posts, 6½ feet long x 2½ to 3 inches in diameter are driven 30 inches into the ground. Dip, rise, and curve posts, 8 feet long x 4 inches in diameter are driven 4 feet into the ground.

SIX-WIRE FOR HORSES, CATTLE, AND SHEEP IN DRY COUNTRY-BOUNDARY

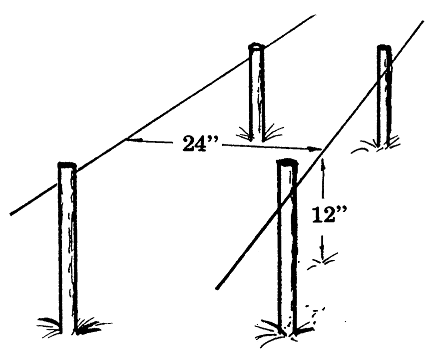


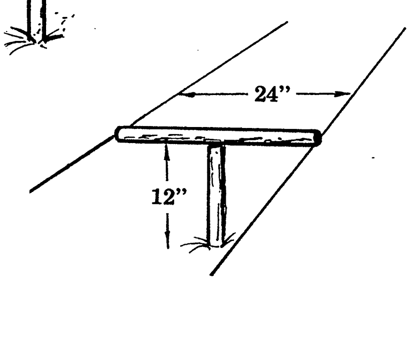
*Bottom wire is neutral

A good fence on even or uneven terrain. A single-span or equivalent brace assembly is required at fence ends, gates, and 90° corners. End, gate and 90° corner posts, 8 feet long x 6 inches in diameter are driven 4 feet into the ground. Line posts, 6½ feet long x 2½ to 3 inches in diameter are driven 30 inches into the ground. Dip, rise, and curve posts, 8 feet long x 4 inches in diameter are driven 4 feet into the ground. The bottom wire is a neutral wire. It can be left uncharged or, when necessary, tapped onto a charged line.

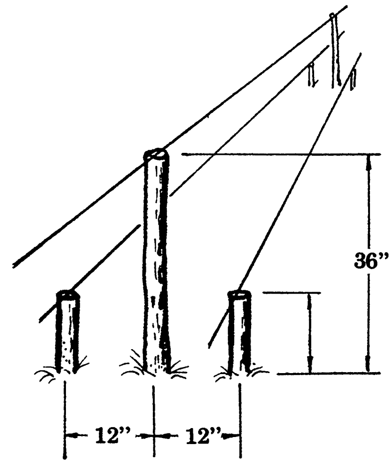
The following illustrations are examples of the visual barrier electric fence. The posts used are either short treated 2 x 2's with insulators or fiberglass posts which are cut in half.

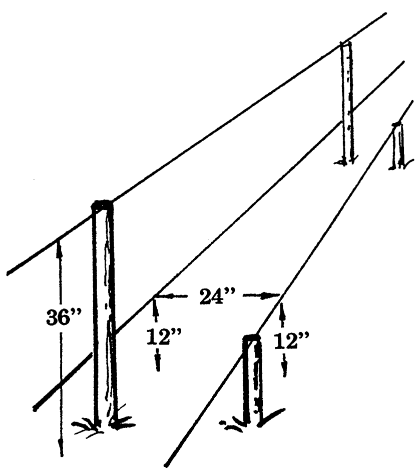
For sheep, two 12½ gauge, high tensile wires run in a parallel line 24 inches apart and 12 inches off the ground. Either of the two designs shown below seems to work well.

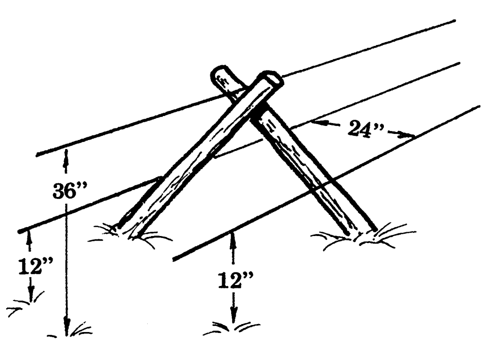




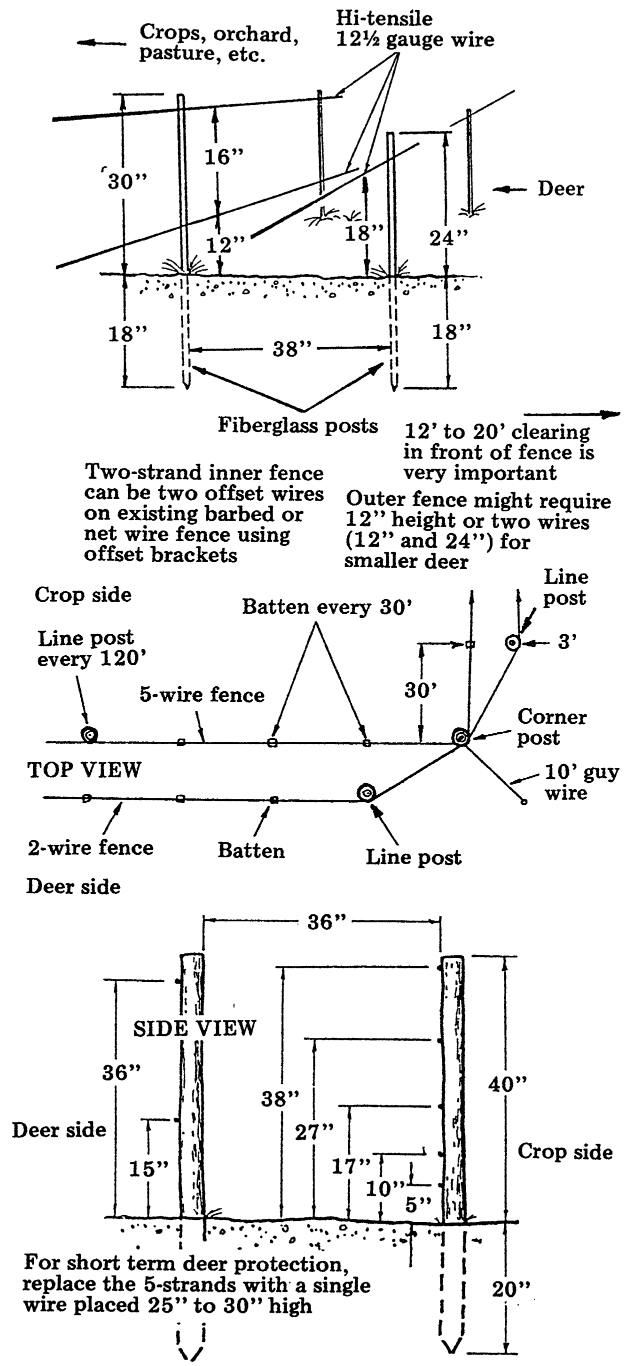
For cattle, three 12½ gauge, high tensile wires are needed. Several designs are available, but the normal configuration for the bottom two wires is the same as for the sheep fence with the third wire running halfway between them 36 inches high. Three designs are shown:





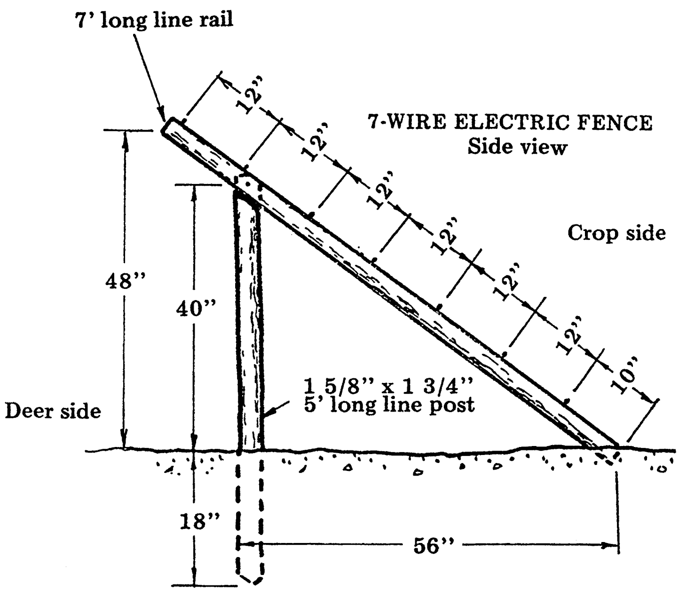


ANTI-DEER TWO FENCE DESIGN

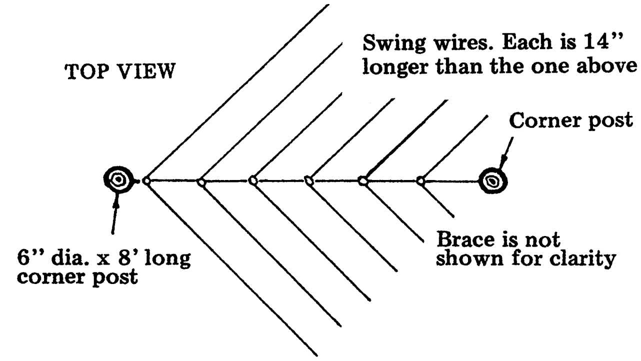


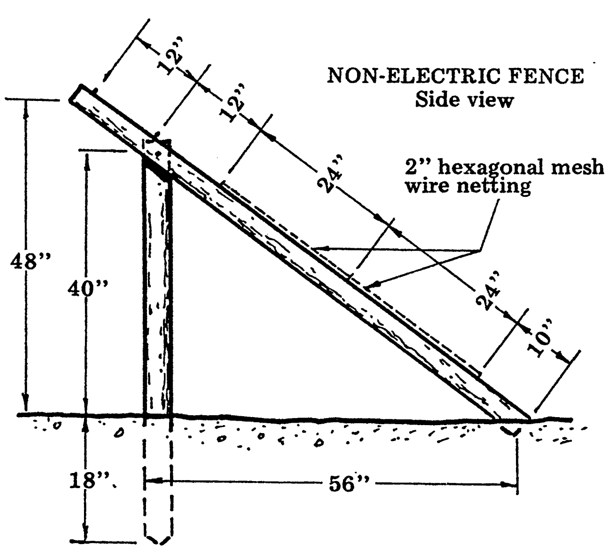
Use a double-span or equivalent brace assembly; or use a single-span or equivalent brace assembly that has 10 feet between the brace posts at fence ends, gates and 90° corners. End, gate and 90° corner posts are 8 feet long x 6 inches in diameter and are driven 48 inches into the ground. Rise and dip posts, 8 feet long x 6 inches in diameter are driven 48 inches into the ground. Line posts, 1-5/8 inches x 1-3/4 inches x 5 feet long are driven 20 inches into the ground. Self-insulating stays are spaced every 30 feet.

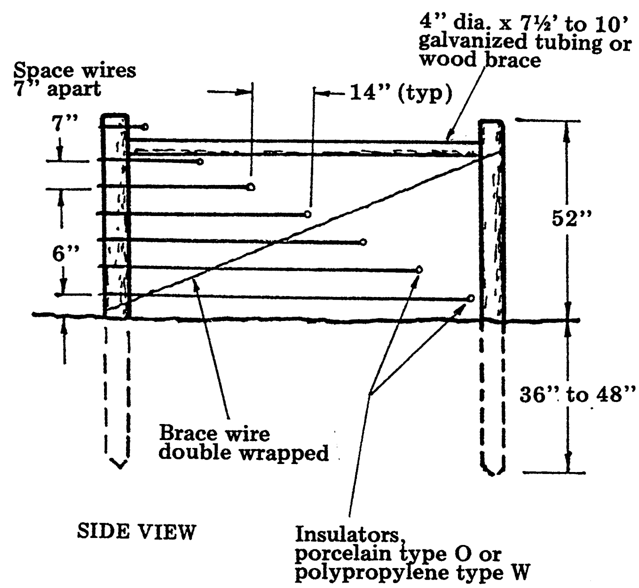
ANTI-DEER SLANTED ELECTRIC FENCE DESIGN



7—STRAND ELECTRIC DEER FENCE SWING CORNER

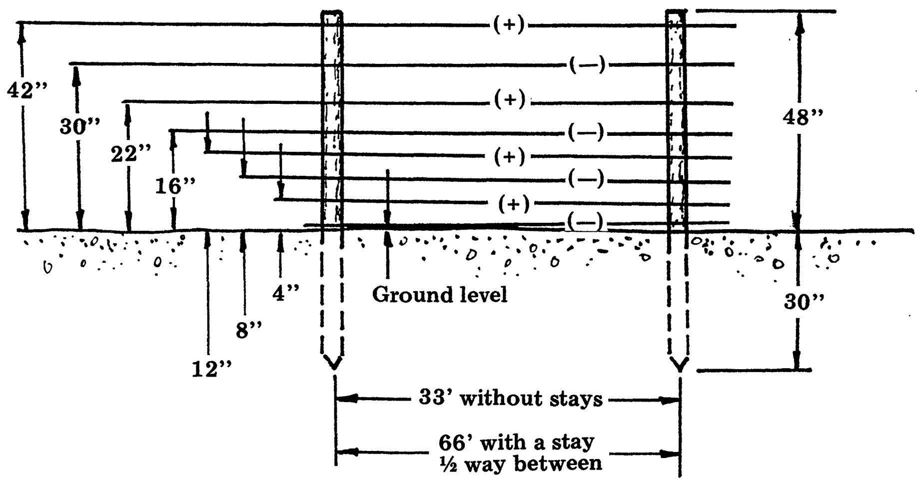


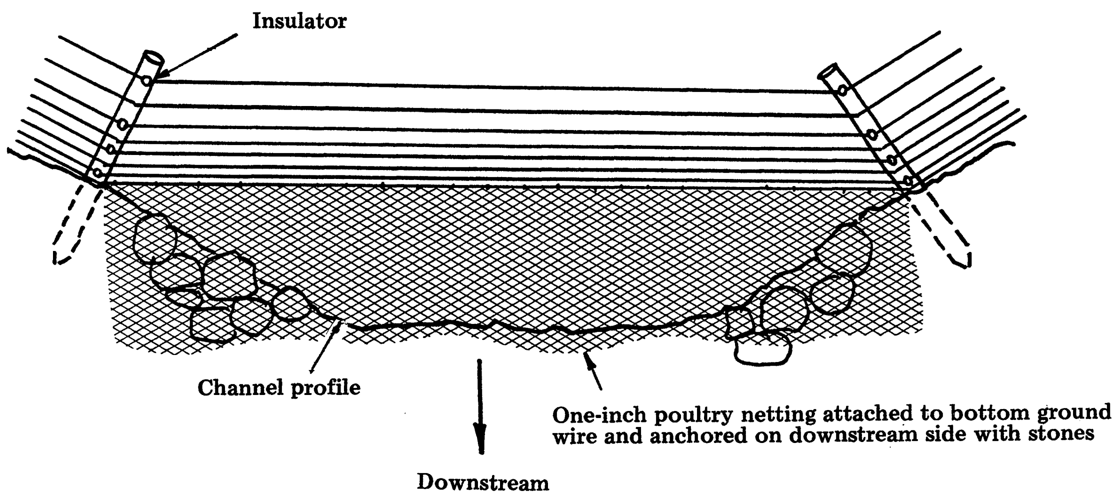




Use a double-span or equivalent brace assembly; or use a single-span or equivalent brace assembly that has 10 feet between the brace posts at fence ends, gates, and 90° corners. End, gate and 90° corner posts, 7 feet long x 6 inches in diameter are driven 48 inches into the ground. Rise and dip posts, 8 feet long x 6 inches in diameter are driven 48 inches into the ground. Line posts, 1-5/8 inches x 1-3/4 inches x 5 feet long are driven 18 inches into the ground. Self-insulating stays, ½ inch x 1½ inches x 7 feet long are spaced every 30 feet. Line rails, 1 inch x 3 inches x 7 feet long are bolted to line posts with a 3/8 inch x 3 inch carriage bolt.

EIGHT-WIRE FOR ROUGH TERRAIN COYOTE-DETERRENT FENCE

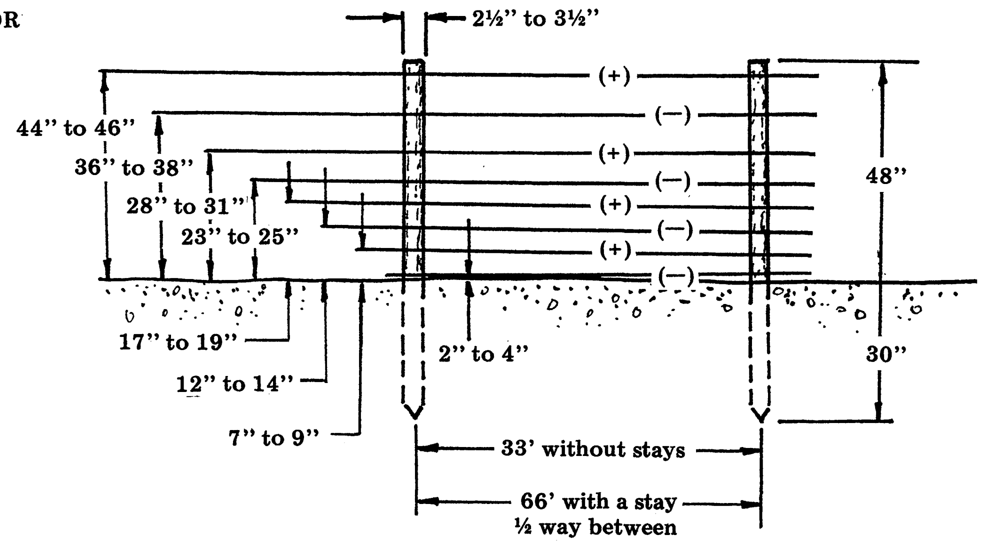




A double-span or equivalent brace assembly is required at fence ends, gates, and 90° corners. End, gate and 90° corner posts, 8 feet long x 6 inches in diameter are driven 4 feet into the ground. Line posts, 6½ feet long x 2½ to 3 inches in diameter are driven 30 inches into the ground. Dip, rise, and curve posts are 8 feet long x 4 inches in diameter, with a 2 inch x 4 inch x 8 inch block nailed near the base for increased holding capacity. Fiberglass and insultimber posts are best used for stays and for posts on relatively level terrain.

Steel "T" posts have more application in rough terrain because they are: not easily pulled out of depressions, not easily bent over under tension, and can be driven where fiberglass and insultimber posts cannot. The bottom wire should always be a ground wire because a charged wire is easily grounded out. One-inch poultry netting is the best protection for crossing channels. The apron of the netting must be on the downstream side so it will swing out freely during heavy water flow.

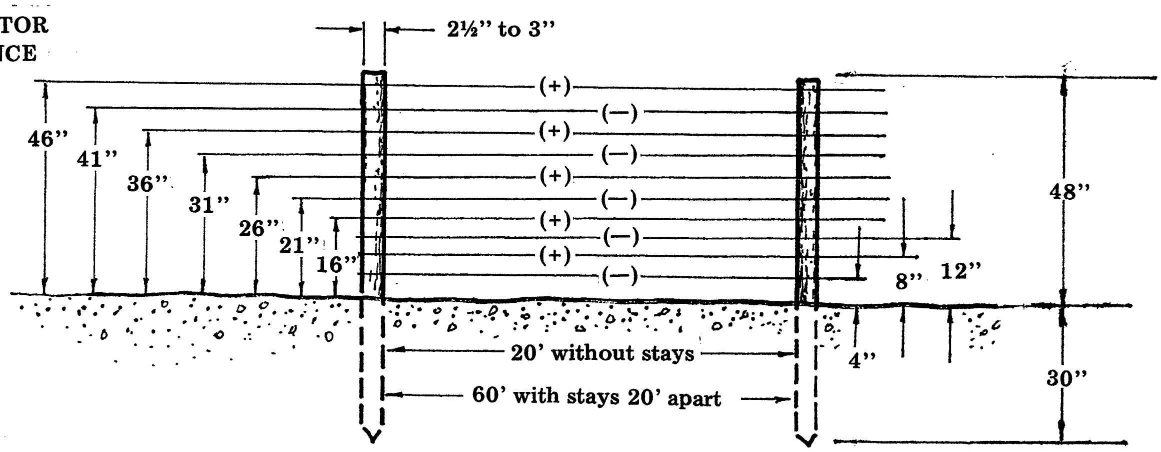
EIGHT-WIRE PREDATOR PROTECTION FENCE



A double-span or equivalent brace assembly is required at fence ends, gates, and 90° corners. End, gate and 90° corner posts, 8 feet long x 6 inches in diameter are driven 4 feet into the ground. Line posts, 6½ feet long x 2½ to 3 inches in diameter are driven 30 inches into the ground. Dip, rise, and curve posts, 8 feet long x 4 inches in diameter, with 2 inch x 4 inch x 8 inch blocks are nailed near the base for increased holding capacity. Fiberglass and insultimber posts are best used for stays and for posts on relatively level terrain.

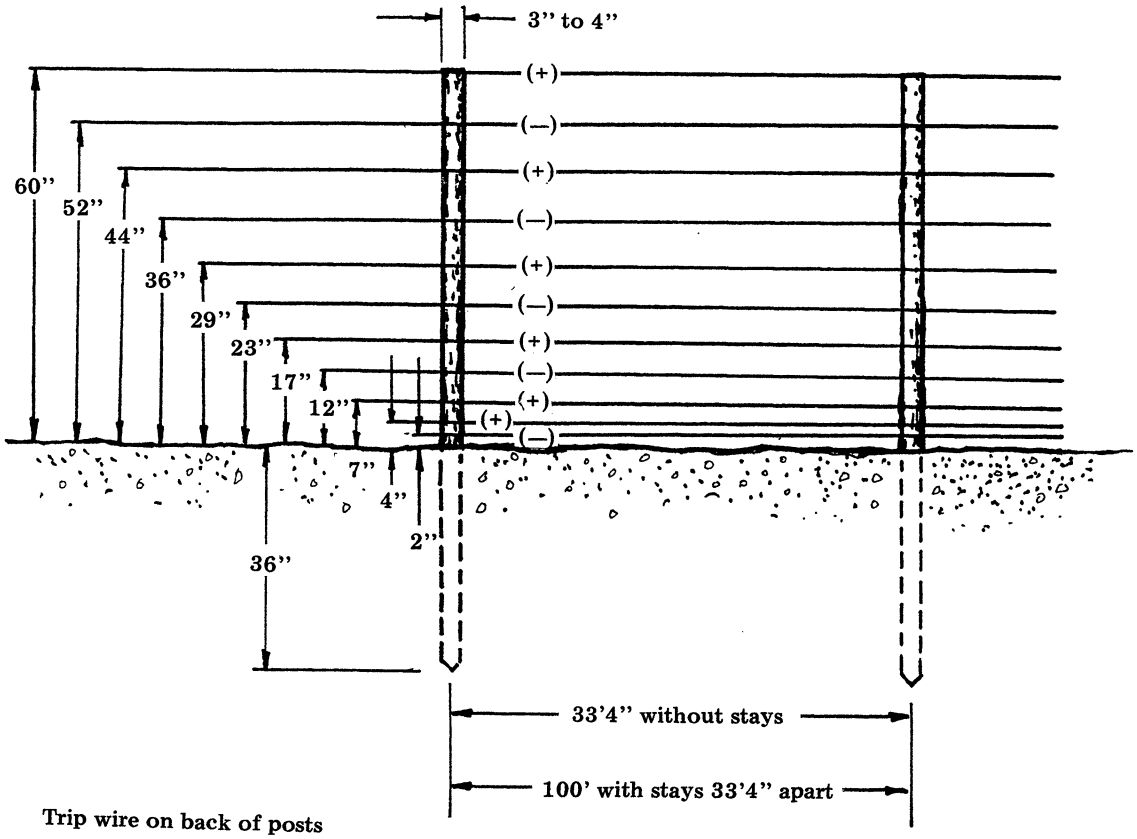
Steel "T" posts have more application in rough terrain because they are: not easily pulled out of depressions, not easily bent over under tension, and can be driven where fiberglass and insultimber posts cannot. The bottom wire should always be a ground wire because a charged wire is easily grounded out. One-inch poultry netting is the best protection for crossing channels. The apron of the netting must be on the downstream side so it will swing out freely during heavy water flow.

TEN-WIRE PREDATOR PROTECTION FENCE



A double-span or equivalent brace assembly is required at fence ends, gates, and 90° corners. End, gate, and 90° corner posts, 8 feet long x 6 inches in diameter are driven 4 feet into the ground. Line posts, 6½ feet long x 2½ to 3 inches in diameter are driven 30 inches into the ground. Dip, rise, and curve posts, 8 feet long x 4 inches in diameter, with 2 inch x 4 inch x 8 inch blocks are nailed near the base for increased holding capacity. Fiberglass and insultimber posts are best used for stays and for posts on relatively level terrain. Steel "T" posts have more application in rough terrain because they are: not easily pulled out of depressions, not easily bent over under tension, and can be driven where fiberglass and insultimber posts cannot. The bottom wire should always be a ground wire because a charged wire is easily grounded out. One-inch poultry netting is the best protection for crossing channels. The apron of the netting must be on the downstream side so it will swing out freely during heavy water flow.

ELEVEN-WIRE ANTI-COYOTE FENCE

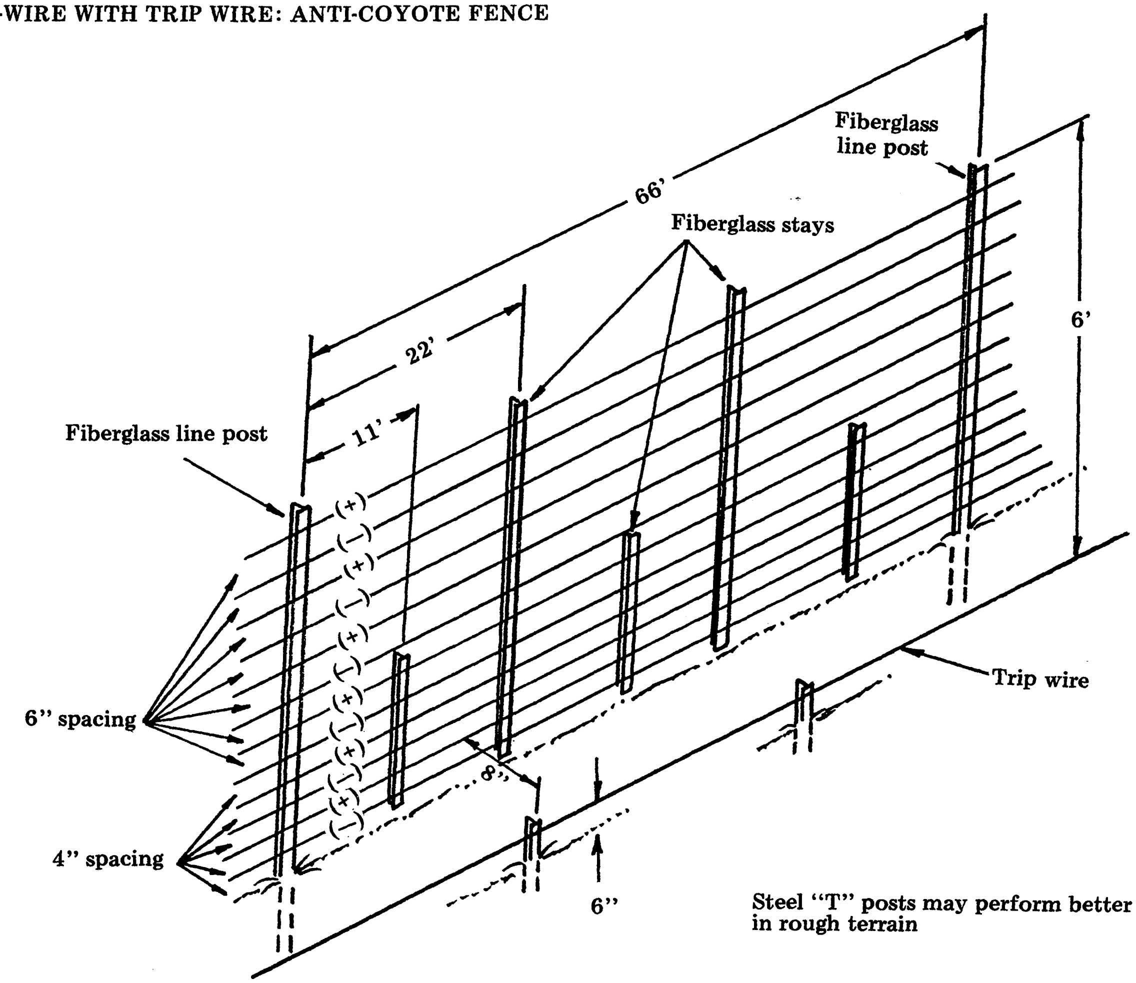


Trip wire on back of posts

A double-span or equivalent brace assembly is required at fence ends, gates, and 90° corners. End, gate, and 90° corner posts, 10 feet long x 6 inches in diameter are driven 58 inches into the ground. Line posts, 8 feet long x 3 inches to 4 inches in diameter are driven 34 inches into the ground. Dip, rise, and curve posts, 10 feet long x 4 inches in diameter are driven 58 inches into the ground. Fiberglass and insultimber posts are best used for stays and for posts on relatively level terrain.

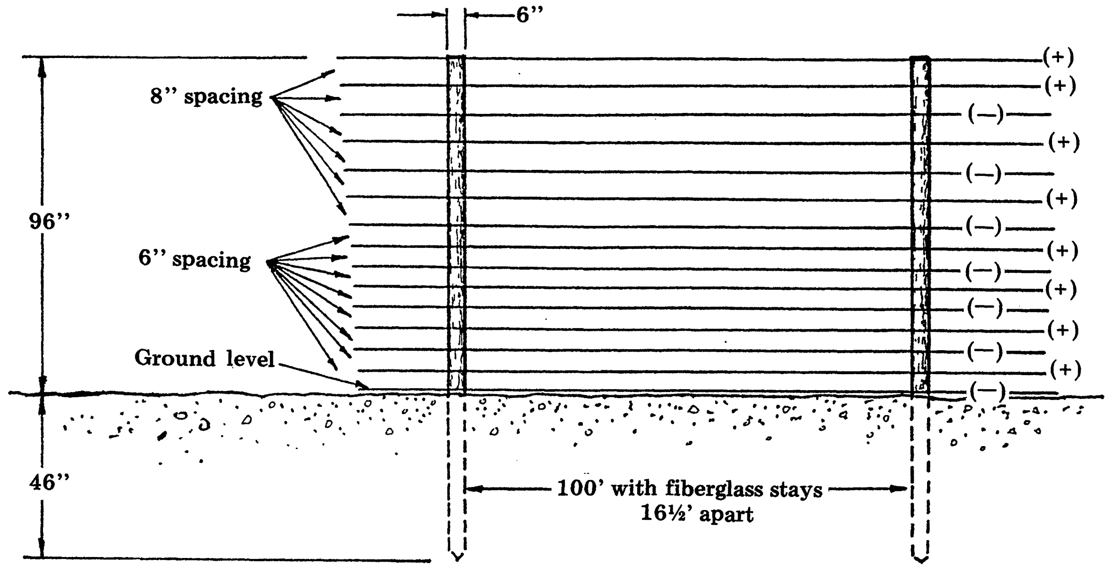
Steel "T" posts have more application in rough terrain because they are: not easily pulled out of depressions, not easily bent over under tension, and can be driven where fiberglass and insultimber posts cannot. The bottom wire should always be a ground wire because a charged wire is easily grounded out. One-inch poultry netting is the best protection for crossing channels. The apron of the netting must be on the downstream side so it will swing out freely during heavy water flow.

TWELVE-WIRE WITH TRIP WIRE: ANTI-COYOTE FENCE



A double-span or equivalent brace assembly at fence ends, gates, and 90° corners. End, gate and 90° corner posts, 10 feet long x 6 inches in diameter are driven 58 inches into the ground. Line posts, 8 feet long x 3 inches to 4 inches in diameter are driven 34 inches into the ground. Dip, rise, and curve posts, 10 feet long x 4 inches in diameter are driven 58 inches into the ground. Fiberglass and insultimber posts are best used for stays and for posts on relatively level terrain. Steel "T" posts have more application in rough terrain because they are: not easily pulled out of depressions, not easily bent over under tension, and can be driven where fiberglass and insultimber types cannot. The bottom wire should always be a ground wire because a charged wire is easily grounded out. One inch poultry netting is the best protection for crossing channels. The apron of the netting must be on the downstream side so it will swing out freely during heavy water flow.

FIFTEEN-WIRE WILDLIFE EXCLOSURE

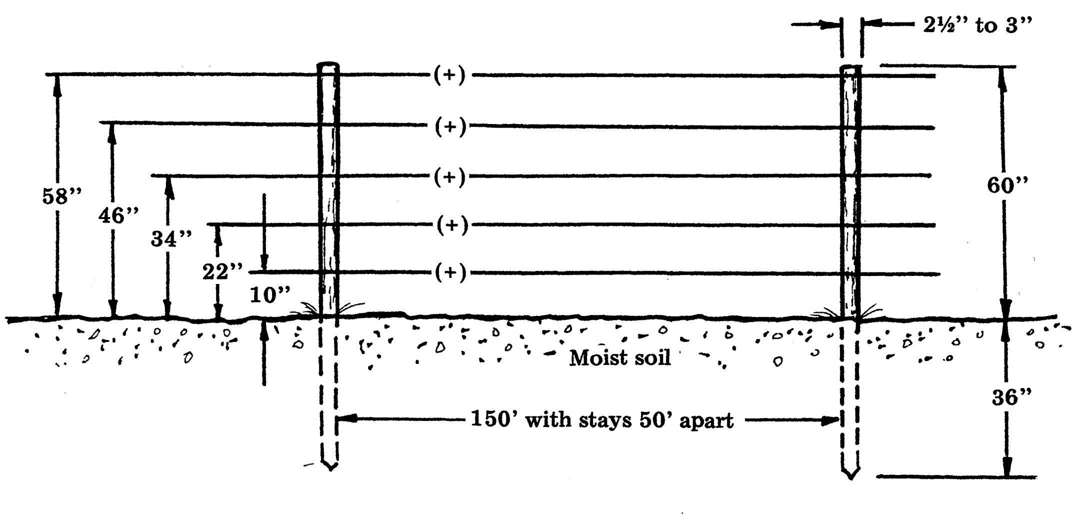


A double-span or equivalent brace assembly at fence ends, gates, and 90° corners. End, gate and 90° corner posts, 12 feet long x 6 inches in diameter are driven 46 inches into the ground. Line posts, 12 feet long x 6 inches in diameter are driven 46 inches into the ground. Dip, rise, and curve posts, 12 feet long x 6 inches in diameter, with 2 inch x 4 inch x 8 inch blocks are nailed near the bases for increased holding capacity and buried 46 inches into the ground. Fiberglass stays are used on 16-½ foot centers. The bottom wire should always be a ground wire because a charged wire is easily grounded out.

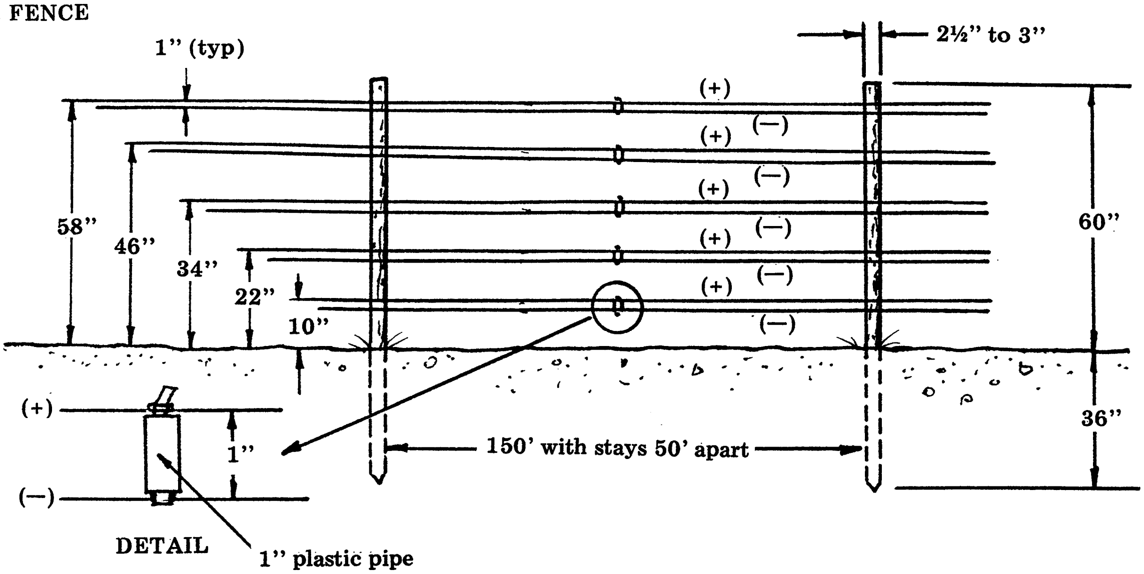
PROTECTING AREAS FROM BEARS

In wet areas, where the ground has enough moisture to carry the charge back to the ground rods and the earth terminal on the energizer, no ground return wires are needed. The following suggestion is one design which has been used; other designs are also effective.

A single-span or equivalent brace assembly is required at fence ends, gates, and 90° corners. End, gate and 90° corner posts, 8 feet long x 6 inches in diameter are driven 4 feet into the ground. Line posts, 8 feet long x 2½ to 3 inches in diameter are driven 36 inches into the ground Dip, rise, and curve posts, 8 feet long x 4 inches in diameter are driven 4 feet into the ground.



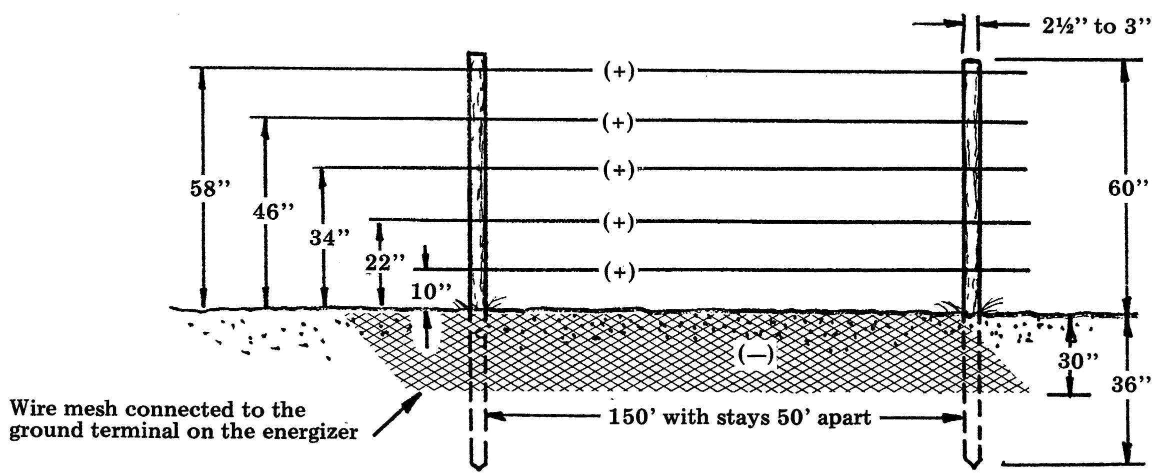
BEAR FENCE



In dry areas, ground-return wires need to be established with the charged lines to provide a conductor to carry the charge back to the earth terminal on the energizer. Because this design places the live and ground wires in close proximity, a separator must be placed between them about every 10 feet or so. A 1-inch plastic hose holds the live and ground wires apart and a plastic tie binds them together. This design should provide a good positive shock as soon as the bear touches

A single-span or equivalent brace assembly is required at fence ends, gates, and 90° corners. End, gate and 90° corner posts, 8 feet long x 6 inches in diameter are driven 4 feet into the ground. Line posts, 8 feet long x 2½ to 3 inches in diameter are driven 36 inches into the ground Dip, rise, and curve posts, 8 feet long x 4 inches in diameter are driven 4 feet into the ground.

BEAR FENCE



Another dry area design is one that uses all live wires on the fence and a ground trip wire. Establishing the correct position for the trip wire so the bear contacts it any time live wires are touched is important. If the correct position for a single trip wire is hard to establish, a wire mesh can be placed on the ground and connected to the earth terminal of the energizer to provide a wide-base ground for the bear to stand on when touching the live wires.

A good fence on even or uneven terrain. A single-span or equivalent brace assembly is required at fence ends, gates, and 90° corners. End, gate and 90° corner posts, 8 feet long x 6 inches in diameter are driven 4 feet into the ground. Line posts, 8 feet long x 2½ to 3 inches in diameter are driven 36 inches into the ground. Dip, rise, and curve posts, 8 feet long x 4 inches in diameter are driven 4 feet into the ground.

Training Animals to Electric Fences

All animals must be trained to respect electric fences. Animals should be put into an electric fence enclosure located inside a stock-proof fence and encouraged to approach the fence by placing food just out of their reach on the other side of the electric fence. Cans coated with molasses and hung on the charged lines will also lure the animals to touch the charged lines. Animals are shocked on their nose or face and learn quickly to relate the shock with the fence wire. Sheep should be trained just after they have been shorn or they should be sprayed with water so their wool acts as a conductor and allows them to receive an effective shock when they touch a live wire. Sheep are particularly aggressive in trying to escape and are stubborn in their attempts to be free. Cattle have been effectively trained in 1 day and sheep in 1 week.

Wildlife also need training to respect electric fences. Since they are not in controlled conditions, electric fences designed to repel them must be soundly constructed. Live wires may be baited to attract wildlife so an effective shock is given on their first contact with the fence.

Electrifying Existing Fences

One of the most common temporary fences is to electrify already existing fences. If wires are not rusted at the appropriate levels, they can be attached to insulators, reattached to the posts, and electrified. If the wires are rusted, they should not be electrified because rust increases the amount of resistance in the wire. A less expensive, but very effective improvement would be to electrify the top wire only.

If an old fence line is improved by repairing the broken, rotten, or loose posts and tightening the wires, it can also become more formidable with the addition of off-set brackets. These off-set brackets will hold the electric wire away so animals cannot rub against the fence. The spacing of the brackets ranges from 35 to 130 feet. The shorter the distance between the brackets, the greater the support given to the wire. Closer bracket spacing decreases the slack in the electrified lines, which reduces the chances of shorting the live wires out on the old fence.

As in any electric fence, the head of the animal should be the target area. In dry conditions, a lower off-set bracket should be established to hold a ground wire so that a positive ground is provided.

Temporary Electric Fences

Temporary electric fences provide temporary pastures, strip grazing, exclude animals from over-grazed or eroded areas, protect reclaimed areas, allow sprayed areas to recover, restrict stock movement in wilderness areas, keep deer, elk, and moose out of hay stacks, and keep bears away from beehives, camps, or cabins.

Temporary electric fences can:

1. Reduce the amount of permanent fence needed
2. Lower construction costs
3. Adapt to a variety of conditions and purposes
4. Be cheaper and easier to maintain
5. Improve operating efficiency and
6. Be easily moved or removed.

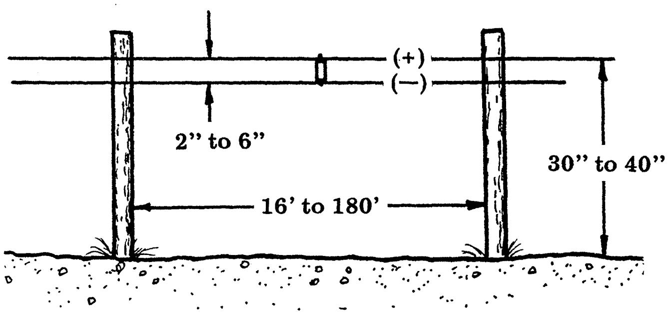
The key to temporary electric fencing is keeping materials to a minimum to reduce the chances of losing power through leakage and to keep the fence portable. Wood line posts may be desirable. A regular 6½-foot x 4-inch treated wooden post is recommended for these sites. Wood posts are durable and easy to insulate, but take longer to install and are not as portable as other post types. Steel posts are easier to install than wood posts and are more portable, but are more difficult to insulate. Insulators should be either porcelain or high strain, ultraviolet-resistant plastic and they should provide resistance to arcing or other leakage of the current to the post.

Fiberglass and plastic posts are probably most suitable for electric fences. Posts should be spaced as far apart as possible while maintaining the desired wire height. Post spacing may range from 16 feet to 180 feet, depending on the terrain, tension applied to the wire, type of animal to be controlled, and availability of food and water. The wider spacings may require stays to keep the wires at the proper levels.

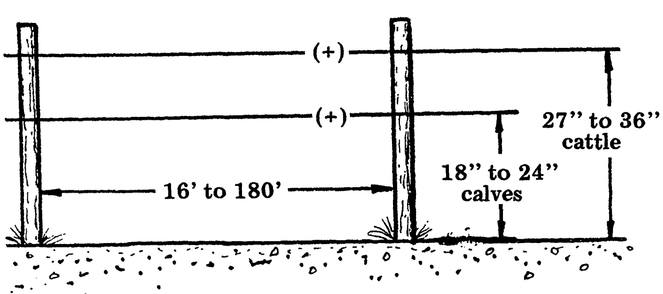
Wire, twine, and ribbon spacing is the same as for permanent electric fence. In areas that receive adequate moisture during the seasons of use (either through rainfall or irrigation), only one energized wire may be needed to control trained animals such as cattle and horses.

If dry conditions exist during the seasons of use a two- or more wire fence is needed. Normally the top wire will be energized and the bottom wire will be the ground return wire. Because the ground does not contain sufficient moisture to carry the current back to the energizer when an animal touches the live wire, a ground wire is necessary to provide this return of current and shock the animal. Be certain that the energized wire is properly insulated and all grounding potentials are removed from the fence line.

A rough estimate used for figuring the live wire height is one-half to two-thirds of the average height of the animals's shoulders. Therefore, if the average height of confined horses is 58 inches, the live wire height would be 38 inches. In areas with moist ground during the seasons of use, a single strand fence for these horses would work.



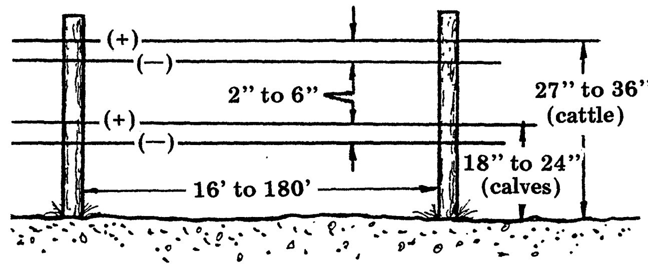
For cattle the same one-half to two-thirds of the average animal shoulder height is used to estimate the height of the top live wire. If calves are present, and the ground contains enough moisture to carry the electric current back to the ground rod and the earth terminal of the energizer, another live wire height should be estimated for the calves. In any situation, where the average animal shoulder height is broken into two different distinct levels, live wire heights should be figured out for each.



Moist ground

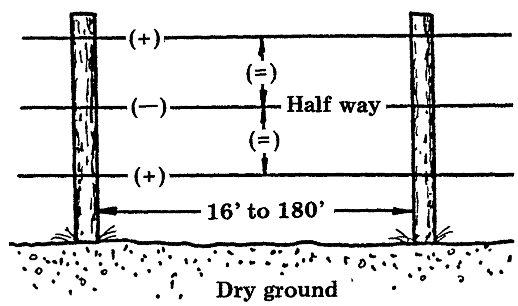
If dry conditions exist, a ground return wire would be added to this design. There are two ways to do this:

A ground wire may be added 2 to 6 inches below each live wire,



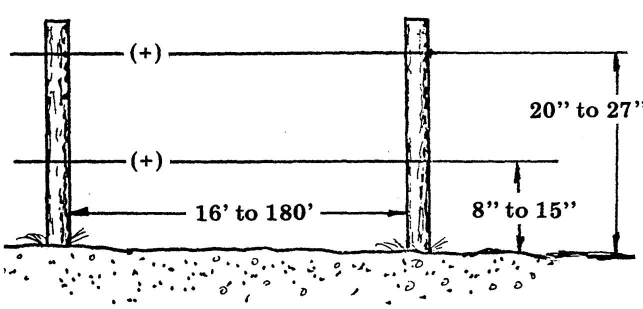
Dry ground

or, one ground wire may be added half way between the two live wires.



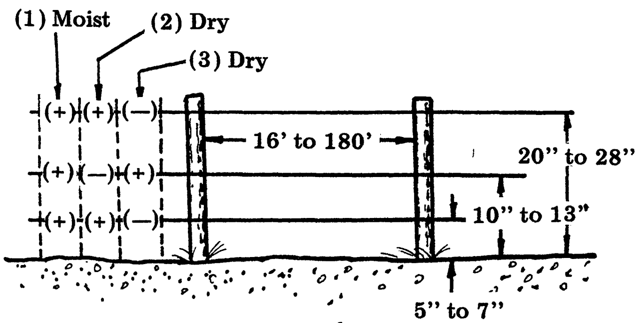
Several temporary electric fence designs for sheep are shown. These should be modified to fit into specific terrain, ground conditions, type of sheep, age of sheep (adult or adult with lambs); or even to accommodate a problem animal in the flock.

If the ground is moist during the seasons of use, either from precipitation or irrigation, a two-wire fence may be used with both wires energized.



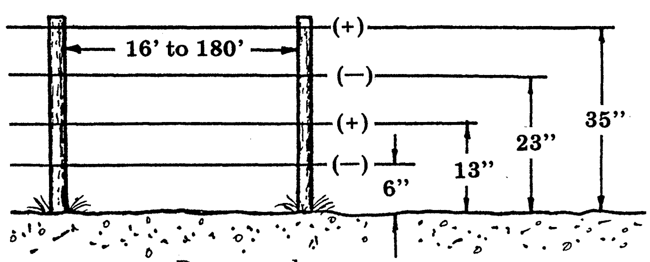
Moist ground

A three-wire fence provides better control for sheep in both moist and dry ground conditions. In moist conditions, all three wires are charged. In dry conditions, the wires may be charged in two ways: the top and bottom wire are charged and the middle wire is grounded; or the middle wire is charged and the top and bottom wires are grounded.



Dry or moist ground

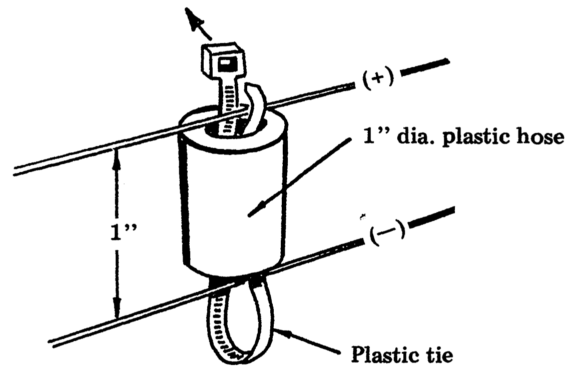
A fourth wire may be added to prohibit sheep from jumping over low fences. Electroplastic netting is also available for temporary fencing for sheep.



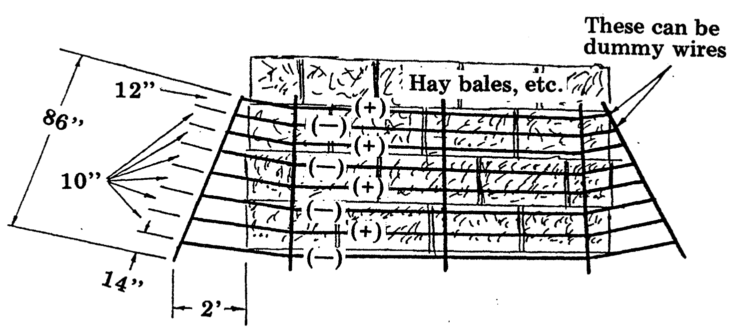
Dry ground

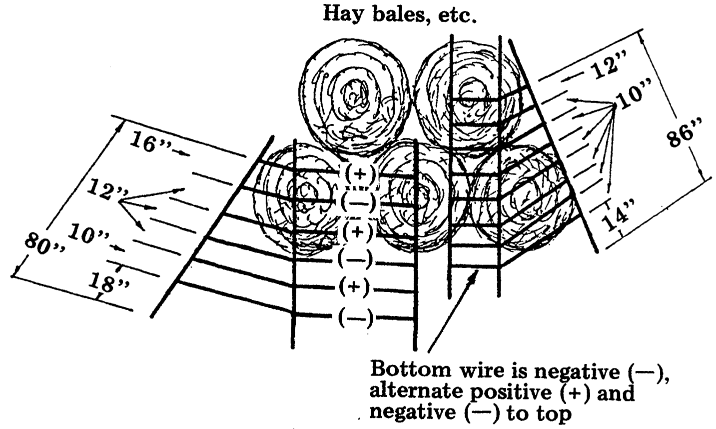
Temporary electric fencing is also used to keep wildlife from getting into unwanted areas like hay stacks. The only completely effective enclosure is a permanent electric fence. Temporary fences, however, can be 90 percent effective.

Poles with insulators, 2 x 4's drilled and fitted with insultube insulator, or fiberglass rods leaned against a hay stack are an easy design that gives an angled barrier. This design places the electric fence close to the hay and discourages jumping the fence. Since the wires lean out at the bottom, the animal's lower body contacts the ground wires. The number and placement of the wires must be varied to fit the needs of the site. Snow depth of 24 inches requires higher placement of the ground and live wires than areas with no snow. The bottom wire should always be close enough to the ground to prevent animals from crawling under the fence. Place a live/ground wire set at a height where a crawling animal will contact with it. This live/ground set is made of a 1-inch plastic hose ¼-inch inside diameter ID and a plastic tie, which can be purchased at most parts shops.



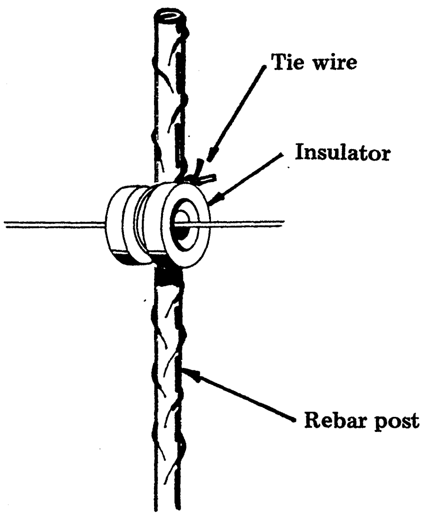
The following designs are examples that should be modified to fit specific site conditions:



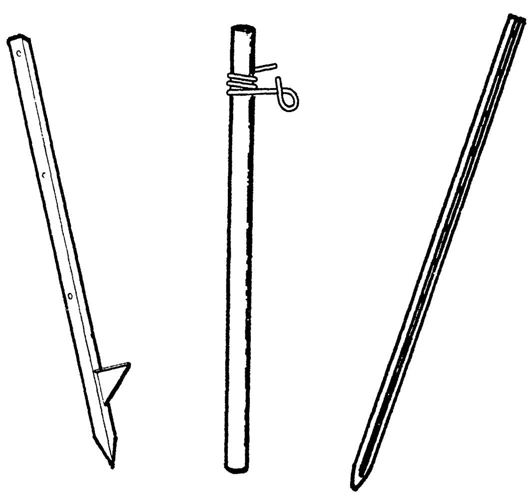


Bottom wire is negative (—), alternate positive (+) and negative (—) to top

Rebar can be used for posts. It is comparatively light and, if pointed, is easily driven into most soil types. The same attention given to insulators for steel posts must be given here.

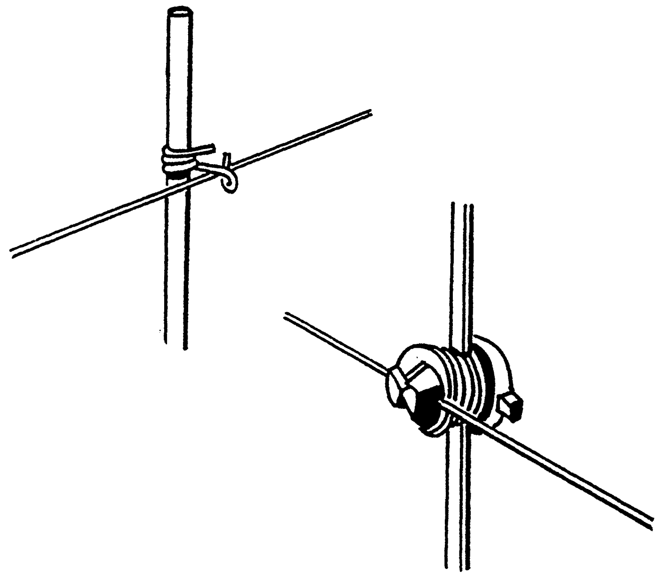


Rods and posts constructed of fiberglass are good for tempoarary electric fences. They are lightweight, strong, flexible, and nonconductive. Wires can be directly attached to them. They come in various sizes and weights. The rods of the T-shaped posts may either be notched or have holes drilled in them at the desired wire spacings for secure attachments of the wire strands. These posts do not stand up to fire well.

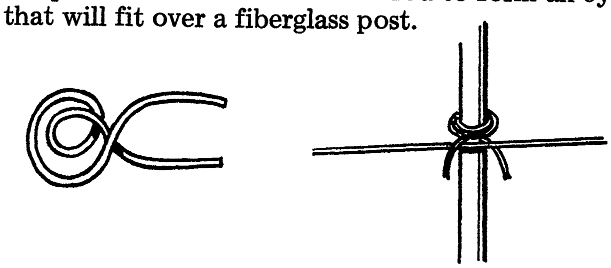


Fiberglass rods and posts.

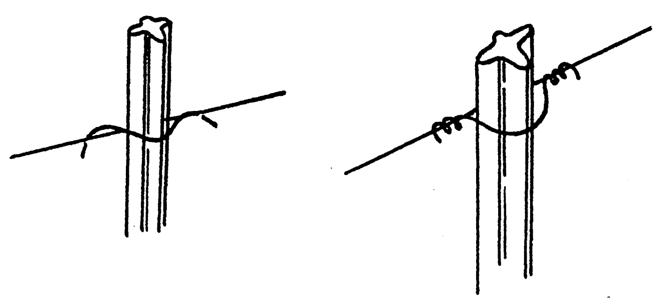
Small diameter fiberglass posts have attachments to hold the wire. Some of these attachments are shown below:



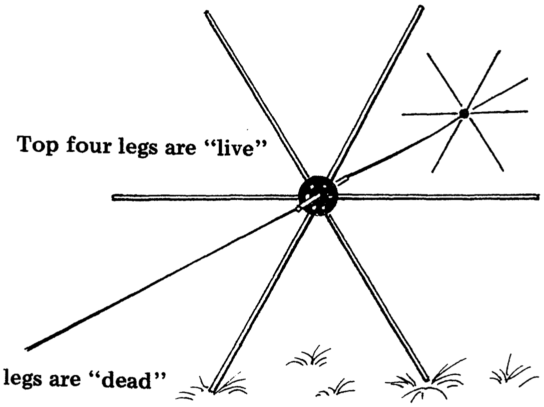
A tie can be made from 12½ or 9 gauge wire. Wrap the wire around a ¼-inch rod to form an eye that will fit over a fiberglass post.

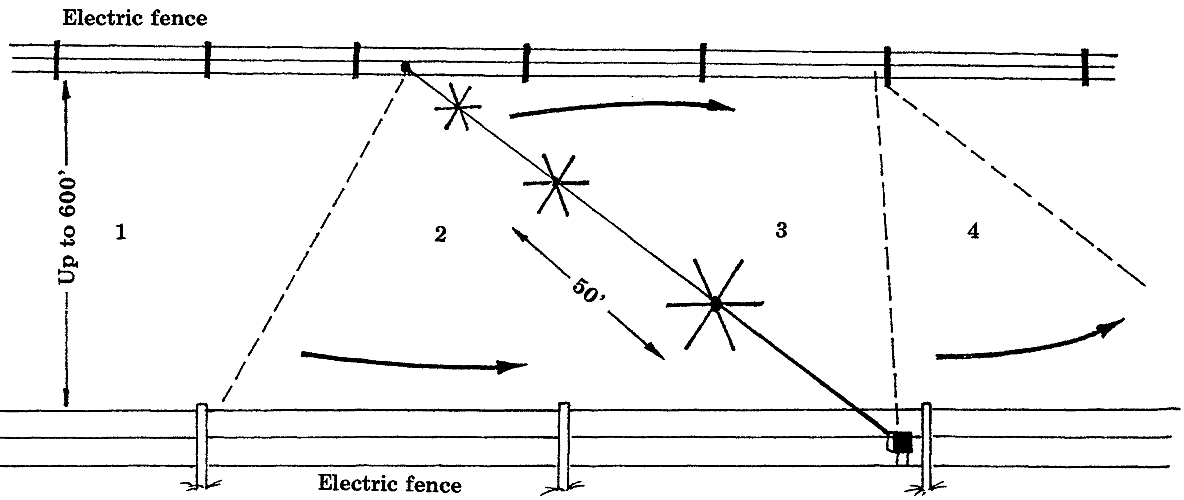


Notched rods or T posts may use spring clips or wire ties to attach the wire.



A walking fence post allows fast and easy fence movement in strip grazing pastures up to 600 feet wide. The star-like posts are normally spaced 50 feet apart. An electrical wire runs through the center hub, the bottom two legs are always dead, and the top four legs are always live to deter livestock from rubbing on them.





Visual barrier electric fence allows vegetation (preferably grass) to grow up between the wires and form a visual barrier to the animals. This visual barrier is complemented by the psychological barrier provided by the electric wires. The advantages of this fence are:

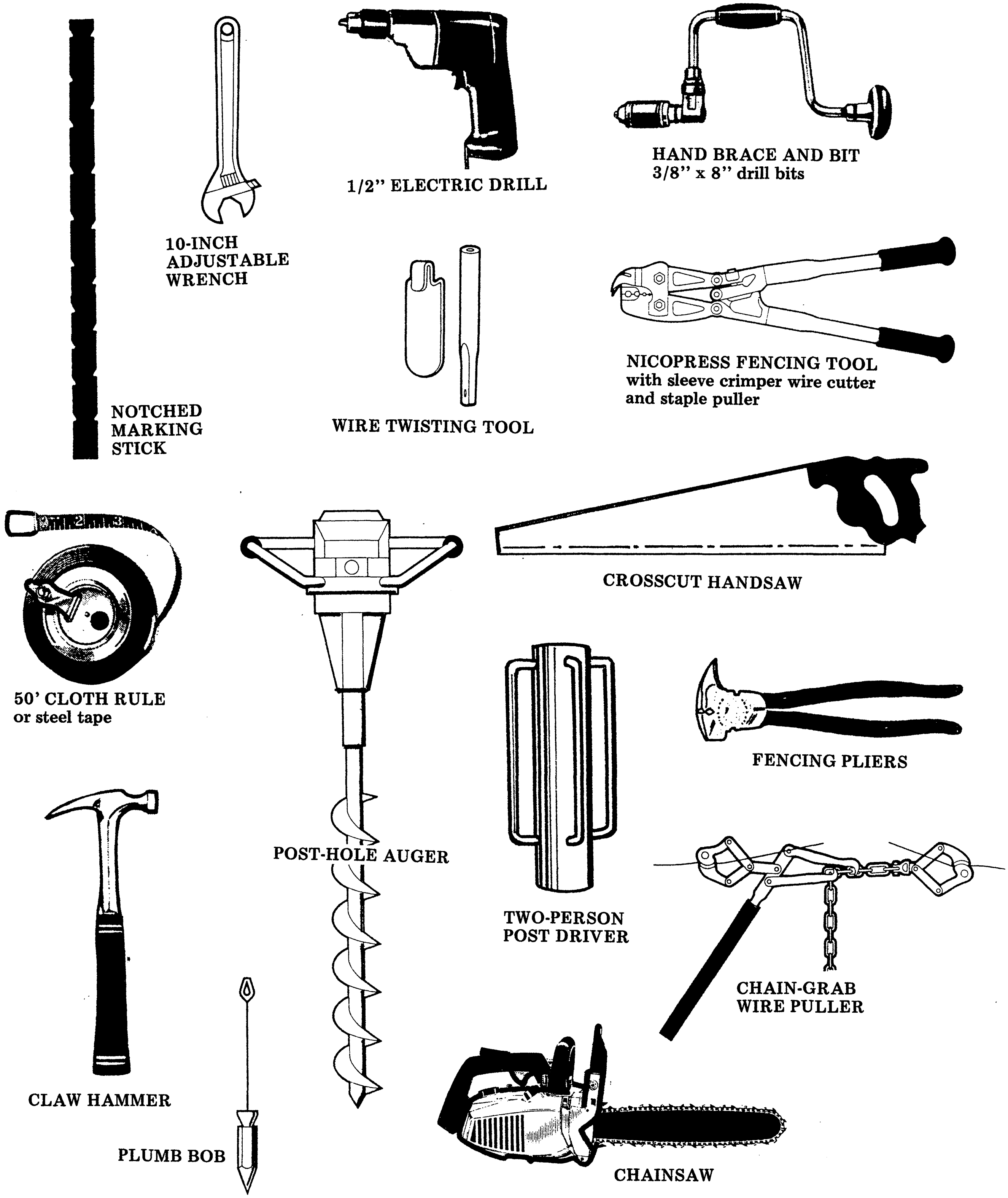
1. It is economical
2. It is easily constructed
3. It does not need brace assemblies.

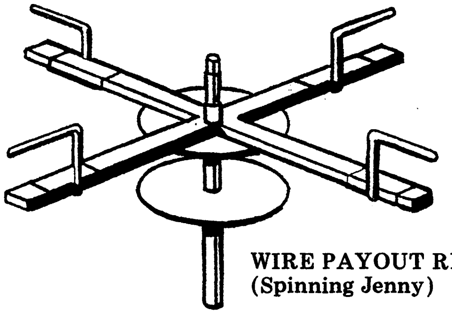
The disadvantages are:

1. It is not easily moved
2. All of the wires must be charged
3. It does not provide an adequate shock in dry conditions
4. The visual barrier will not grow up during dry conditions
5. Animals will run through it under pressure.

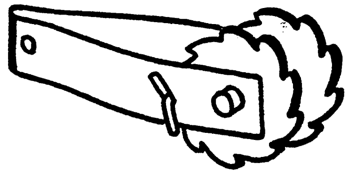
Because of these disadvantages, this fence design has not been widely accepted. It should only be used where adequate moisture provides adequate growth for a visual barrier and provides soil moisture levels for good grounding.

Tools

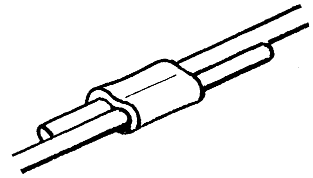

NOTCHED MARKING STICK
10-INCH ADJUSTABLE WRENCH
1/2" ELECTRIC DRILL
HAND BRACE AND BIT
3/8" x 8" drill bits
WIRE TWISTING TOOL
NICOPRESS FENCING TOOL
with sleeve crimper wire cutter and staple puller
50' CLOTH RULE
or steel tape
POST-HOLE AUGER
CROSSCUT HANDSAW
TWO-PERSON POST DRIVER
FENCING PLIERS
CHAIN-GRAB WIRE PULLER
CLAW HAMMER
PLUMB BOB
CHAINSAW



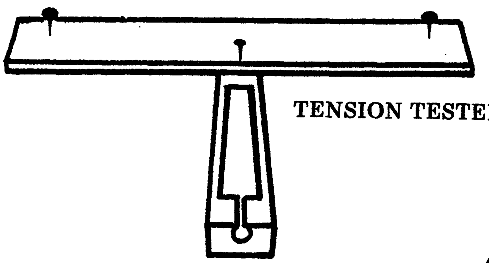
WIRE PAYOUT REEL
(Spinning Jenny)



IN-WIRE STRAINERS

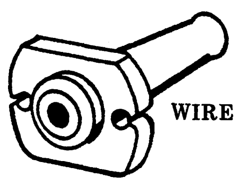


NICOPRESS SLEEVE

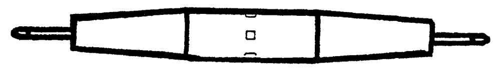


TENSION TESTER

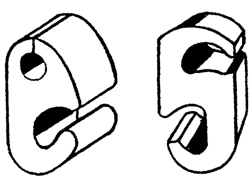
TENSION INDICATOR SPRING



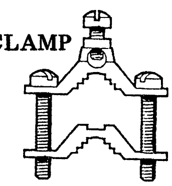
WIRE VICE



RELIABLE WIRELINK

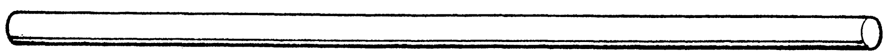


NICOTAP SLEEVES



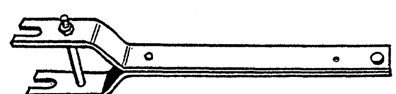
GROUND ROD CLAMP

1 3/4" STAPLES

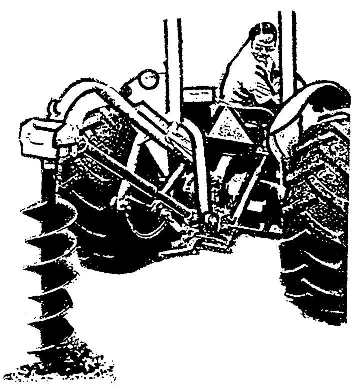


6' x 5/8" GALVANIZED STEEL ROD
(ground rod for lightning protection)

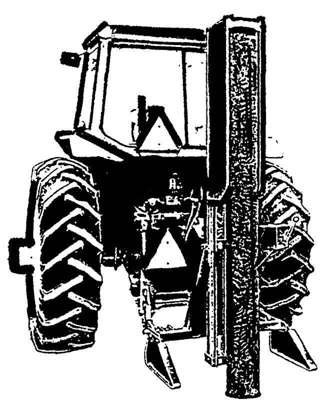
When constructing long fences the following tools will help reduce construction time.



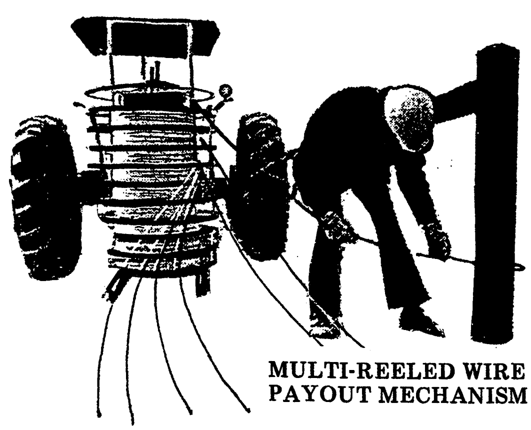
IN-LINE STRAINER
TENSIONING HANDLES



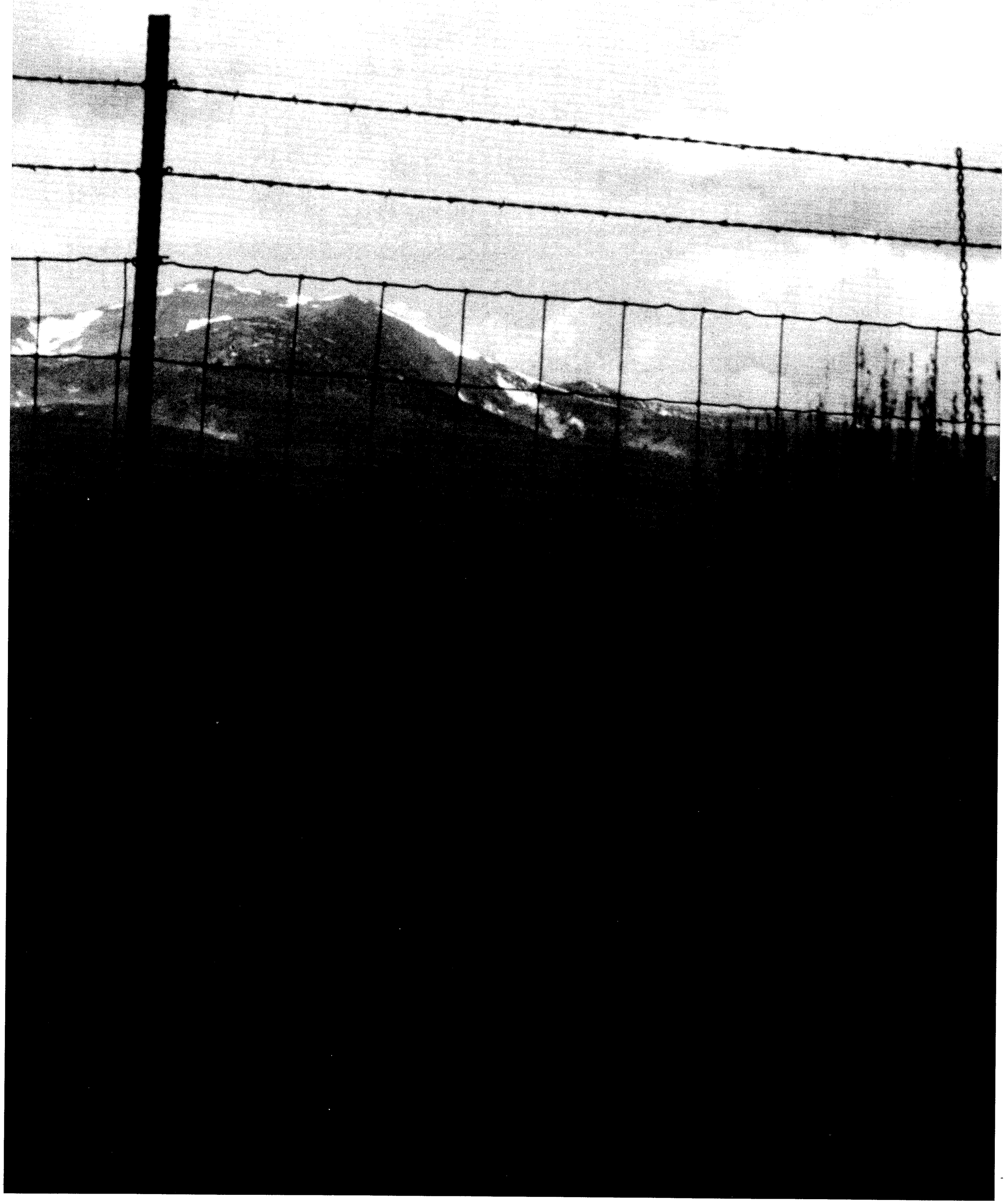
TRACTOR-MOUNTED
HOLE AUGER



TRACTOR-MOUNTED
POST DRIVER



MULTI-REELED WIRE
PAYOUT MECHANISM



Wire is the most common fence material.

Wire Fences

Wire is divided into three major categories: Smooth high tensile wire, barbed wire, and woven wire. In general, wire is the most commonly used material for constructing fences. Wire fences are an effective deterrent but are moderately expensive to build and maintain. Specialty fences for excluding wildlife, crossing gaps, etc. are also discussed.

Smooth Wire

High tensile wire fences have some definite advantages over barbed wire:

1. Lower maintenance costs
2. Greater durability
3. No barb damage to animals.

New Zealand pioneered the use of high tensile wire.

Better quality braces are needed for high tensile wire fences than for those used with conventional barbed wire. Because high tensile wire lasts longer, stress continues on the braces many years after the construction is completed.

For high tensile wire fencing, round pressure-treated wood posts work best. The higher the fence, the deeper the post must be set. In-line fence posts should be:

In-line Fence Posts

	Size *Length by diameter*	Depth *Inches*	Post Spacing *Feet*
Livestock	6 ft, 6 in x 4 in	30	60
Range	6 ft, 6 in x 4 in	30	16
Horse	8 ft x 4 in	36	12
Corral	8 ft x 4 in	42	10
Rise or dip post	8 ft x 4 in	48	Varies

The wire itself is the unique difference in this fencing design. High tensile wire exceeds 100,000 psi breaking strength. Twelve-and-a-half gauge wire has been found most effective at the least cost. All high tensile wires have Class III zinc coating.

There are various manufacturers of high tensile wire. The American Society for Testing Materials has graded metallic coated high tensile steel fence wire as follows:

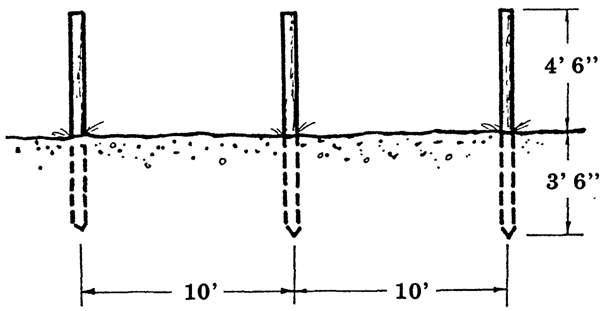
Metallic Coated High Tensile Wire

Grade	Minimum Tensile Strength *Lb/in² (psi)*	Minimum Breaking Point *Lb of direct pull for 12½ gauge*
135	135,000	1,039
180	180,000	1,386
200	200,000	1,540
220	220,000	1,694

For wire with 200,000 psi or above, a 340-pound-per strand of wire tension is recommended. For wire below 200,000 psi, a 250-pound-per-strand of wire tension is recommended. Some fence builders simply take the slack out of the wire rather than measure tensions. Wire tension is measured with the use of a tension meter, a manufacturered tension spring, or a tension handle with a pre-set 'click over' tension indicator.

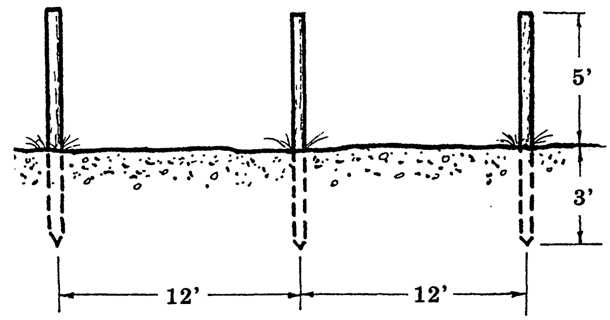
Wire fences should be inspected periodically to prevent problems. Burning weeds under wire fence can damage both the posts and the galvanized coating on the wire. Keep high tensile wires tightened to the recommended pounds of tension. In areas with extreme temperature changes, reduce the tension on the wires at the onset of cold weather and restore it to the correct tension in the spring.

CORRAL ON LEVEL TERRAIN



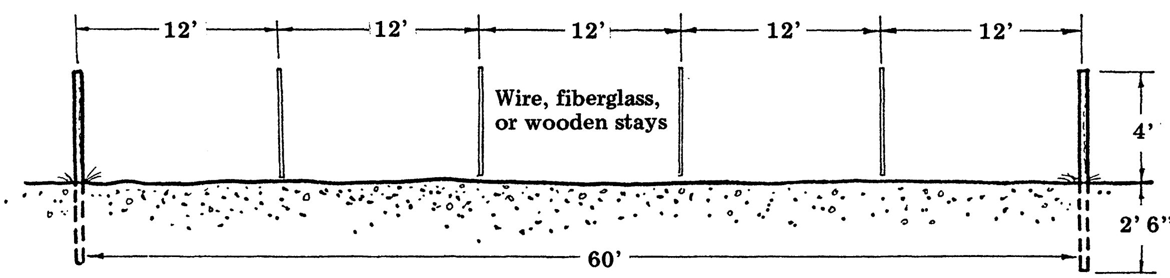
1. Use wire, fiberglass, or wooden stays.
2. Stays rest solidly on the ground.
3. Use No. 14 galvanized stay tie wire for straight-grooved wooden or fiberglass stays.
4. Post spacing may be increased up to 60 feet if stays are used with 5-foot spacing.

HORSE FENCE



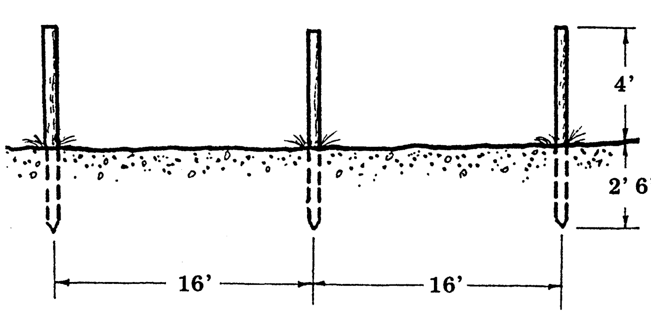
1. Double-span brace assemblies are required at all end, gate, and 90° corner locations.
2. A pilot hole may be needed to lower the height of the post so it will fit under the raised ram of the post driver.

PASTURE ON LEVEL TERRAIN



1. Use wire, fiberglass, or wooden stays.
2. Stays rest solidly on the ground.
3. Use No. 14 galvanized stay tie wire for straight-grooved wooden or fiberglass stays.

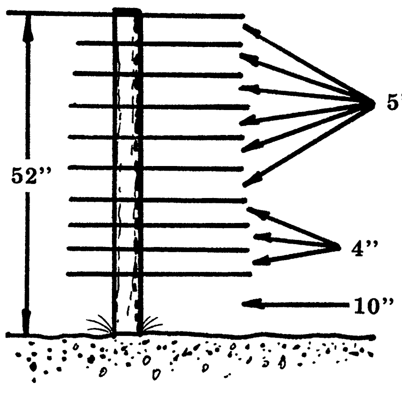
RANGE ON LEVEL TERRAIN



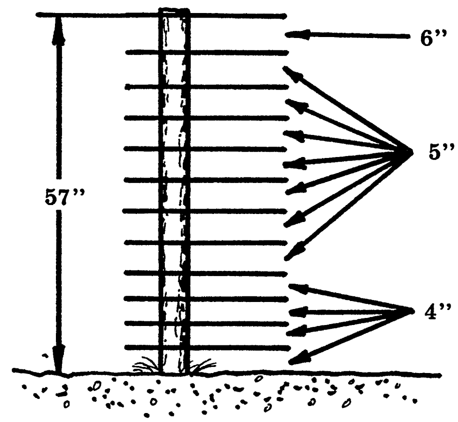
1. Post spacing may be 60 feet if stays are used with 15-foot spacings between posts.
2. In areas of light use, post spacing may be 100 feet if stays are used with 20-foot spacings between posts.
3. Use wire, fiberglass, or wooden stays.
4. Stays do not rest solidly on the ground. They must be free to move.
5. Use No. 14 galvanized stay tie wire for straight-grooved wooden or fiberglass stays.

Wire spacing for high tensile smooth wire should be:

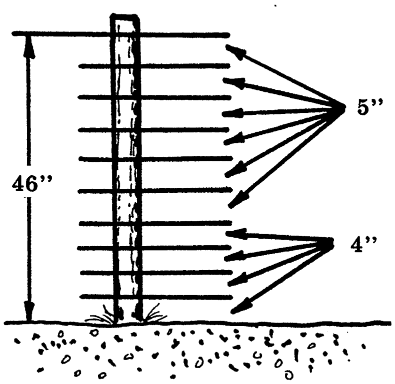
FEEDLOT 10-STRAND FENCE



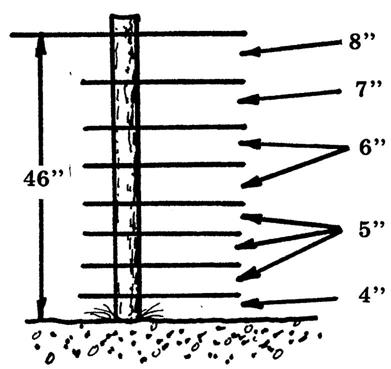
HORSE 12-STRAND FENCE



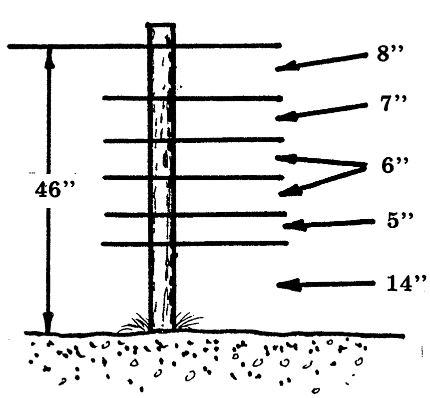
A VARIETY OF TYPES AND AGES OF LIVESTOCK 10-STRAND FENCE



RANGE 8-STRAND BOUNDARY FENCE



RANGE 6-STRAND DIVISION FENCE



Barbed Wire

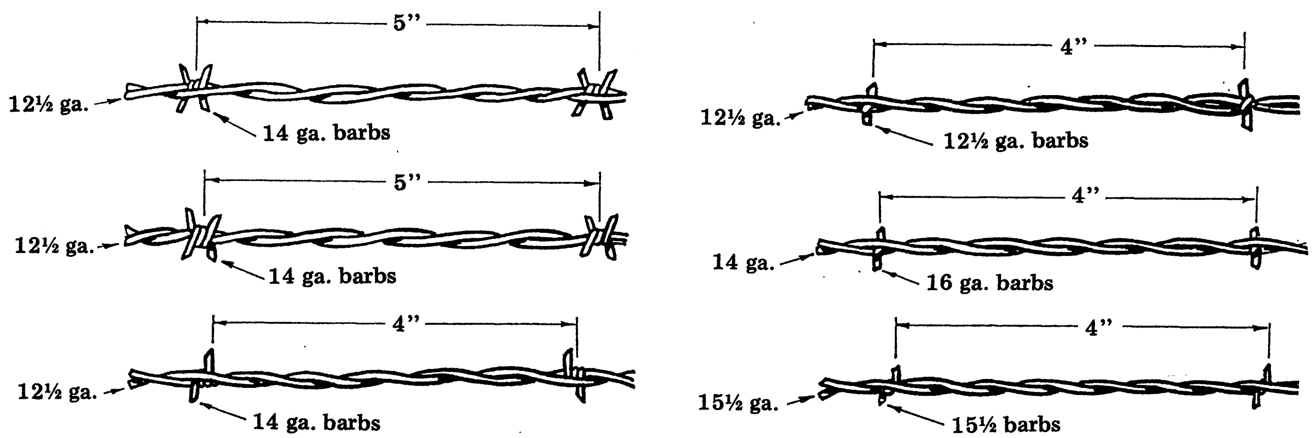
Common barbed wire is the most common fencing wire. Barbed wire ranges from 15½ to 12½ gauge. Usually 12½ gauge, Class 1, zinc-coated wire with a breaking strength of 950 pounds or 70,000 psi is used. Wires have a variety of spacings between barbs. Barbed wire is long-lasting and moderately expensive to install and maintain. It has one major disadvantage—the barbs can cause injury.

Relative Strength of Barbed Wire

Gauge No.	Relative strength
12½	1.0**
13½ H.T.*	1.1
14	0.6
15½ H.T.*	1.0

*High Tensile strength wire.
**12½ gauge used as the standard.

COMMON BARBED WIRES



Kinds of Barbed Wire Available

Line Wire Gauge	Shape	No. Points	Wire Gauge	Spacing (inches)	Wraps on Line Wire	Approx. wt. 80 rd.
12½	half round	2	14	4	1	76
12½	round	2	14	4	2	80
13½ H.T.*	round	2	14	4	2	64
14	round	2	16	4	2	52
12½	flat	2	12½	4	1	77
12½	round	4	14	5	2**	88
12½	half round	4	14	5	1	83
13½ H.T.*	round	4	14	5	2**	71
15½ H.T.*	round	4	16	5	2**	41

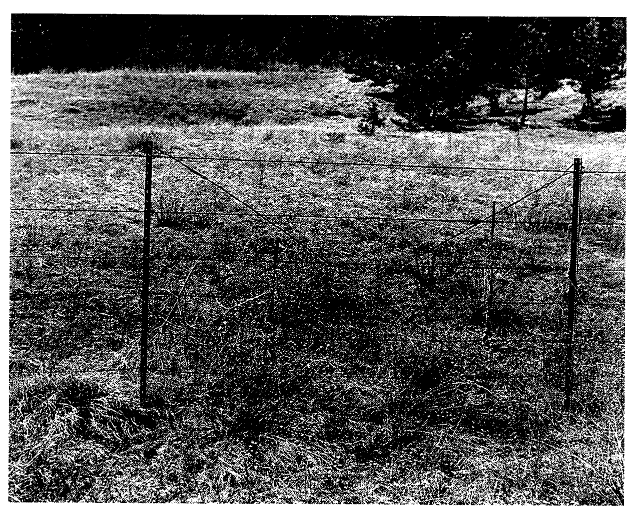
*High tensile strength wire.
**Wrapped around both strands; interlocked with one barb projecting between the strands.

Life Expectancy for Class 1 Galvanized Barbed Wire

Wire Size	Years Till Rust Appears — Climatic condition: Dry	Humid	Coastal & industrial	Years After Rust Appears Until Wire Reaches Half Strength — Climatic condition: Dry	Humid	Coastal & industrial
9	15	8	3	50+	50+	25
11	11	6	2	50+	50	16
12½	11	6	2	50+	35	12
14½	7	5	1.5	50	20	7

Common Barbed Wires

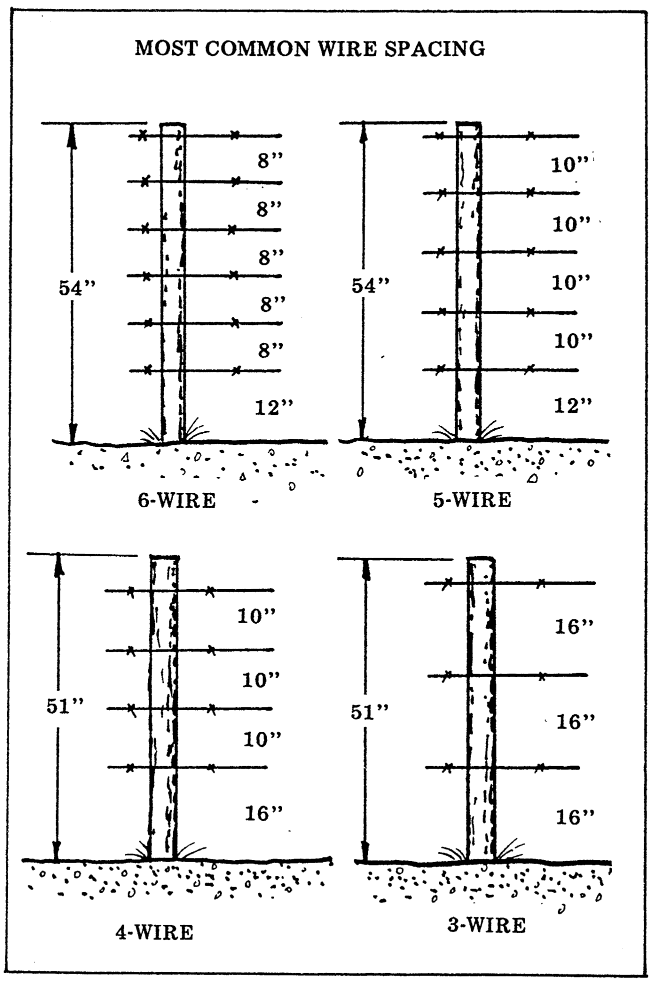
Border fences probably should be constructed of at least four strands of barbed wire to effectively control livestock. Fences inside management units can be constructed of three strands of barbed wire to reduce cost.



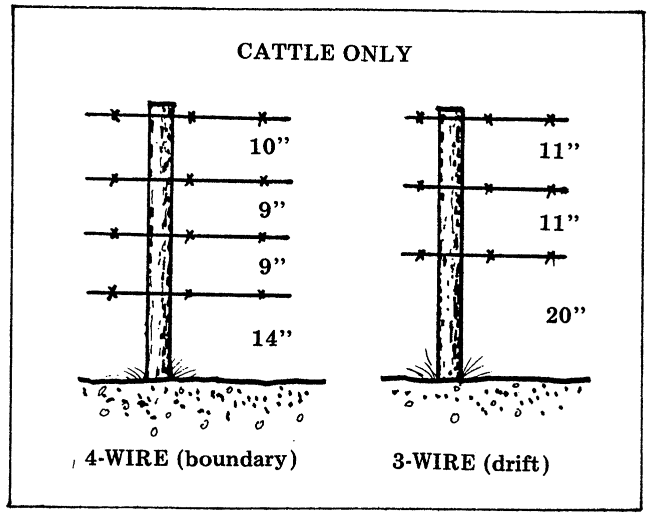
Common barbed wire fences.

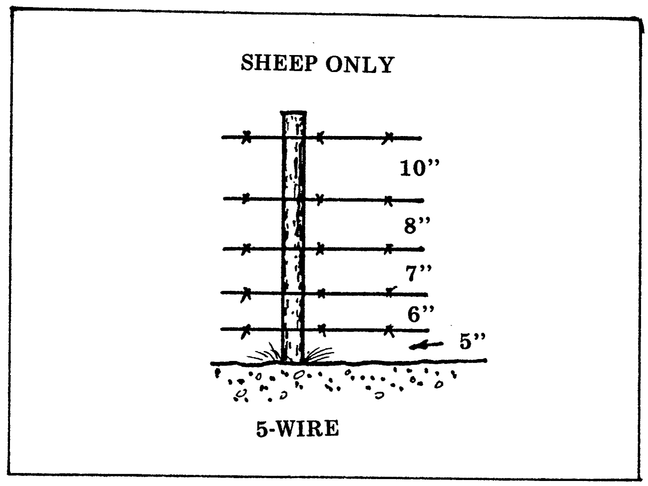
Gaucho wire is an alternative to conventional barbed wire. Its smaller size (15½ gauge) gives the Gaucho a lighter weight, which produces less structural strain. The Gaucho's high tensile strength has the same minimum breaking strength (950 lb) as conventional barbed wire. Gaucho wire is Class 3, zinc coated. It has approximately a 12-year rust-free life compared to a 5-year rust-free life for conventional barbed wire. However, its expected useful life after rusting is only 3 years compared to 7 years for conventional barbed wire. Because of its high tensile strength the Gaucho wire has less sag in the fence line and only 300 pounds of tension is needed. Gaucho wire is spliced using either the telephone splice or compression sleeves. Its stiffness may make it more difficult to work with than conventional barbed wire. Retail costs are approximately 20 to 25 percent less than conventional barbed wire.

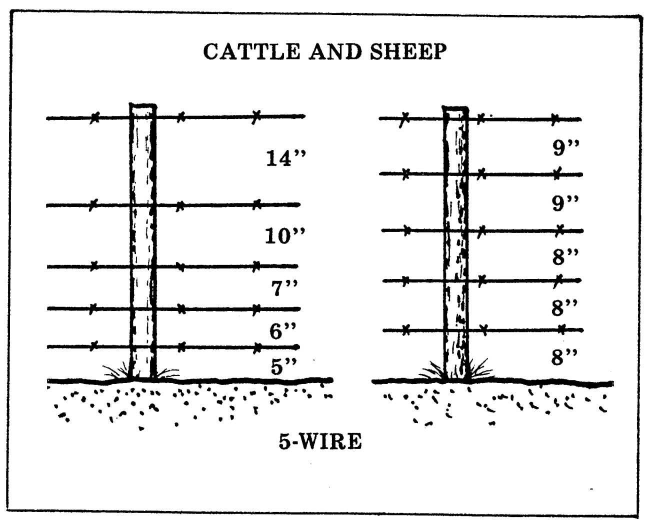
The intended use of the fence determines wire spacing.



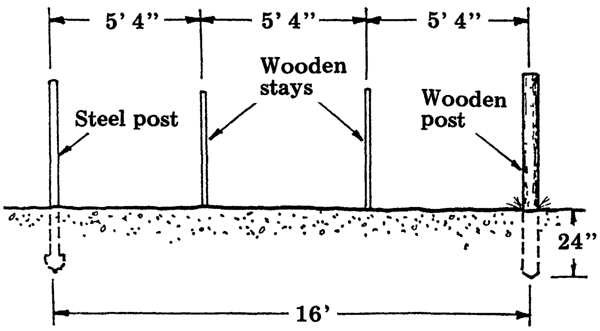
Wire Spacing





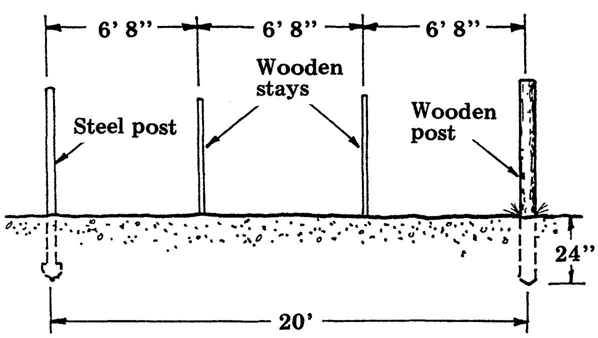


HEAVY SNOW WITH LEVEL TOPOGRAPHY



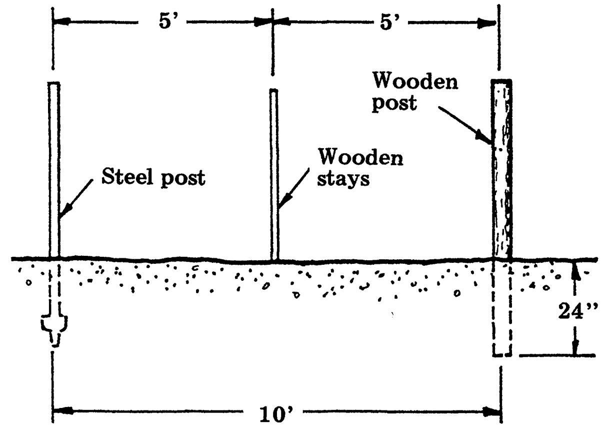
1. Use wooden stays only—1½ inches x 2 inches x 48 inches
2. Stays rest solidly on the ground
3. Use No. 14 galvanized stay tie wire
4. Steel posts may be used
5. Every fifth post should be wooden—minimum standard.

MODERATE SNOW WITH LEVEL CONDITIONS



1. Use wooden stays only—1½ inches x 2 inches x 48 inches
2. Stays rest solidly on the ground
3. Use No. 14 galvanized stay tie wire
4. Steel posts may be used
5. Every fifth post should be wooden.

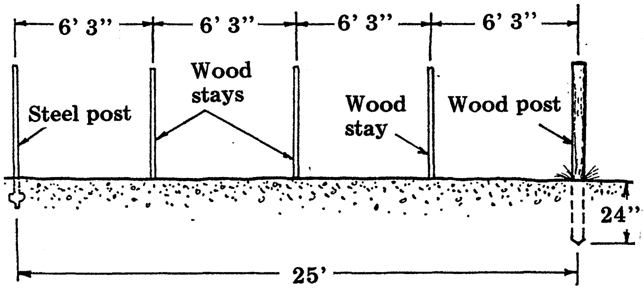
HEAVY SNOW WITH STEEP TOPOGRAPHY

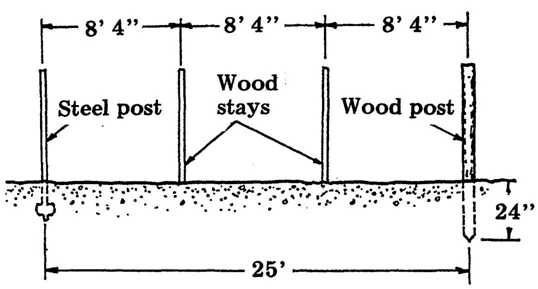


1. Use wooden stays only—1½ inches x 2 inches x 48 inches
2. Stays rest solidly on the ground
3. Use No. 14 galvanized stay tie wire
4. Steel posts may be used
5. Every fifth post should be wooden—minimum standard.

Post spacing for barbed wire fence is generally the same as for smooth wire fence. However, the kind of post used, post spacing, and post depth depend on the conditions at the site. Barbed wire does not hold up well in heavy snow conditions. Where possible, use jack-leg posts in areas of heavy snow accumulation and switch back to regular wood or metal posts where the snow is not as deep. The drawings below show post spacings in various snow depths.

LIGHT OR NO SNOW WITH LEVEL TOPOGRAPHY

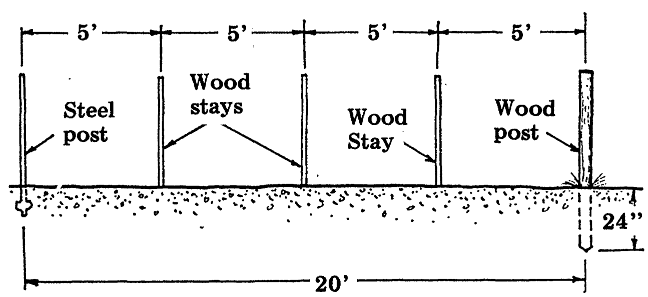




1. Wood or wire stays
   wood 1½ inches x 2 inches x 48 inches
   wire 48 inches
2. Stays rest solidly on the ground
3. Use No. 14 galvanized stay tie wire for wooden stays
4. Steel posts may be used.

These photos were taken on the same site. Note the difference in condition of the wire between the two fence post types.

MODERATE SNOW WITH STEEP TOPOGRAPHY

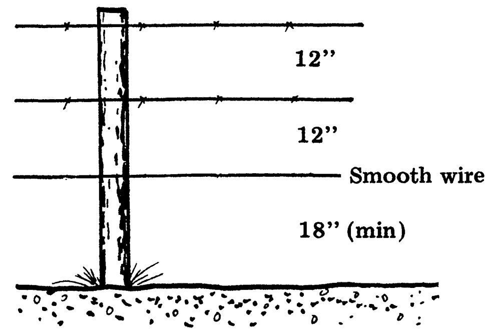


1. Use wooden stays only 1½ inches x 2 inches x 48 inches
2. Stays rest solidly on the ground
3. Use No.14 galvanized stay tie wire
4. Steel posts may be used
5. Every fifth post should be wooden.

Pronghorn antelope crawl under fences rather than jump over or crawl through them. Bottom-wire-to ground clearance of 16 to 18 inches is adequate for antelope passage. Wire spacings depend on the kind of animal to be controlled.

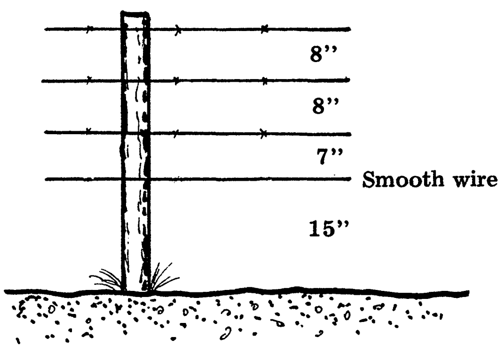
Adjustable fence segments can allow antelope to move freely. In adjustable fence segments one or more wires are moveable. Use Davison fence clips, a three-staple lock, or some other fast-hooking system to allow wires to be moved quickly and easily.

CATTLE WITH ANTELOPE



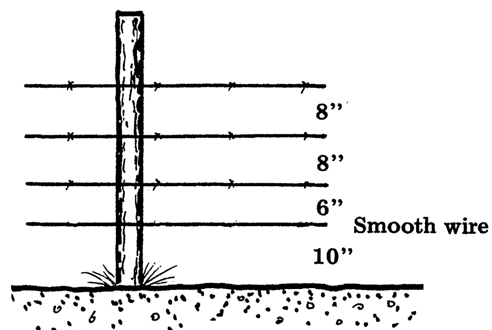
3-wire.

CATTLE AND SHEEP WITH ANTELOPE



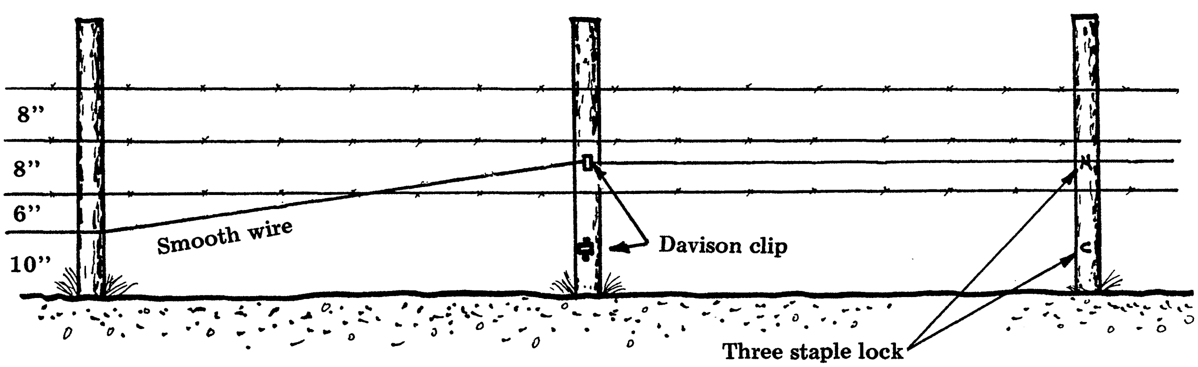
3-wire.

SHEEP WITH ANTELOPE



4-wire.

SHEEP WITH ANTELOPE



4-wire with one wire removeable.

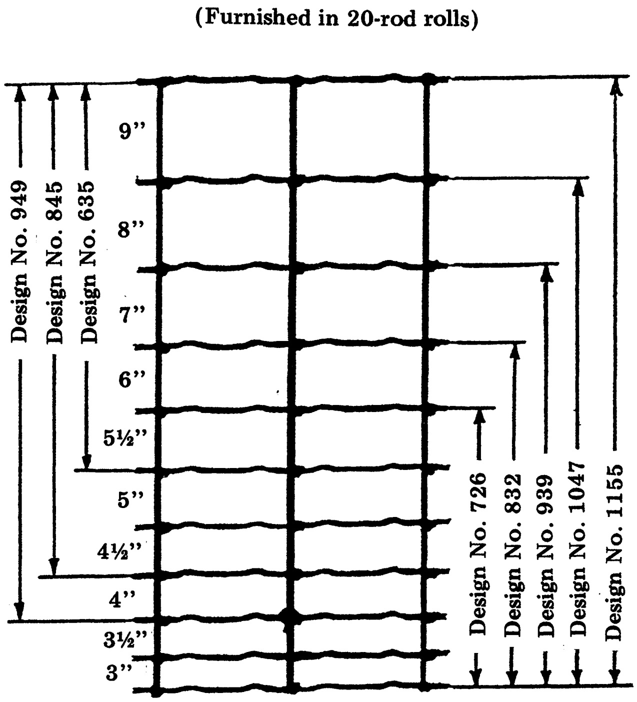
Woven Wire

Woven wire fences are available in eight standard heights with various combinations of horizontal wires, gauges, and stay-wire spaces. It is best used in areas where tight control is necessary—hog, sheep, predator control, or people. Each fence type has a design number that accurately decribes the fence. For example, design No. 1155-12-9 has 11 horizontal wires, is 55 inches high, has 12-inch spacing of vertical stays, and has 9 gauge intermediate wires. The following table covers standard designs:

Standard Designs of Woven Field Wire

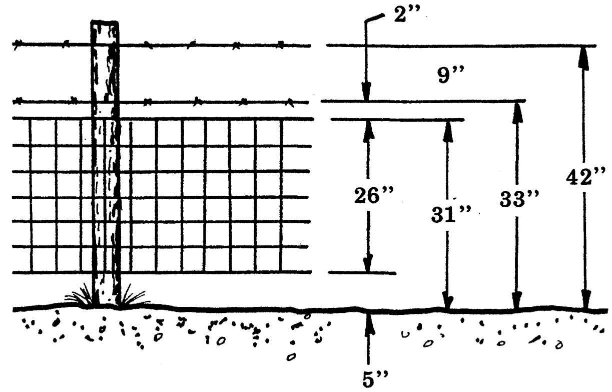
Height (inches)	No. of horizontal wires	Spacing of vertical stay wires (inches)	Gauge of top and bottom wires	Gauge of intermediate wires	Approximate weight per 20-rod roll (lb)	Design No.
55	11	12	9	9	342	1155-12-9
49	9	12	9	9	288	949-12-9
			9	9	416	1047-6-9
			9	11	280	1047-6-11
		6	10	12½	190	1047-6-12½
47	10	or				
		12	9	9	306	1047-12-9
			9	11	212	1047-12-11
			10	12½	146	1047-12-12½
			9	9	258	845-12-9
45	8	12	9	11	180	845-12-11
			10	12½	126	845-12-12½
			9	11	246	939-6-11
			10	12½	168	939-6-12½
		6	11	14½	112	939-6-14½
39	9	or				
		12	9	9	270	939-12-9
			9	11	188	939-12-11
			10	12½	132	939-12-12½
			9	9	194	635-12-9
35	6	12	9	11	140	635-12-11
			10	12½	100	635-12-12½
			9	11	214	832-6-11
			10	12½	148	832-6-12½
		6	11	14½	98	832-6-14½
32	6	or				
		12	9	9	236	832-12-9
			9	11	166	832-12-11
			10	12½	116	832-12-12½
			9	9	266	726-6-9
			9	11	184	726-6-11
			10	12½	128	726-6-12½
		6	11	14½	86	726-6-14½
26	7	or				
		12	9	9	202	726-12-9
			9	11	144	726-12-11
			10	12½	102	726-12-12½

Horizontal spacings are:



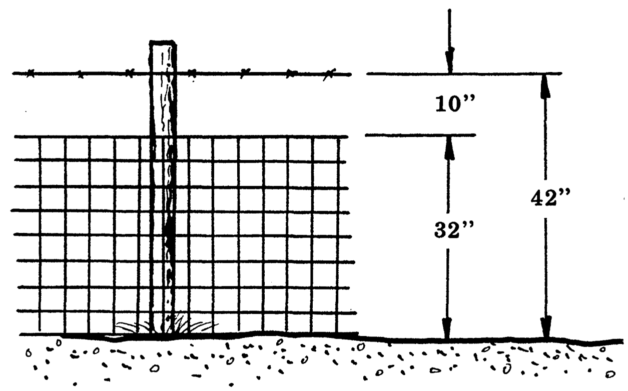
Typical woven wire fence.

CATTLE AND SHEEP ONLY



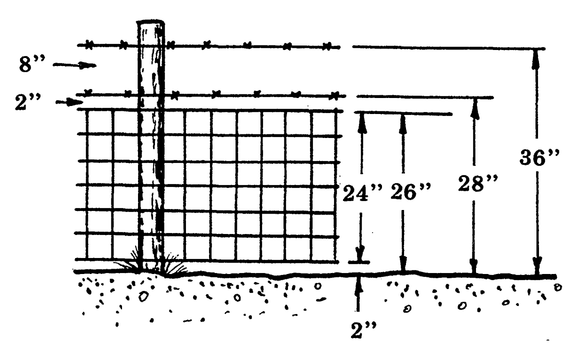
Woven wire with 2 strands barbed wire

CATTLE AND SHEEP ONLY



Woven wire with 1 strand barbed wire

SHEEP ONLY



Woven wire with 2 strands barbed wire

Speciality Fences

Suspension fences are subjected to greater tensions than conventional fence posts. They should be built with double brace assemblies every ¼ mile or closer.

Semi-suspension fences are most often constructed with 50-foot post spacing and stays 16 feet apart. However, post spacing may range from 25 to 50 feet with stay spacing 10 to 16 feet. Design and spacing will have to be adjusted to accommodate changing topography and soil conditions. Although semi-suspension fences do reduce costs by using fewer posts, they do not have the flexibility or whipping action that full suspension fences have. Semi-suspension fences are are generally made with four strands of 12½ gauge barbed wire. A sheep fence may require six strands. High tensile strength smooth wire may be substituted for barbed wire.

Suspension and semi-suspension fences share these advantages:

1. They require fewer posts (about 200 less per mile).

2. They cost about half as much to construct as a conventional barbed wire fence.

3. The whipping action of a suspension fence turns livestock better than conventional fences.

4. Their flexibility allows tumbleweeds to blow under or over the fence.

5. They stand up to moderately heavy snowpack and big game use.

6. They last as long as conventional barbed wire fences if they are properly constructed and maintained.

They are not suitable for rough or broken country nor for areas where vegetative growth will interfere with the whipping action of the fence. They are also not suitable for fence lengths of less than 650 feet (200 m). They do not withstand pressure from livestock in high use areas like watering points.

Posts are the chief material expense for constructing suspension fences. Fewer posts per mile reduce costs. The average post spacing is 100 feet. However, 80- to 120-foot spacing may be required in undulating topography. Spacing of less than 80 feet reduces the flexibility of whipping action of the spans. Treated wood or steel posts may be used. A 6-foot long, 6-inch by 4-inch wood post that is driven 2 feet, 6 inches into the ground is preferred. If steel posts are used, they should be at least 6 feet long, driven 2 feet into the ground, and have anchor plates.

Stays or droppers are constructed of wire, wood, or fiberglass. They are used to maintain wire spacing, serve as visual barriers to stock, and they distribute pressure evenly to all the wires in a span. Stays may either be steel spiral twists or treated wood slats. Treated wood stays are preferred because they are a more effective visual barrier to livestock and are more durable under moderate to heavy snowpack. Stays on a suspension fence must neither touch the ground nor be encumbered in dense vegetation or they will limit the whipping action. Stay spacing between posts is recommended at 15 to 20 feet, however, 25-foot spacings are being used with success.

Exclosures are variable-sized fenced areas that exclude grazing on a range area. There are three types:

(1) Total exclosure of domestic livestock and wildlife;
(2) Exclosure of domestic livestock only;
(3) Open range check plots.

Exclosures are built to prevent grazing on the area. Exclosures might be used to compare ungrazed range, range grazed by all animals, and range grazed by wildlife alone. Exclosures sometimes protect demonstration areas, administrative study sites, watering sites, nesting sites, or instrument installation sites. We have included designs for excluding livestock and wildlife. These designs may be adapted to other uses.

Fences should not influence the vegetation of the study plot. Size is mostly influenced by density of the vegetation. A minimum size of 1 acre may be used in dense vegetation, but the exclosure may need to be as large as 5 acres if the vegetation is sparse. The area should be large enough so wildlife are not discouraged from entering the unit. Gates should never be included to discourage using the facility as a holding facility for livestock. Ladders, steps, stiles or walk-throughs should be used if the exclosure will be entered frequently. Otherwise, pass between the wires or simply climb the fence.

The site for the exclosure should be carefully chosen. Exclosures should be constructed on a uniform soil type. Information gathered from one exclosure over several soil types is useless. Avoid snowdrift areas. Let-down fences or panels are more flexible in heavy snow areas.

Signs may discourage vandalism and be a good source of information on the purpose of the exclosure. The date it was started, vegetation being studied, types of animals being excluded should be included.

Exclosures provide data on:

1. Production by species, which helps determine the amount of total available forage.

2. Utilization by species, which indicates the amount of remaining forage and determines how long pasture may be grazed without damage.

3. Palatability or preference by species, which determines stocking capactiy.

4. Competitive ability of species, which indicates the recuperative ability of overgrazed ranges and the ability of a range to withstand heavy grazing.

5. Pasture mixes for reseeding, which shows those native species with the highest palatability to compete with other species.

6. Provide a comparative consumption of the domestic livestock and the wildlife.

7. Results of total exclusion of all grazing animals.

8. Time required for a range to recuperate naturally, which determines if it is quicker and more economical to artificially revegetate the area or more economical to exclude or control grazing and allow the range to revegetate naturally.

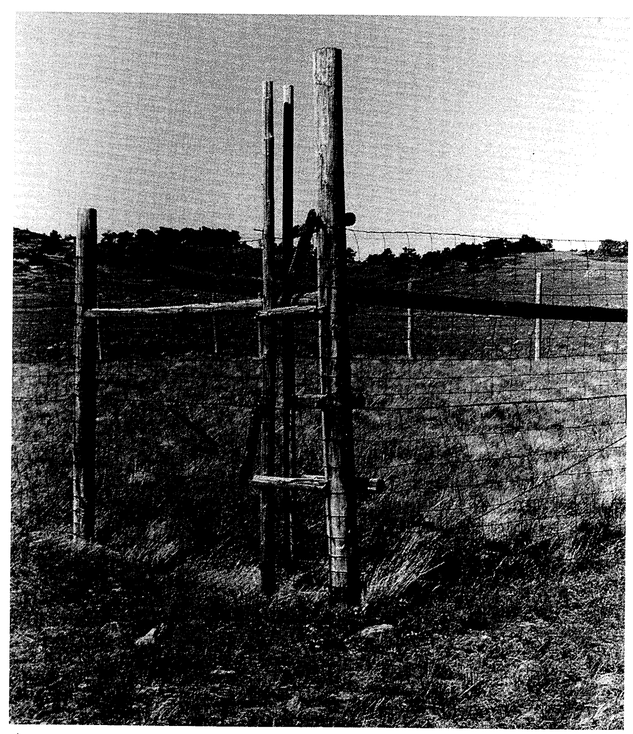
Materials Needed for a 1-Acre Study Plot

Exclosure	Deerproof	Elkproof
Size	1 acre	1 acre
Height	7 feet	9 feet
Construction	Woven wire 6 feet,6 inches high topped with 1 strand barbed wire	woven wire 8 feet high topped with 2 strands barbed wire
	wooden posts 12 foot center, 10 foot spacing at corners no gates 1 stay between posts	wooden posts 12 foot center, 10 foot spacing at corners no gates 1 stay between posts
Corner and Brace		
Posts	(12) 6-inch diameter 10 feet long	(12) 6-inch diameter 12 feet long
Line posts	(60) 5-inch diameter 10 feet long	(60) 5-inch diameter 12 feet long
Wooden stays	(64) 3-inch diameter 7 feet long	(64) 3-inch diameter 9 feet long
Heavy-Duty Woven Wire	(6) 20 rod rolls, 39 inches high	(6) 20 rod rolls, 48 inches

Materials Needed to Construct a 3-Acre Livestock Exclosure

Exclosure	Cattle	Sheep
Size	3 acres	3 acres
Height	36 inches	34 to 36 inches
Construction	3 strands high 18 inches smooth wire barbed wire 40 inches, 4-inch wooden rail or barbed wire	woven wire 32 inches high with 4-inch wooden rail on top or barbed wire at 36 inches and 40 inches
	wooden or iron posts 12 foot center no gates	wooden or iron posts 12 foot center no gates
Corner and Brace		
Posts	(11) 6-inch diameter 7 feet long	(11) 6-inch diameter 7 feet long
Line posts	(94) iron or 4-inch diameter 6 feet long	(94) iron or 4-inch diameter 6 feet long
Stays Wooden	(200) 2-inch diameter 48 inches long	Same
Wire	One roll barbed, 1,5000 feet smooth wire	(4) 20 rod rolls 32 inches heavy-duty woven wire
Poles	(1,200) 4-inch diameter poles	(1,200) 4-inch diameter poles

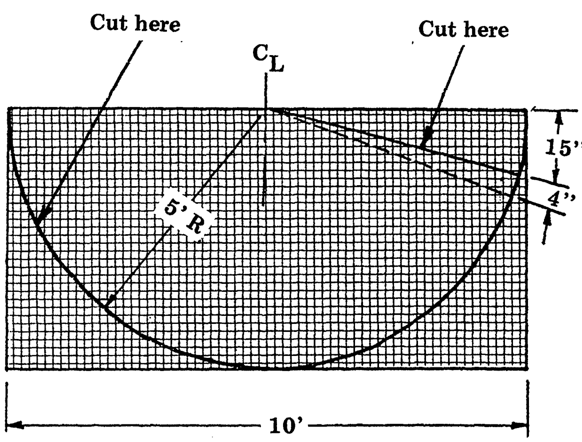
Utility cages protect plants from grazing, browsing, and trampling by large animals. They should be constructed large enough to provide a representative plot for clipping, but not so large that they cannot be easily moved by one person. The main purpose of utility cages is to allow comparison of grazed range vegetation and protected vegetation for determining utilization and total herbage production of the various plants in the community. Utility cages allow plant vigor to be determined by comparing production of similar species on similar sites. The cages may also help demonstrate fluctuations of forage production and use due to changes in climate and plant phenology. Utility cages are also a good way to demonstrate potential production. Cages should be placed on a representative site. The type of cage will depend most on the vegetation to be enclosed. Sod-forming grasses and small forbs may be sufficiently protected by a conical cage. Bunch grasses, low shrubs, and taller forbs need to be enclosed in the square or box cage. Taller shrubs require cylindrical open top designs.



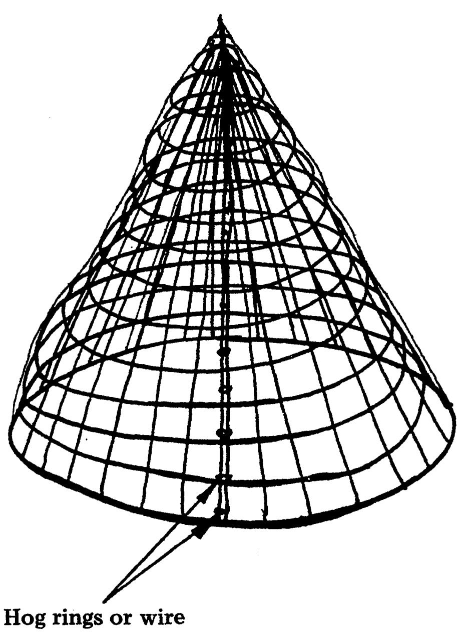
Typical utility cage.

Conical

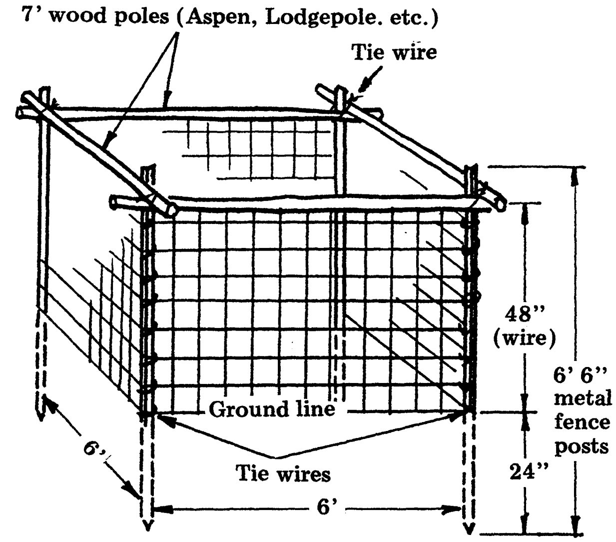
By cutting out a half circle (using a 48-inch radius) from a roll of 48-inch galvanized, general-purpose welded wire fabric (Style 1348-2-12½ C.F.&I. Co.) with a pair of sharp bolt cutters, a cone can rapidly be constructed by folding the straight side in half and lacing it together with a light malleable wire. The protected area under this cage is approximately 12 square feet, allowing ample area for a 9.6 square foot circular plot sample to be clipped. Cone shaped cages are all steel—all welded construction of galvanized No. 12½ gauge wire. The cage is securely held in place by three 80 penny spikes wired to the bottom of the cage by a light malleable wire. Eighteen cages can be packed on a pack horse at one time.



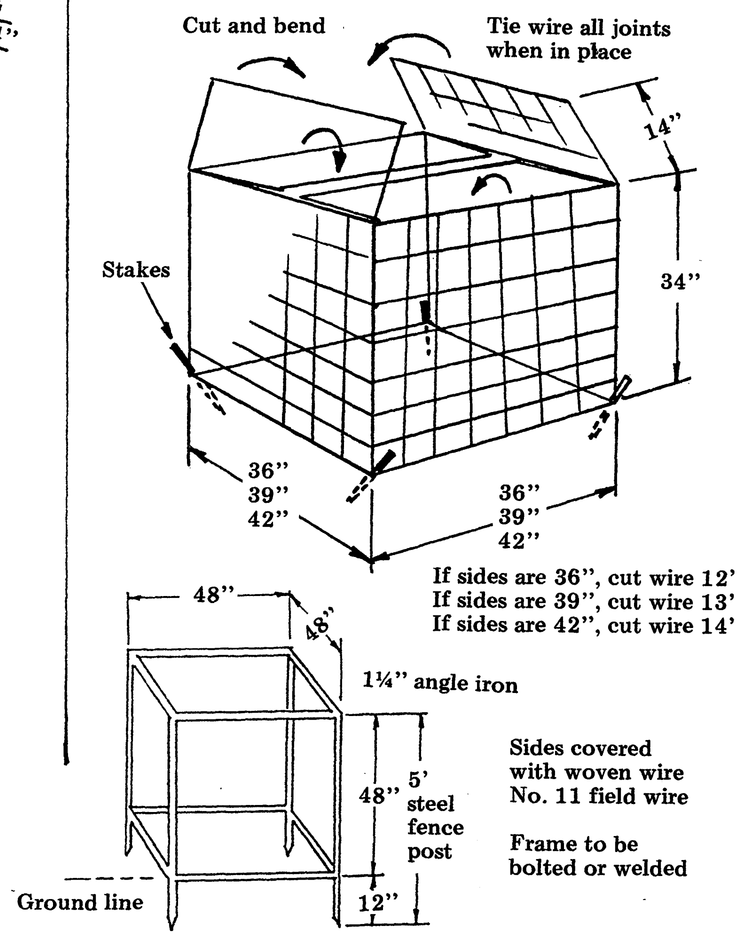
Cutting pattern.



Square Utilization Cage



Utilization cage — type 1.



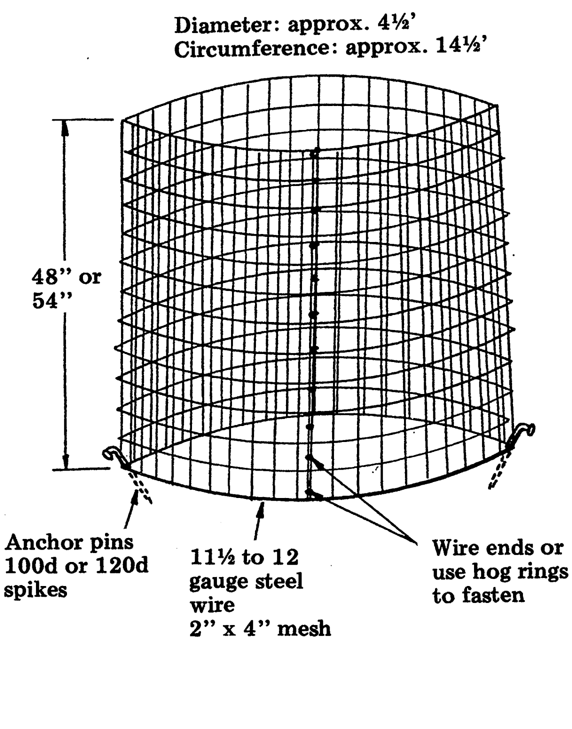
Utilization cage — type 2.

Cylindrical Open-Top Cage

The materials to construct utility cages will vary. The strength of the structure depends on the type of animals that may push or rub against the cage. Ten-gauge concrete reinforcing wire is recommended but 12½ gauge woven wire will suffice. Combination panels may also be used. If these panels are rust proof, they will last for many years and can be dismantled and transported.

A skeletal frame is required to support the square closed construction. Angle iron may be used. On-site aspen or lodgepole pine rails are usually sufficiently strong and are much less expensive. The pole frame will be wired at the corners of the frame. Steel fence posts or wooden posts serve as corner posts. Soft steel wire of No. 14 gauge is satisfactory. Attach the cage to the ground to prevent it from being blown or pushed over. The square cage can be fastened down by making the corner braces longer and driving them at least 1 foot into the ground. Stakes can be made by cutting rebar and bending one end into a hook to pin the cages. Also, 80 to 120d spikes with the head-end bent over into a hook can anchor the cage. Steel posts can be cut to approximately 18 inches and driven into the ground. The cage can then be wired to the sunken posts.

The cylindrical open-top cage is made by cutting a length off a roll of wire. A piece 14.33 feet long will make a cylinder 4.5 feet in diameter. This is large enough to protect a 9.6 square-foot plot. The ends are joined by using the ends of the cut woven wire, hog rings, or No. 14 gauge soft steel wire. The cage is then pinned.



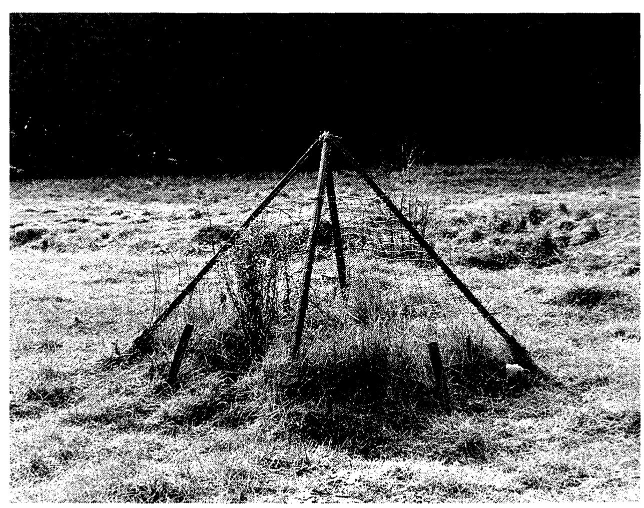
A conical cage requires a little more cutting. A 10-foot wire section 5 feet wide makes a cone that will protect an area of approximately 12-square feet. This will be ample to provide a 9.6 square-foot circular plot. Cut a 10 foot x 5 foot piece of steel mesh half circle. Cut a thin wedge approximately ¼ foot from one edge of the half circle. The cone can then be fastened together. Both cut edges can also be fastened to a piece of pipe equal in length to the cut edge on the inside of the circle. The cage can then be fastened down.

Tools for constructing utility cages are: a pair of good wire cutters; pliers to bend or wrap wire; a mallet to drive the stakes; a tape measure; chalk to draw out patterns; a welding machine may be required to weld the framework on the square closed cage; a drill for drilling metal; a wrench to tighten bolts; and a saw to cut poles.

A comparison of cost for the styles is estimated as follows:

Cage	No./Roll	Cost/Cage
12½ gauge, 6- x 6-inch mesh, 47 inches wide, 330-foot roll,		$90/roll
square	18	$5
cylinder	23	$4
cone	33	$3
10 gauge, 6- x 6-inch mesh, 5 feet wide, 150-foot roll,		$50/roll
square	10	$5
cylinder	10	$5
cone	15	$4

Cages should be made as unobtrusive as possible. Sharp wire ends and corners should be avoided. Consult Forest Service, Bureau of Land Management, Soil Conservation Service, universities, or county extension services for specific information on exclosure facilities.

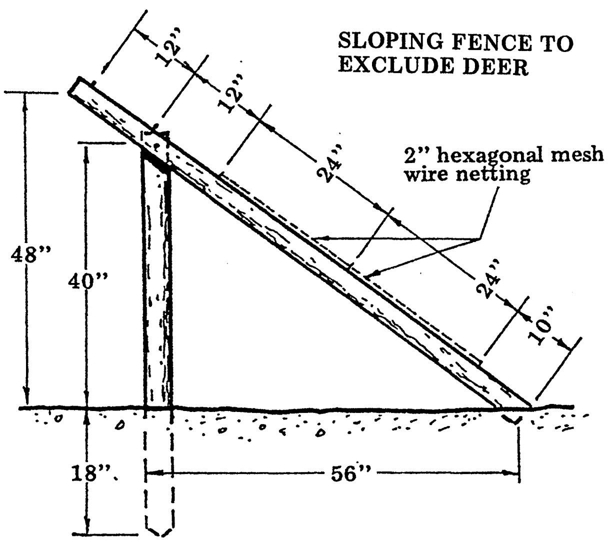


Pyramid utilization cage.

Excluding wildlife requires some special considerations. Animal pressure varies according to availability of food, water, cover, breeding areas, birthing areas, migration routes, and hunting pressure. All affect how wildlife respond to various fence designs. For example, where food is readily available, almost any design will exclude wildlife; but where food is scarce, only formidable, well-built fences will exclude wildlife.

Antelope normally crawl under or through fences rather than jump them. If the bottom-wire-to-ground clearance is kept at 8 inches or below and the spacings of the wire on the fence remain at 8 inches or below, antelope will be excluded. Antelope will jump fences 30 inches or below.

Deer normally jump fences, but will crawl through them if the fence is too high to jump. Most deer can easily jump a 42-inch high fence. To exclude deer requires a vertically built fence at least 78 inches high. A sloping fence makes it possible to build a lower fence and still exclude deer.



Use wooden stays ½ inch x 1 inch x 7 feet. Stay spacing should be 2½ feet—half way between line posts. Use galvanized wire clips or 14 gauge stay tie wires.

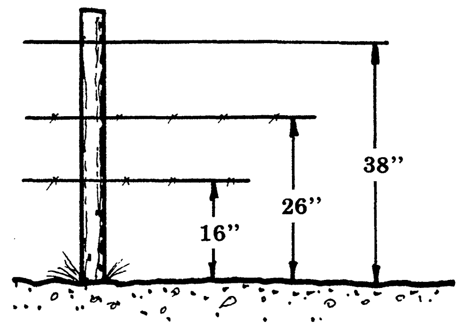
Buffalo will be excluded by a 12 strand fence. Elk require 15 strands.

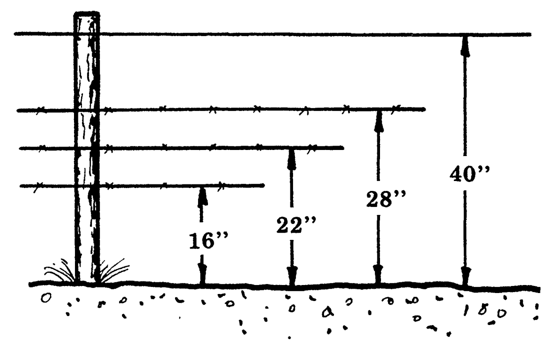
Normally, fences that exclude buffalo and elk will also exclude deer and antelope. Fences should have 12 to 13 horizontal lines, be 61 to 75 inches high, and have 6- to 12-foot vertical wire spacing. Use high tensile woven wire to exclude wildlife.

Exclusion of Pronghorn Antelope

A well-constructed sheep fence acts as a very effective deterrent to antelope. A woven wire fence higher than 32 inches with two or three barbed wire strands on the top provides good protection.

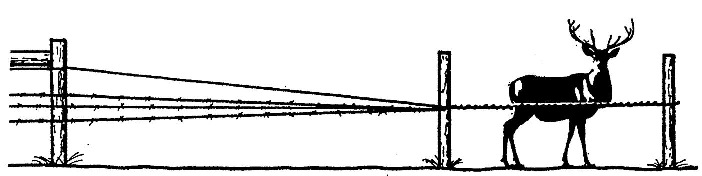
Cattle with Deer, Elk, or Moose



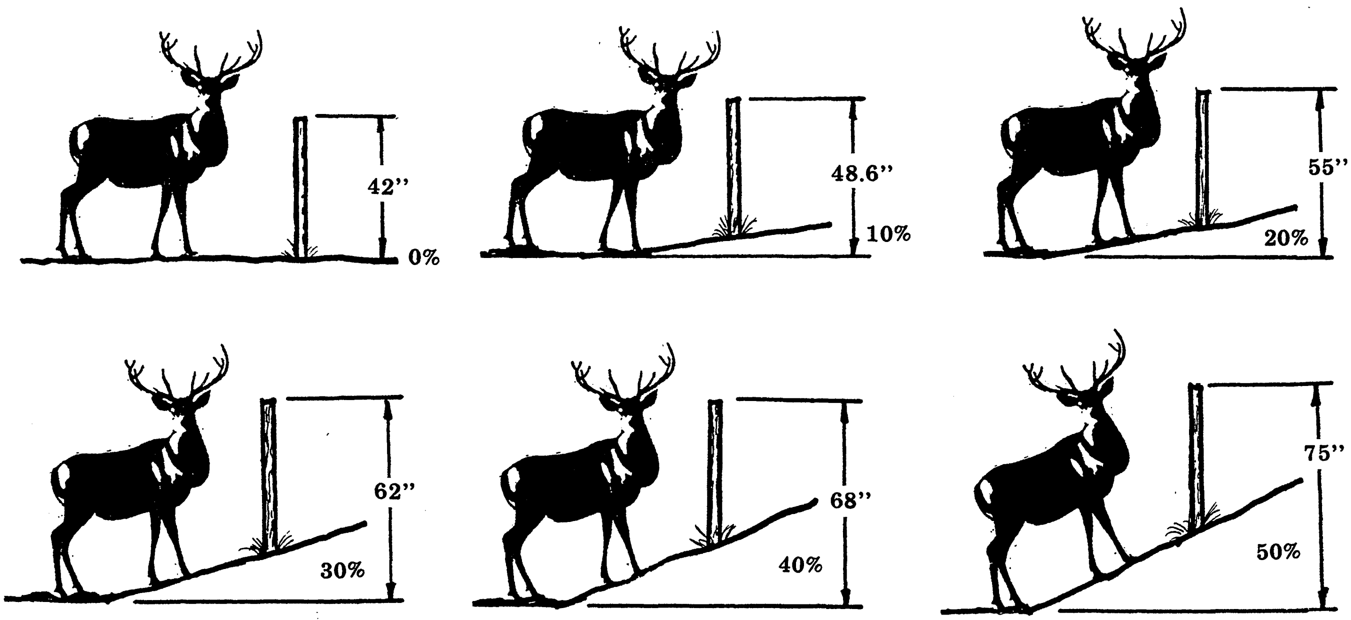


Deer normally jump with their hind legs forward. If the top two fence wires are loose or too close together, deer can entangle their hind legs and damage the fence. Entanglement can be fatal. Elk and moose more often damage fence than injure themselves. They seldom become entangled because they drag their hind legs over the top wire. Adjustable fence segments, let-down fences, swing-back fences, post with pole and wire fences, or wood fences are designs to consider for safe wildlife movement.

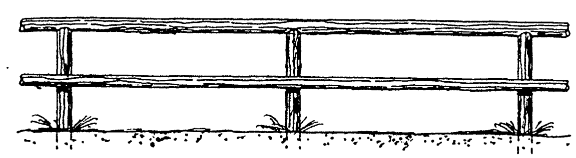
Adjustable Cattle with Deer, Elk, or Moose

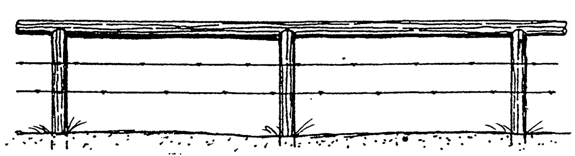


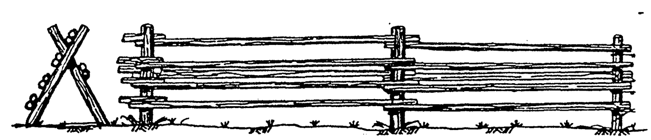
The barrier height of any fence is increased with the increase of ground slope for deer, elk, or moose. The following diagram illustrates this increase in barrier height for a 42-inch high fence as the ground slope increases.



In the areas of heavy seasonal movement by deer, elk, or moose, the preferred fence is the post, pole and wire fence, or any wood fence design. These designs provide a visual barrier height that wildlife can negotiate without causing damage to the fence or to themselves.



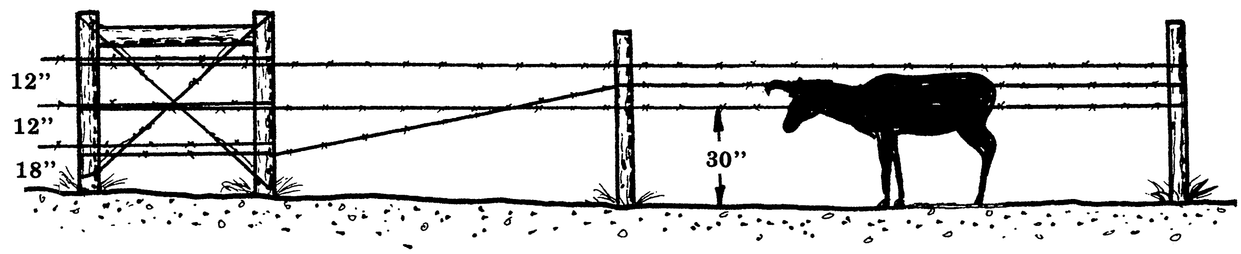


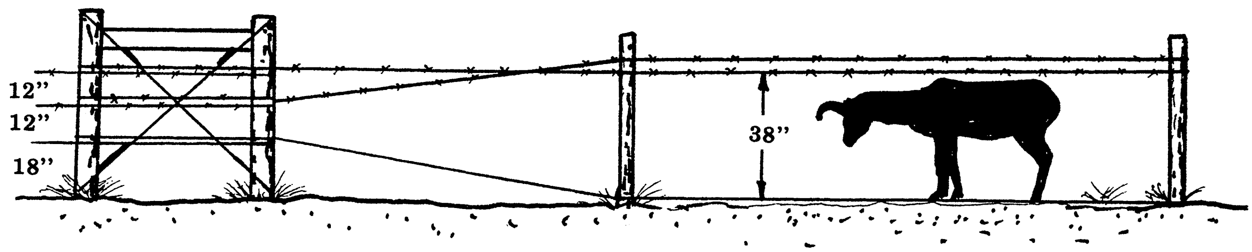


In wildlife areas, all new wire fences should be marked with flagging. In areas of seasonal movement, permanent flagging may be required.

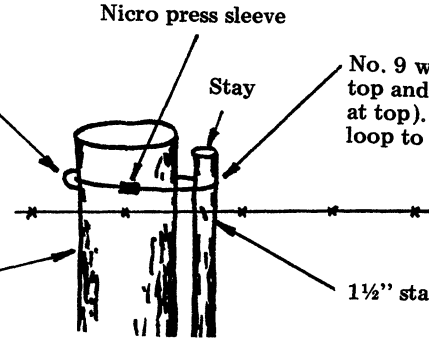
Adjustable Cattle with Antelope

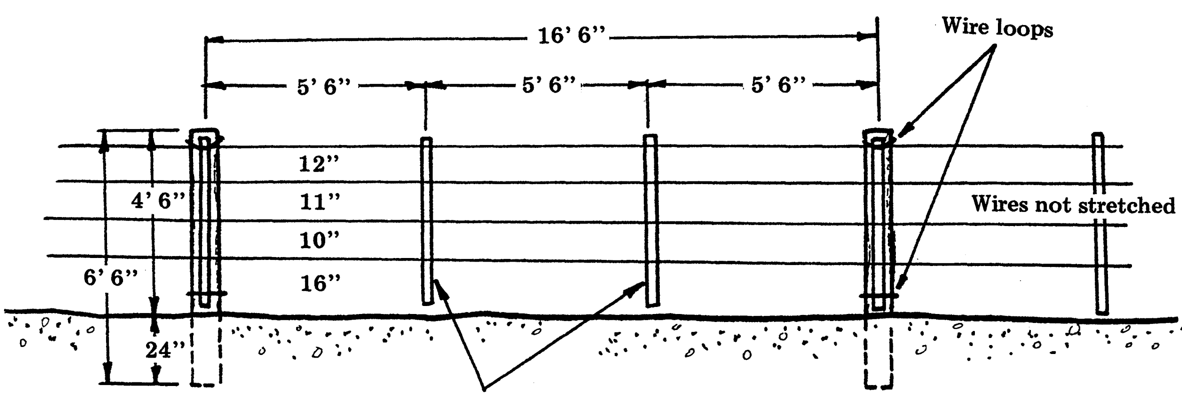
The *stay let-down fence* allows you to lay the fence barrier on the ground. The posts remain set and the bottom of the stays are attached to these posts so wildlife do not become entangled. Because fencing wires contact the ground, they tend to corrode quickly. However, fence damage from migrating wildlife is eliminated and wildlife movement is virtually unhindered.





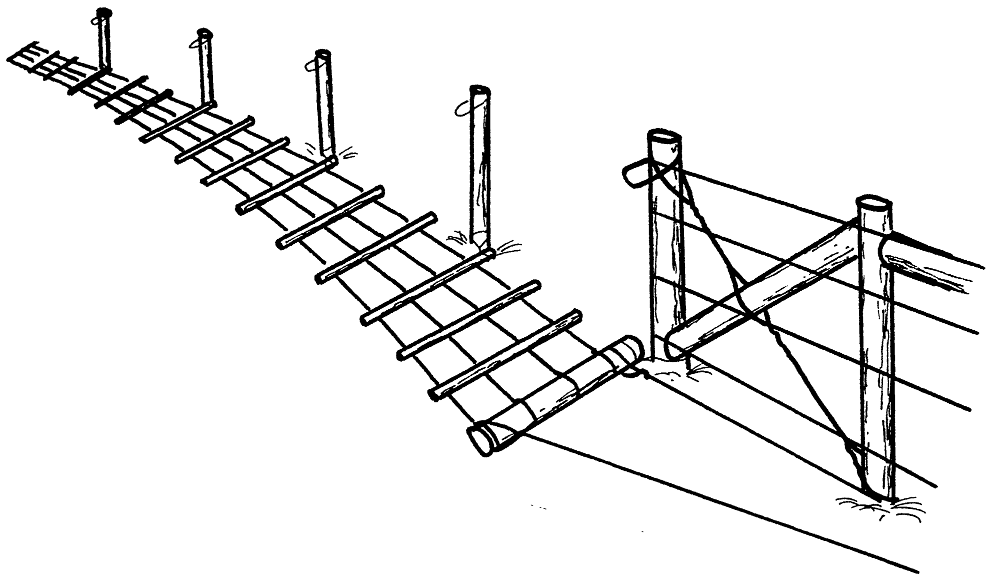
Stay Let-Down Fence





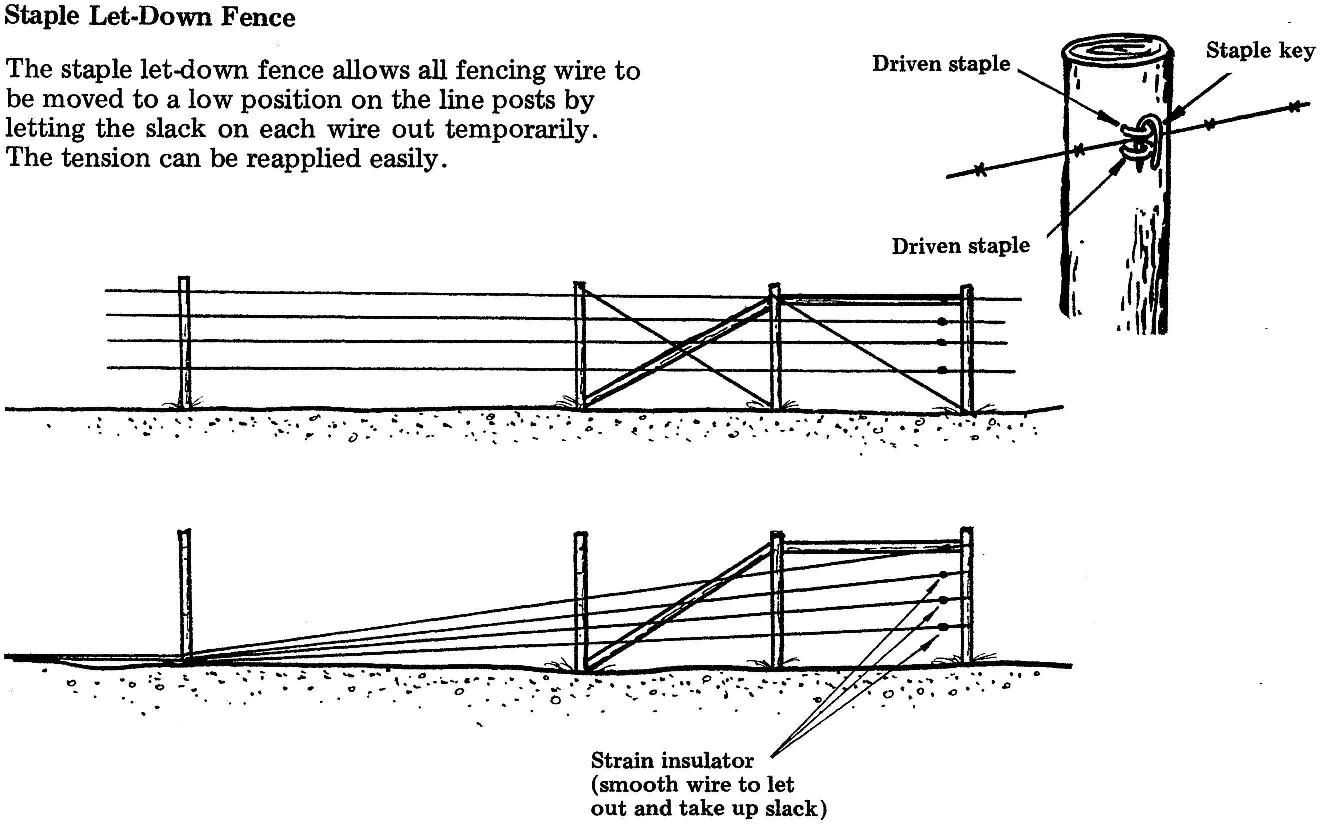
Laydown Fence for Snow Country

Where damage from snow is severe on standard wire fences, a laydown fence has reduced maintenance costs by two-thirds on Black Mesa in western Colorado. Basically it is a standard 4-wire fence that can be laid down as a unit. One person can let it down or put it up.

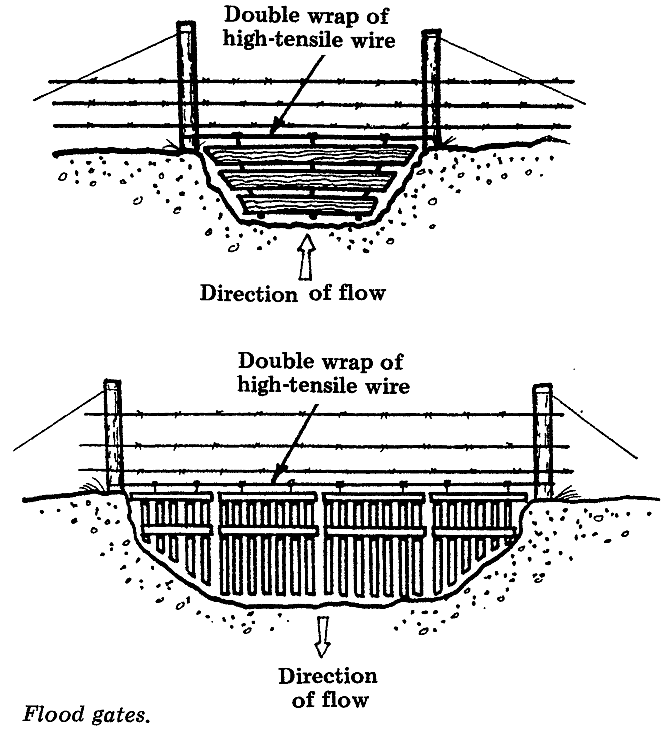


Staple Let-Down Fence

The staple let-down fence allows all fencing wire to be moved to a low position on the line posts by letting the slack on each wire out temporarily. The tension can be reapplied easily.



Flood gates may have to be installed in low areas subject to flash floods. As with any fence on uneven terrain, it is often necessary to install one or more self-cleaning flood gates in high tensile wire fences crossing wash gaps. While various types of flood gates have been made of sheet metal, barbed wire, and even used automobile tires, economical and functional flood gates can be fabricated of one or more panels of pressure-creosoted boards held together with high tensile wire and staples, or with wood stays and galvanized nails. The panels can be fashioned to fit the contour of the slope on each side of the gap or segmented to swing only in areas subjected to flooding. The panels can also be suspended with loops of high tensile wire from a horizontal cable consisting of a doublewrap of high tensile wire strung between the line posts on either side of the gap. These posts should be diagonally guy-wired to the adjacent line posts:

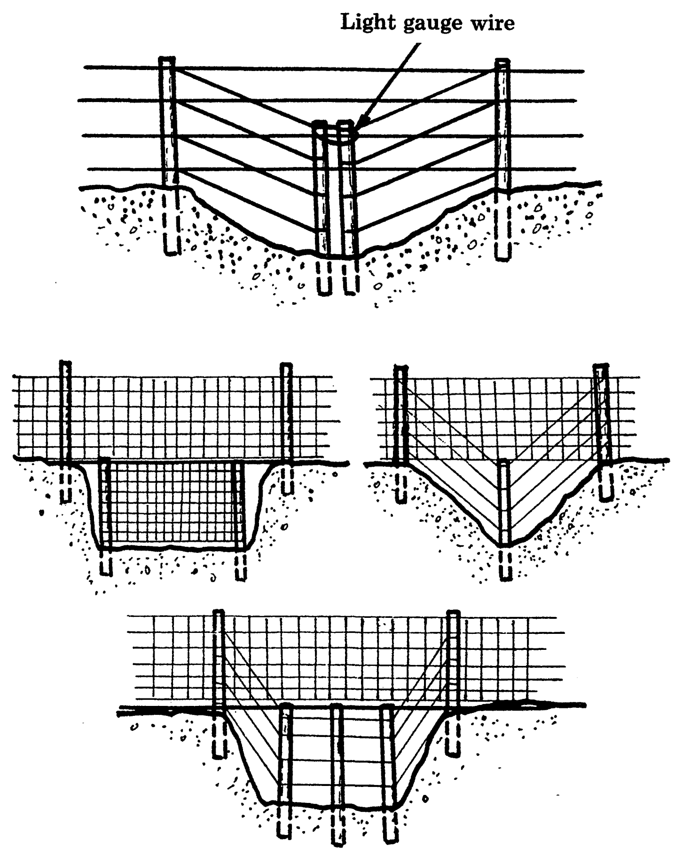


Flood gates.

Water gaps control livestock where fences cross streams or drainages. Fences may be damaged during heavy runoff unless water and water-born debris are allowed to pass under. Consult an engineer when deciding whether or not to install a water gap. Most water gaps or flood gates are designed to be self cleaning. Sometimes the cleaning action is not totally complete and the gate is blocked partially open. Livestock are then able to get through this opening. Check gates after heavy rainfall.

There are two basic types of water gaps: For areas with very little water and only occasional flooding, a breakaway fence will be sufficient. In areas with regular flooding, it may be best to construct floating gates or panels.

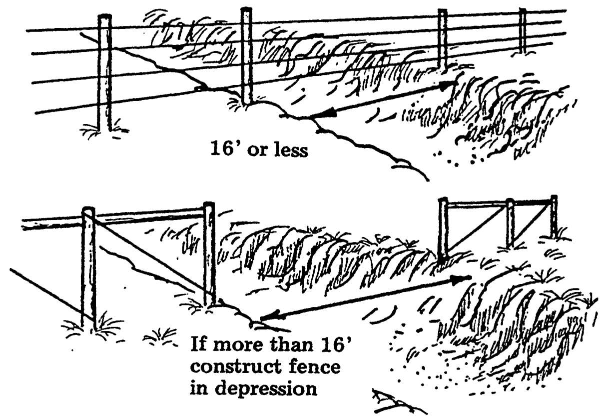
For depressions less than 16 feet wide, fence across the depression with no braces. For depressions over 16 feet wide, construct a fence that will breakaway only in the depression and leave the rest of the fence undamaged. Start by constructing braces on each side of the depression. Next, construct the fence in the depression. Set the end posts 6 to 12 inches from the brace posts. The short section of breakaway fence will then be attached to the main fence brace with a light gauge wire. This tie-wire is to break if the fence in the depression fails. When the fence in the depression breaks free of the main fence, damage to the main fence is eliminated.

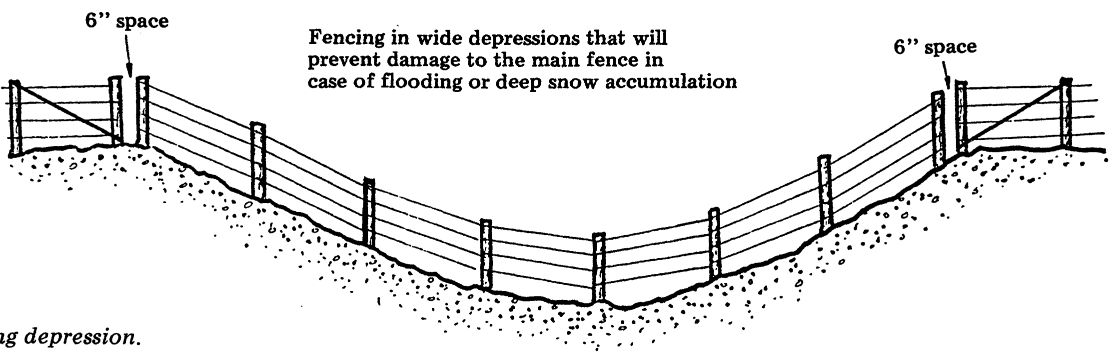


Water gaps.

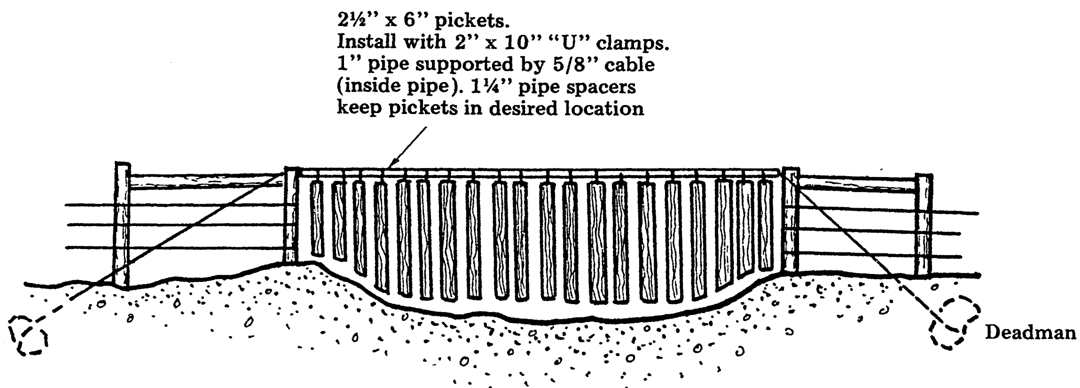
Use the same posts, wire, and wire spacing as that used on the regular fence. Post depth may be reduced to 12 inches to prevent damage to the posts when the fence in the depression fails.

If the depression to be fenced has regular flooding, use a swinging or floating panel. The panel must be free to swing when water comes through. Construct cross braces on the down-stream side of the panel to provide a smooth edge for the debris to slide by. Consult an engineer.

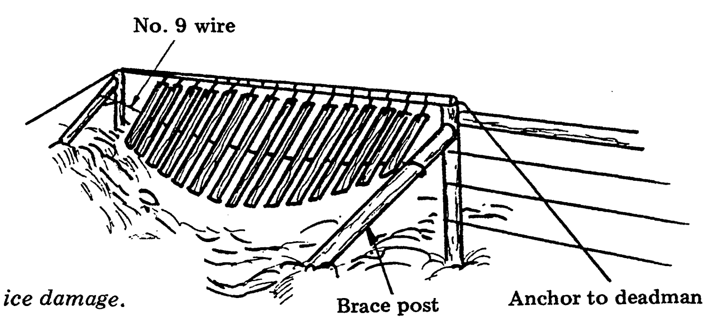




Fence crossing depression.

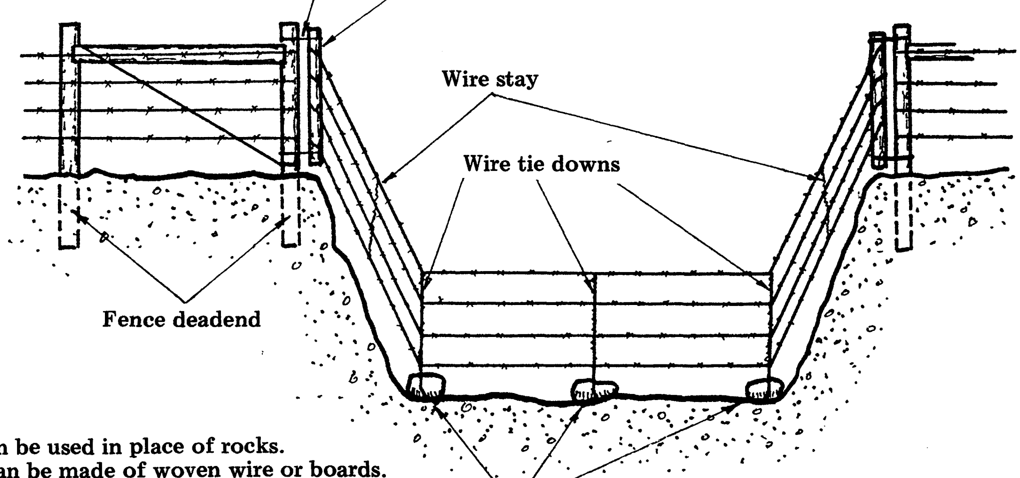


Picket fence across streams.



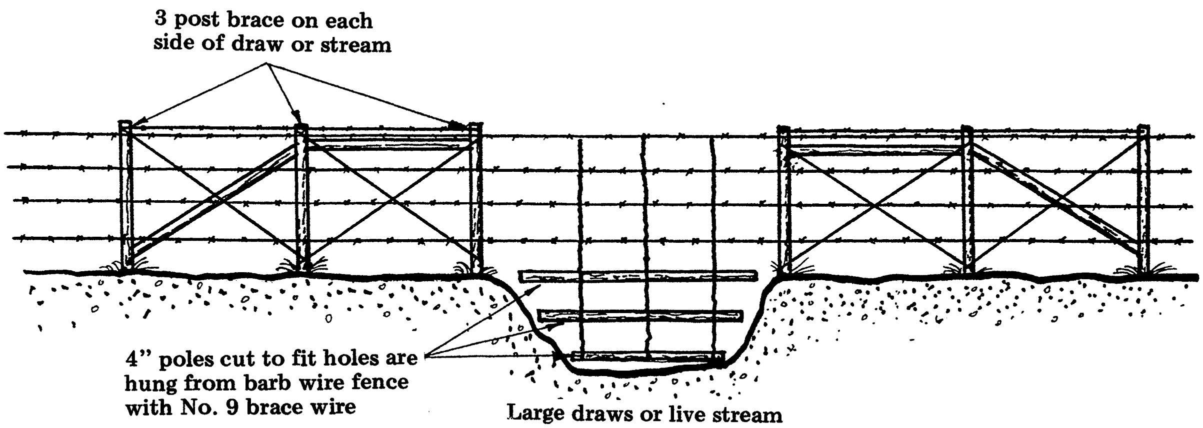
Lifting pickets above water to avoid ice damage.

Typical swinging picket fence crossing a stream.

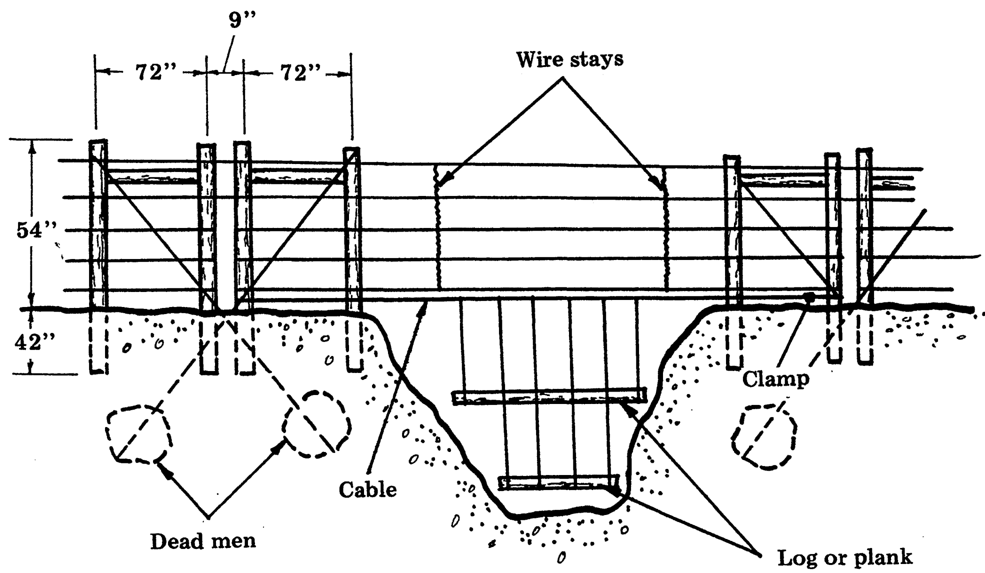


Poles can be used in place of rocks.
Panels can be made of woven wire or boards.
Tie panel ends with light wire so during flood periods one or both ends will break loose without disturbing main fence line

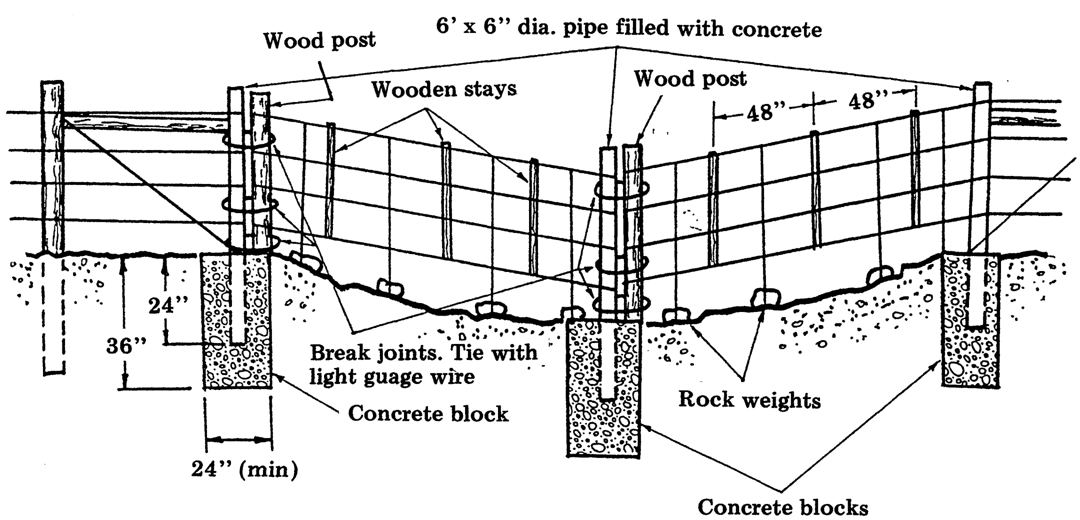
Brace design and placement considering changes in topography.



Crossing large washes and live streams.



Water gap for narrow drainages.



Break-away fence for wide, shallow water gaps.

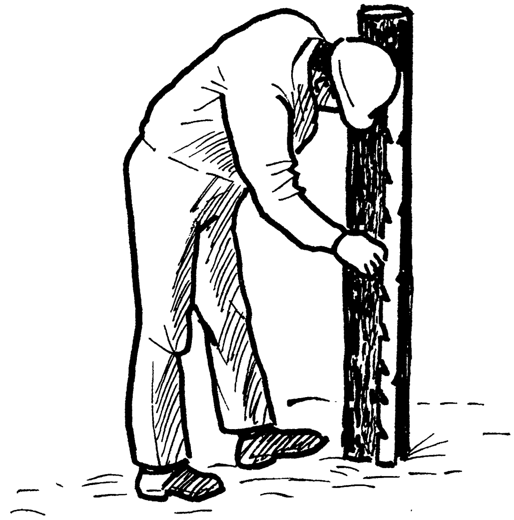
Construction

The fence design will determine post spacing between the brace assemblies and wire spacing between the ground and the top of the posts.

Stringing the Guide Wire

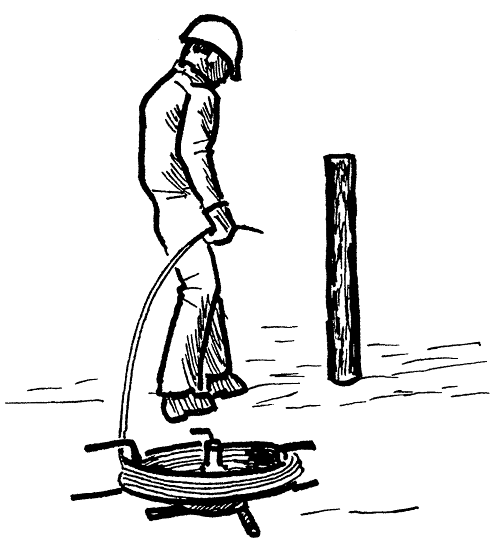
Proper stringing of the guide wire is the key to building a straight fence, and a fence where the bottom wire remains the same height off the ground. The procedure for stringing the guide wire is:

On Level Terrain—having set the braces, mark the wire spacing on each brace for the type of fence. Use a wooden stay that has been notched at the height of each wire. For dark posts, use chalk; for light posts, use some type of dark marker.



Marking wire spacing.

Anchor a single-coil payout reel (spinning jenny) at the first brace. Starting with a coil of high tensile fence wire of sufficient length to reach the far end post, grip the outside end of the wire and, allowing the jenny to turn freely but not override, pull the wire out in a straight line to the far brace. Maintain enough tension on the wire to keep it on the ground and to prevent loops or recoils of slack wire. Do not attempt to pull out high tensile wire from a stationary coil. A rotating payout reel (spinning jenny) is necessary to keep the wire from spiraling and forming permanent kinks.

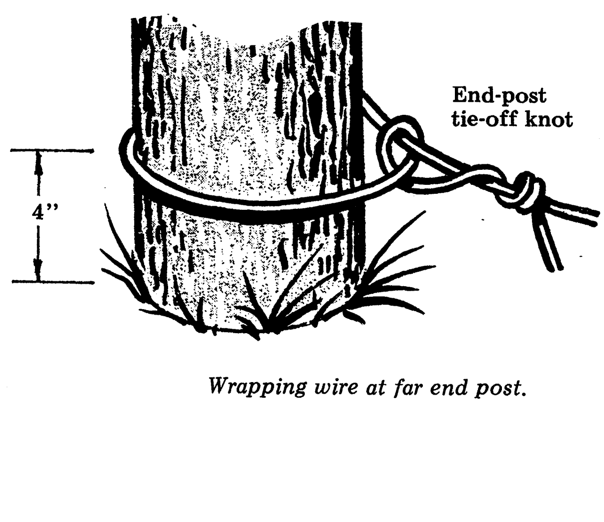


A rotating payout reel is used to string the guide wire.

At the far end post, allow about 3 feet of wire beyond the post. Wrap the wire around the post from the livestock (wire) side, and secure it back onto itself 4 inches above the ground with an end-post tie-off knot or with two mechanically crimped sleeves.

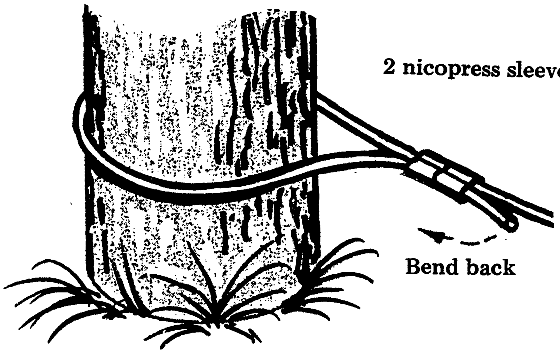
Individual high tensile wires can be fastened to end, corner, and gate posts in the following ways:

1. By tying off the wire with an end post knot. Allow about 30 inches of wire beyond the post. Wrap the wire around the post from the livestock side of the fence and loop the end over the top of the wire on the livestock side, allowing several inches clearance from the post. Bend the end of the wire underneath and around the line wire and over the top of the loop end as in tying a simple overhand knot. Slip the resulting loop back to the post. Twist the loose end of the wire as closely and tightly as possible around the line wire (at least two full turns). Place the loop toward the line wire side of the post. Pull tests show this knot to be effective up to 60 percent of the breaking strength of the wire, or about 1,100 pounds.



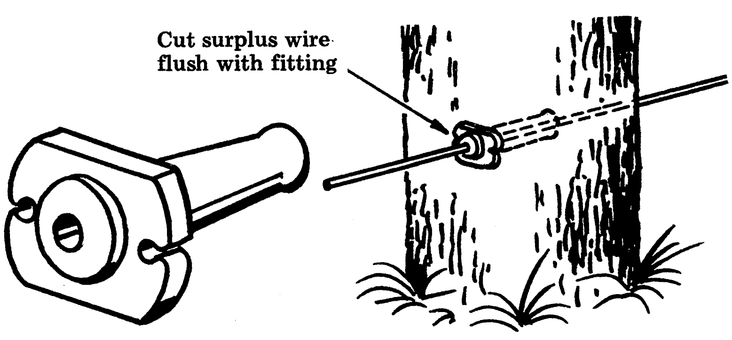
Wrapping wire at far end post.

2. With nicopress sleeves. Allow 24 inches of wire beyond the post. Thread two nicopress sleeves onto the wire and slide them back on the wire about 24 inches. Wrap the wire around the post from the livestock side and bring the end back to within a few inches of the post. Crimp both sleeves with a nicopress tool. This method of fastening has been pull-tested and found effective up to 100 percent of the breaking strength of high tensile fence wire. The end of the wire should be bent back towards the sleeves to prevent any chance of slipping.



Using nicopress sleeves to fasten wires to end, corner, and gate posts.

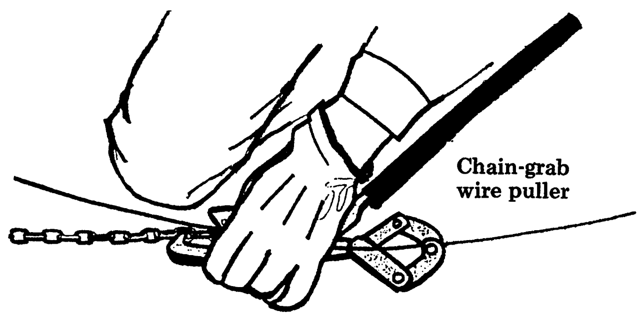
3. With reliable wirevise[R]. Drill a 3/8-inch hole for each wire at premarked heights completely through the post and at a slight angle opposite the livestock side of the fence. Thread the wire(s) a few inches through the holes and into a wirevice fitting for each wire. Slide the wirevice back over the wire until it is inserted into the hole. When tension is applied on the wire in the reverse direction, the wirevice becomes embedded in the post. The surplus wire should be cut off flush with the fitting. This fastener has been pull-tested and found effective up to 100 percent of the breaking strength of high tensile fence wire. If conditions exist that require the wire tension to be increased or decreased, the surplus wire should be wrapped around the post so these adjustments can be made.



Using Reliable Wirevise[R] to fasten wires to end, corner and gate posts.

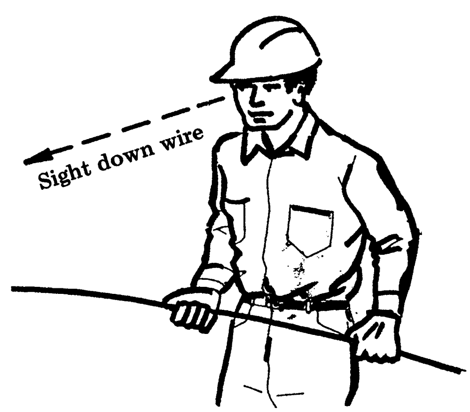
Return to the starting post and again allow 3 feet of wire to wrap around the post from the livestock side. Cut and fasten the wire back onto itself with a tie-off knot or two mechanically crimped sleeves.

About 20 feet from the starting post, attach a chain-grab wire puller on the guide wire and pull it up until taut (about 100 pounds tension). The wire puller used for tensioning all high tensile wire should have smooth jaws. Wire pullers with serrated jaws are not recommended because they damage the galvanized coating and permanently score and weaken the wire.



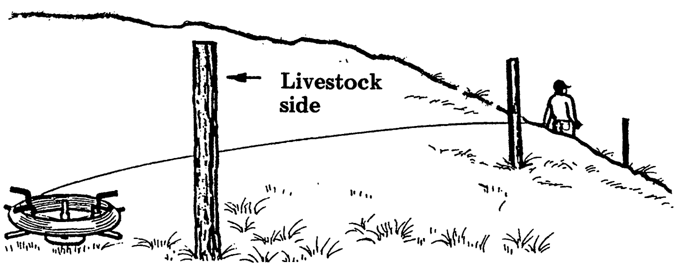
Tightening guide wire.

Sight down the wire and make sure it is straight. If it is not, take up slightly more tension. Lifting and whipping the wire up and down a few times aids in straightening it out. When paying out high tensile wire, use a full coil of wire, or a partial coil of known length. Mark all coil remnants with tags indicating their approximate length.



Check alignment of guide wire.

On Uneven Terrain—Allow the temporary sighting poles to remain standing on rises and in dips. Follow the same procedures as for paying out the wire on level terrain. Keep the wire on the same side (the livestock side) of and within a few inches of the sighting poles in rises and dips.

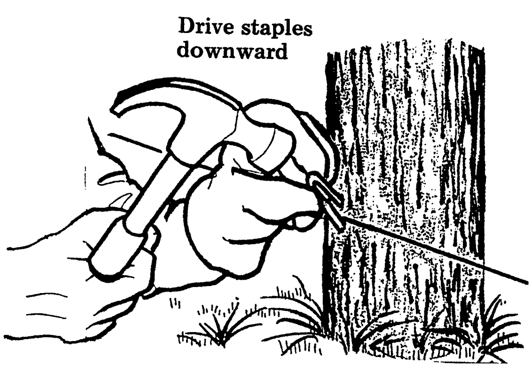


Paying out wire on uneven terrain.

At a highpoint where an end post can be seen (both, if possible), attach a chain-grab wire puller on the wire and pull it up until taut or to about 100 pounds tension. The wire will be resting on the ground on rises, but bridging the low points in dips.

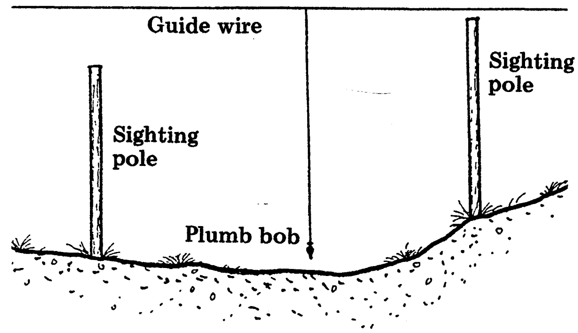
At the highest point in each rise, lift and whip the wire up and down to get it as straight as possible and touching the guide poles. Mark the locations for setting rise posts. When driven, rise posts (and all line fence posts) should be ½-inch off the guide wire so it neither pushes against the wire, nor has to be pulled more than ½-inch on to the posts for stapling.

At the post marks on the rises, drive line posts 8 feet long by 4 inches in diameter to a depth of 48 inches. Mark the posts at the height of the lowest wire. In this case 4 inches up from the ground. Staple the guide wire to the rise posts. Drive the staples in a downward direction to prevent pull out.



Stapling guide wire.

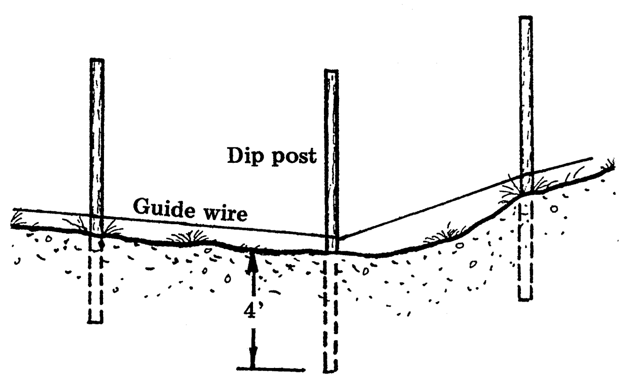
Near the sighting poles in each dip, mark the locations for driving the dip posts. If the guide wire is not too high, this can be done with a plumb bob. Do not pull the wire out of alignment when pulling it down for stapling.



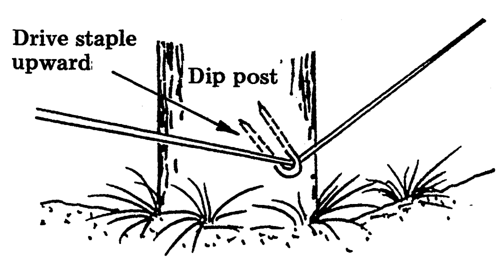
Marking dip post location.

At each dip post, set a longer (8 foot x 4 inch diameter) post 4 feet deep. Driving longer posts deeper in the soil greatly increases resistance when tension is taken up on the line wires.

Relieve the tension on the guide wire sufficiently to pull it down to the lowest mark on the dip post (4 inches from the ground). Staple the wire at that point in an upward direction. Tension the wire to 100 pounds.



Setting dip post.



Stapling guide wire to dip post.

Driving the Line Posts:

Driving is the most satisfactory method of setting line posts for wire fences. Wood posts can generally be driven into any soil that can be dug with a shovel. The pull-out resistance of a dip post mechanically driven can be as much as ten times that of a hand-set post. A two-person crew can set up to five times as many posts per hour by driving as by hand-setting. Driving posts in pilot holes predrilled with an auger greatly speeds setting the large diameter posts required for brace assemblies and posts, which must be set with some degree of lean to withstand the pull of the high tensile wires. The recommended procedures for setting line posts are:

On level terrain—Having set the end posts and strung and tensioned the guide wire, premark the location for driving each line post by pacing off the fence line or by dragging a measured length of lightweight chain. Make a heelmark or other suitable mark where each post will be placed.

Drive a truck or trailer loaded with 6½-foot x 4-inch line posts (and any larger posts, if required) parallel with the guide wire. Unload and lay out each post as near as possible to the location for driving. Place the smaller end toward the hole mark so each post need only be tilted up and centered for driving.

Drive each line post perpendicular to the surface of the ground 30 inches deep. Leave 48 inches above the ground. To maintain a straight fence, avoid pushing the guide wire out of straight alignment. Because of the increasing diameter of the tapered posts, drive each post ½ inch to 3/4-inch away from the guide wire.

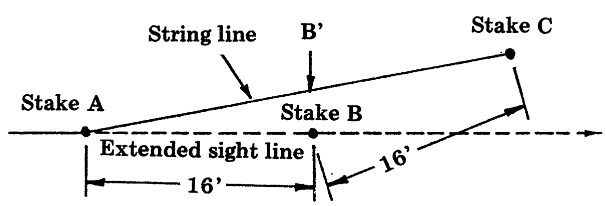
On uneven ground—Driving line posts on uneven or sloping terrain presents special problems. Not all fence posts should be "spirit-level-plumb" on sloping terrain. If the angle of the slope is steep enough, this will significantly reduce the overall height of the fence. Although driving posts vertically on a 20-degree slope reduces the height of the top wire by only 3 inches, on a 40-degree slope the height of the top wire is reduced by 11 inches. The best method of setting posts on a sloping terrain is to drive them perpendicular to the surface of the ground. Overall height of the fence should be sacrificed only when the slope becomes too steep to drive the posts.

Posts should be set on the downhill side of the wire on fences running across a slope. Line posts should be located on the side of the wire opposite the greatest livestock pressure.

Around curves—It is possible to continue wire fences around curves, even corners, without constructing brace assemblies. Several factors must be considered when laying out and staking the line. Whether a curve is gradual (long and sweeping) or abrupt (sharp), extra care must be taken in measuring the exact location of each post in the curve. As a rule, longer fence posts and, posts with larger diameters, will be needed, either of which must be driven deeper into the soil than line posts on a straight fence. On all curves, posts should be driven with a 4-inch lean off vertical toward the outside of the curve to compensate for movement when tension is taken up on the wires. On sharp curves, it will also be necessary to reduce the spacing between the posts. To prevent staple pull-out, the guide wire and all line wires should be strung around the outsides of all posts in curves.

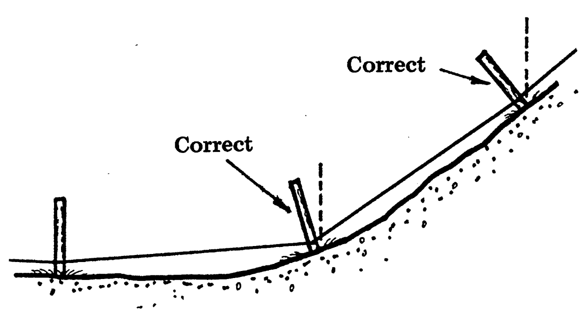
Depending on the relative sharpness of the curve, high tensile wires can be strung around a curve in three ways:

1 Rounding a shallow one post curve.



Note: The wire is strung around the outside of post at B

Rounding a shallow one post curve.



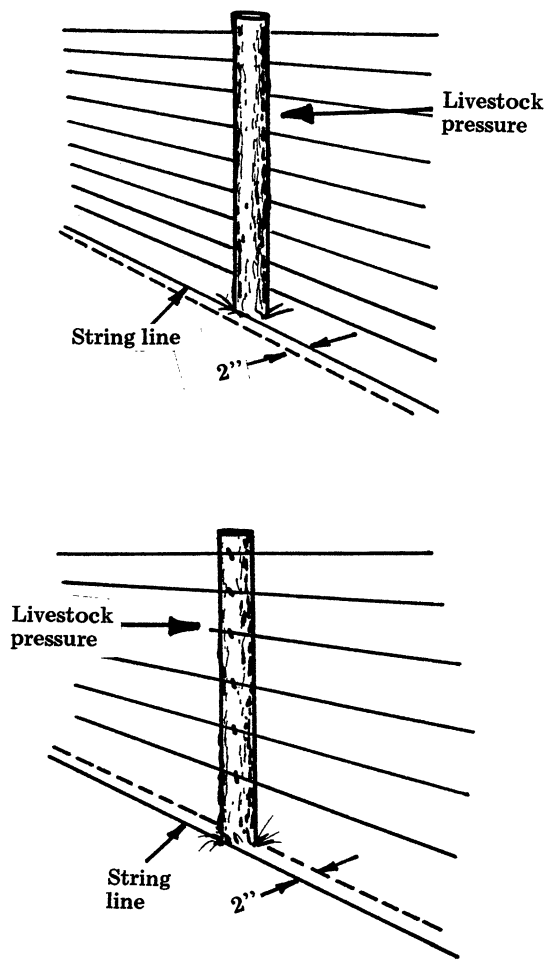
Setting posts on sloping terrain.

Assuming the direction of the fence will change (20 degrees or less) at point B, toward point C, set temporary stakes 16 feet apart at points A and B. Set a stake where you think it should be at point C, 16 feet from B. Stretch a length of builder's twine from A to C. Perpendicular to the stringline (point B'), measure the distance from the string to stake B. If the distance from B' to stake B is:

1. Less than 2 feet, drive an 8 foot x 4 inch post 4 feet deep at B.
2. Between 2 feet and 4 feet, drive an 8 foot x 5 inch post 4 feet deep at B.
3. Over 4 feet, but not over 5 feet, 10 inches, drive an 8 foot x 6 inch post 4 feet deep at B.

The post at B should be driven at a 4-inch lean toward the outside of the curve to allow movement when tension is taken up on the wires. These recommendations are for fences with seven or more wires. On fences with up to six wires, the diameters of the posts in steps 2 and 3 can be reduced by 1 inch, but not their lengths or driving depths.

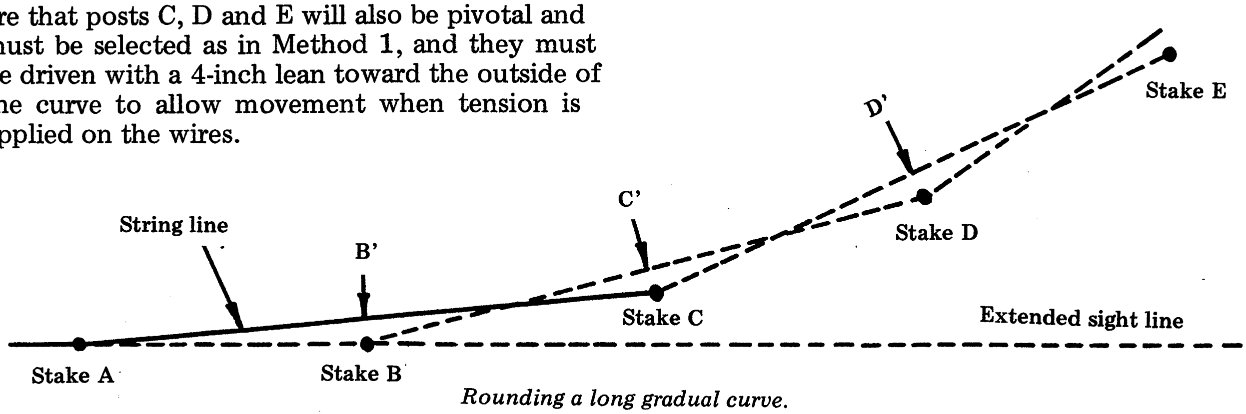
Before driving posts at points A and C, remember that the line wires will move 2 inches toward the inside of the curve when tensioned. Also remember that posts A and C should be on the side of the wire opposite the greater livestock pressure. For these reasons, drive posts A and C against the stringline toward the inside or outside of the curve, depending on which side will have the greater livestock pressure (See figure below). The object is to neither have to pull the line wires into posts A and C for stapling nor to have the live wires put any strain on the posts when tensioned.



Installing line wires on a shallow one-post curve.

2 Rounding a long gradual curve.

Rounding a long-sweeping curve is simply an extension of Method 1. The essential differences are that posts C, D and E will also be pivotal and must be selected as in Method 1, and they must be driven with a 4-inch lean toward the outside of the curve to allow movement when tension is applied on the wires.

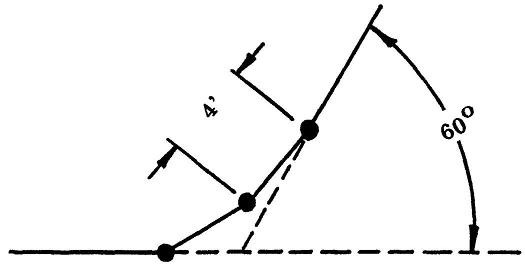


Rounding a long gradual curve.

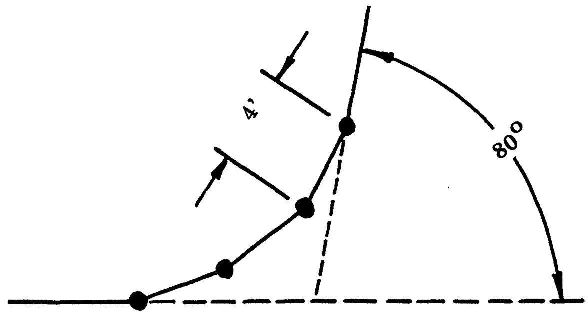
3 Rounding a sharp curve or corner

Rounding a sharp curve or corner in 20-degree increments is similar to Method 2, but all posts are 8 feet x 6 inches, driven 48 inches deep and with a 4-inch lean toward the outside of the curve. Note also that the post spacing has been reduced to accommodate the reduced radius of the curve. However, to avoid disturbing the soil strata when driving the posts, 4-foot post spacing is the minimum.

Locate the last straight-line post *before* a curve and the first straight-line post *after* a curve so that these posts are in proper position for stapling the line wires after tensioning.

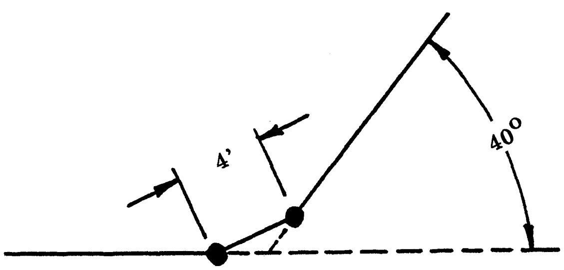


Three post corner.

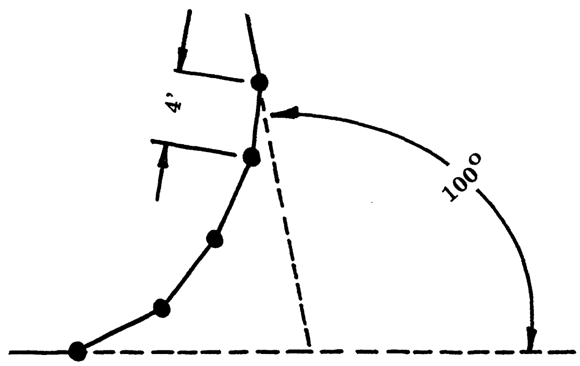


Four post corner.

Single post corner.



Double post corner.



Five post corner.

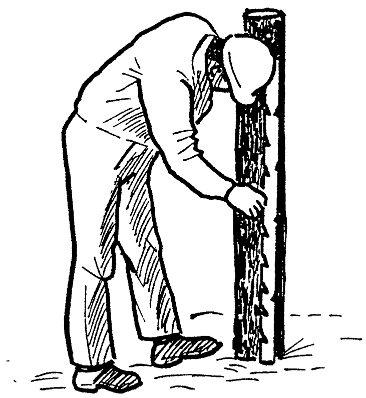
Stringing the Line Wires

High tensile wire is stiffer and somewhat harder to bend than soft wire and it has a tendency to recoil when it is cut. To cut high tensile wire, hold the needed end in one hand and hold the end not needed down with one foot. If it is necessary to let go of the cut end, weigh it down with a tool, or simply push the end several inches into the soil.

Wear clothing that completely covers your arms and legs, shoes with heavy soles, leather-reinforced gloves, and safety glasses or shatterproof eyeshields.

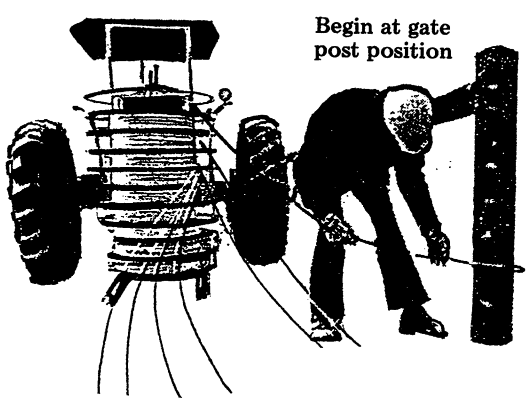
On relatively short fences, electric fences, and those with fewer than six wires, it is practical to string and tie-off the wires one at a time. This is particularly true if half the needed wire is placed at each end of the fence, and two payout reels are used so wires can be strung alternately from each end. On long fences, or those with six or more wires, a tractor-mounted, multi-reeled payout mechanism can save labor and construction time.

On level terrain—Having set all line posts, mark the wire spacing on each post for the type of fence.



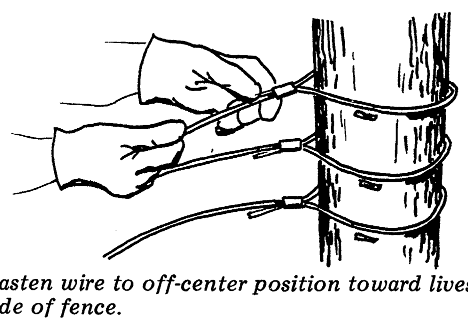
Mark wire spacing.

Load coils of high tensile fence wire onto the payout reels and, beginning at the gate post position on the livestock side of the fence posts, start from the location of the second wire from the bottom and working upward tie-off all wires at their premarked heights by looping each wire around the post and fastening it with two crimped nicopress sleeves.



Start with second wire from bottom.

In fastening each wire to the post, bend it to position it on its mark, but off-center toward the livestock side of the fence.



Fasten wire to off-center position toward livestock side of fence.

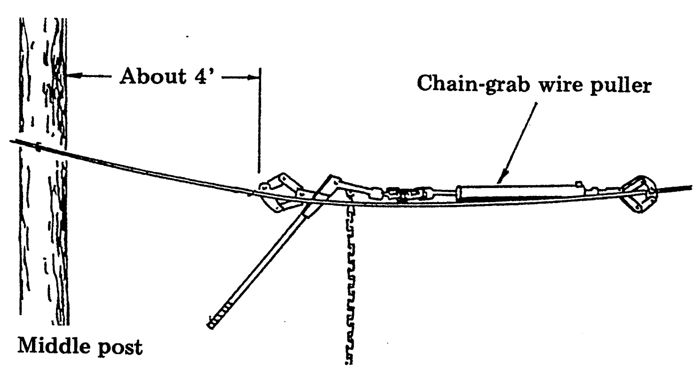
Having tied off all wires, start the tractor and drive at an even, slow speed down the fence line, paying out all wires as close as possible to the line posts. Maintain sufficient tension on the wires to prevent loops which could become kinks when tension is taken up on the wires.

At midpoint in the fence, stop the tractor and staple all wires from top to bottom at their proper marks on the midpoint post. Do not drive the staples tight against the wire but allow space for the wires to move within the staples.

Continue paying out the wires to a point about 5 feet beyond the far end post. Stop the tractor and the payout reels so sufficient tension is maintained on the wires to keep them separated and off the ground.

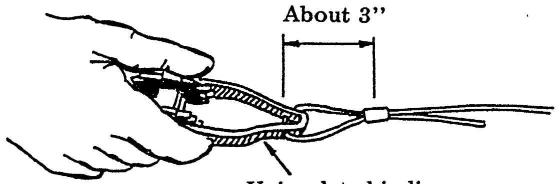
Working from the lowest (second) wire upward, cut each wire off its reel. Allow about 3 feet to wrap it around the end post and tie it off with an end-post knot or with two mechanically crimped sleeves. Again, place the wire off-center toward the livestock side of the fence, but do not staple.

Installing In-line Strainers—Return to the post at midpoint in the fence where the wires have been stapled to the post. Working from the top wire, attach a chain-grab wire puller about 4 feet away from the middle post and pull the slack out of the wire. An in-line strainer will travel along the wire to be taken up on the drum. Place the strainer of the wire with the drum away from the nearest post. Allow 2 feet for turning the handle. The strainer may be positioned towards the post if enough room is allowed for its movement.



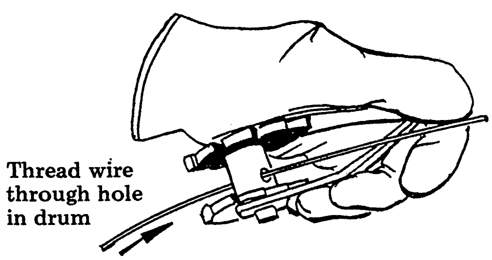
Pulling slack from wire.

Cut the wire at midpoint in the slack between the jaws of the wire puller and install an in-line strainer by threading two nicopress sleeves onto the end of the wire nearest the midpost. Slide them back 12 inches and thread the wire through the holes in the shank of the strainer about 6 inches. Bend the wire back onto itself. Slide the sleeves forward about 3 inches to enclose the end of the wire and crimp the sleeves. To insure that the wire does not slip, bend it back on itself over the sleeves.



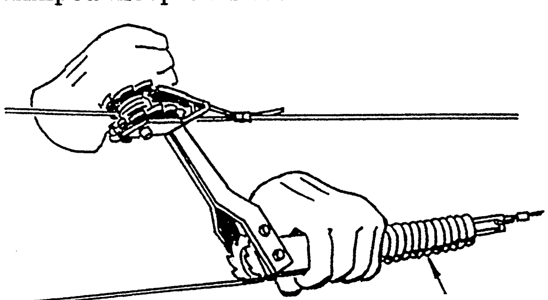
Installing in-line wire strainer.

Thread the line wire through the hole in the drum of the in-line wire strainer and cut off the surplus wire close to the drum. Attach the handle and turn the drum enough to secure the wire and insert the ratchet pin. Continue turning the drum until no slack remains in the wire.

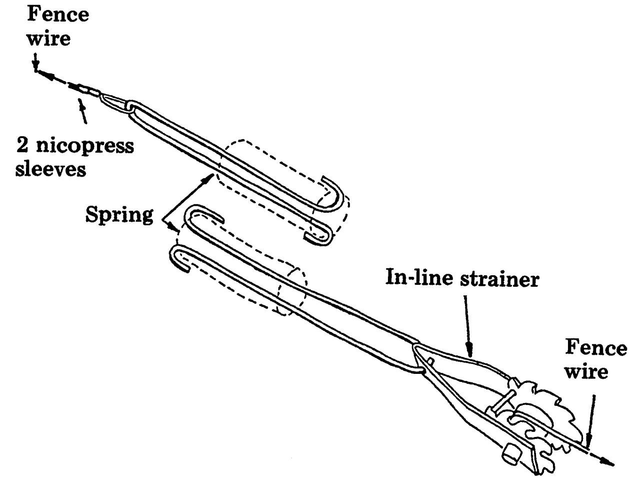


Attaching line wire to in-line wire strainer.

Attach the wire puller to the next lower wire and pull out the slack. Cut the wire between the jaws of the wire puller and install an in-line strainer to which a tension indicator spring has been attached. Secure the spring loop to the line wire with two crimped nicopress sleeves.



Installing tension indicator.



Install an in-line wire strainer and tension indicator spring.

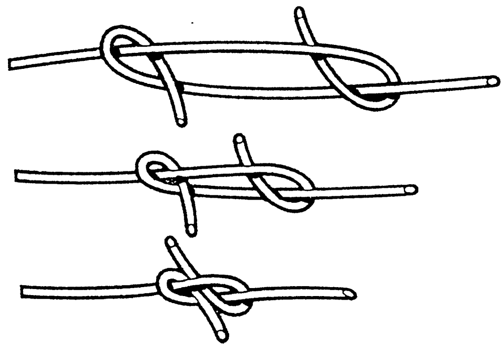
The imprinted notches on the clevis are the tension indicators. The first notch is zero tension and each notch from there is in 100-pound increments.

Following procedures for installing in-line wire strainers, install in-line wire strainers in the remaining wires, place the strainer in the same direction and crank the drum to take out the slack.

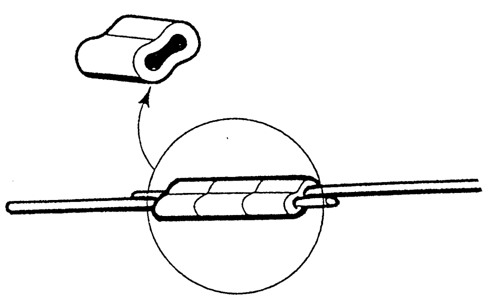
Splicing Wire

Avoid slack while paying out high tensile wire. This reduces recoils which, when the wire is tensioned, can become sharp bends or kinks. High tensile wire can withstand bends up to 90° and restraightening without significantly reducing the breaking strength of the wire. Bends greater than 90° should be cut out and the wire must be spliced at those points. In-line splicing may be accomplished by tying a figure-8 knot. Overlap the ends of the wires to be spliced 10 inches to 12 inches and bend a loop in the end of each around the other wire, but in opposite directions. Bring the end of the wire in each loop under itself, so that the ends of the wires are parallel but pointing in opposite directions. Pull the loops together until the ends of the wires are touching. After final tensioning, cut the surplus ends of the wires as close as possible to the loops. This knot has been found effective up to 66 percent of the breaking strength of the wire.

In-line splicing may also be accomplished by installing three nicopress sleeves. Two wires can be lap-spliced by threading three nicopress sleeves of the proper size onto one wire, then sliding them forward and threading them on the opposite wire. The sleeves must then be crimped. This mechanical splicing method has been tested and found effective up to 100 percent of the breaking strength of the wire. Some suggest bending the ends of the wires up to reduce the chance of slipping.

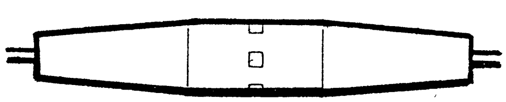


In-line splicing by tying a figure-8 knot.



In-line splicing with three nicopress sleeves.

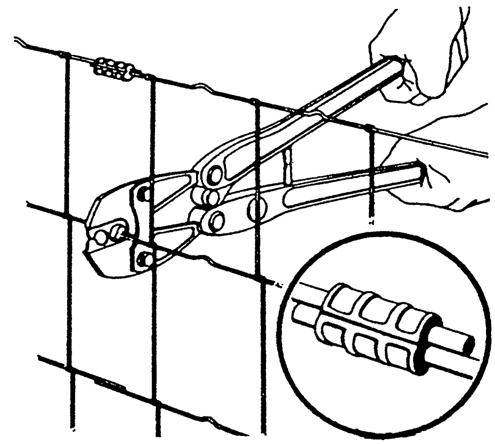
Installing a Reliable Wirelink is another recommended method for in-line splicing. Two high-tensile wires can be butt-spliced by simply inserting both wires as far as possible into the ends of the fitting and pulling in the opposite direction. This mechanical splicing method has been tested and found effective up to 100 percent of the breaking strength of the wire.



In-line splicing using a Reliable Wirelink.

Line Splice for Barbed Wire

Commercial compression sleeves are used to make splices on all types of wire. These sleeves can be purchased in different sizes to meet various wire gauges.



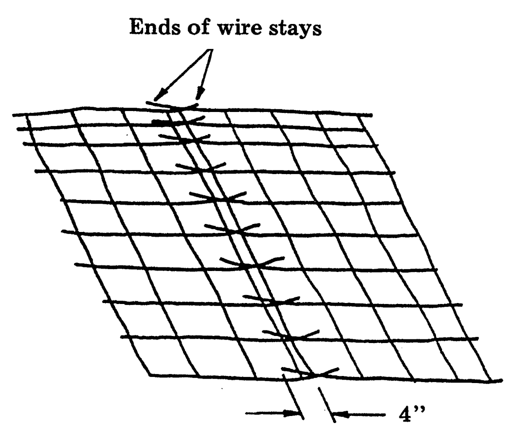
Splicing wire using a commercial compression sleeve.

When using a splicing tool on net fencing, cut ends of line wires on each section so about 4 inches of each line wire extends beyond the stay wire.

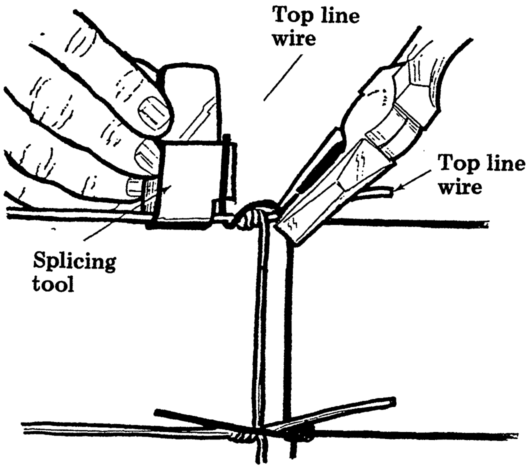
Pull ends of fence sections together until stay wires meet.

Bend top line wire of one fence section around top line wire of other fence section and wrap.

Wrap remaining top line wire in opposite direction.



Splicing a net fence.

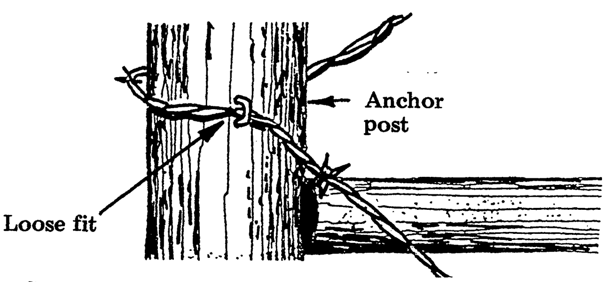


Splicing a net fence using a splicing tool.

Laying Barbed Wire

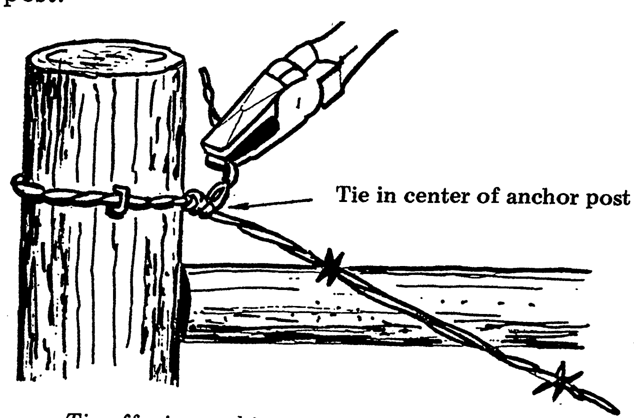
Unroll barbed wire to the next brace assembly. Do not loop the wire off the side of the roll. Be sure to wear leather gloves and boots.

Starting with the top wire, attach the end of the wire to the anchor post of the brace assembly. Be sure the wire can easily slide in the staple.



Start with the top wire. The wire must easily slide through the staple.

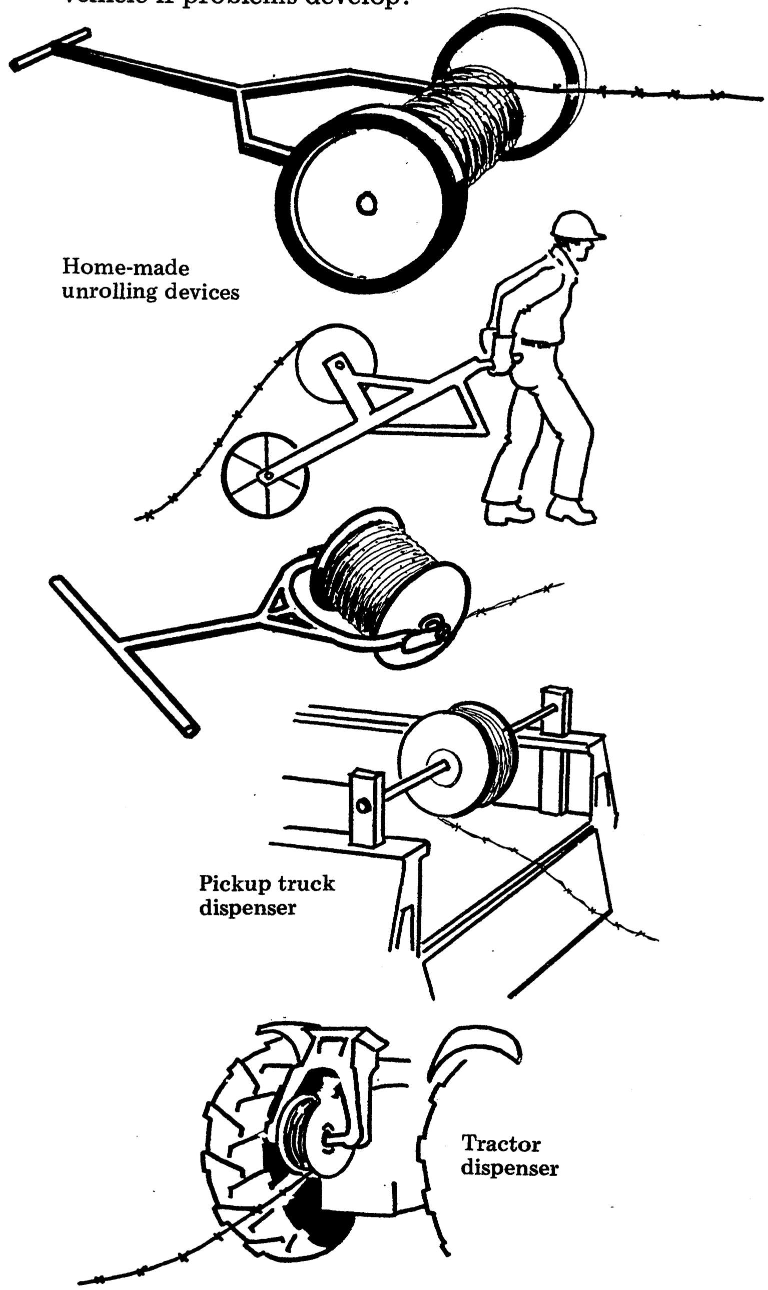
Then, extend the wire around the post and wrap the end around the wire itself at least five times. Be sure that the tie is in the center of the anchor post.



Tie off wire, making sure the tie is in the center of the anchor post.

There are several improved methods of unrolling barbed wire. This may be done by hand or mechanically. If done by hand, safety precautions such as shields and leather gloves are mandatory. The safest hand method employs a home-made or purchased frame that rolls directly on the ground so the spool is not carried.

A frame for unrolling up to five rolls of barbed wire can be mounted on the back of a pickup or tractor. When using this type of unrolling device, 2 miles per hour is maximum truck speed and one person will be assigned as lookout to stop the vehicle if problems develop.

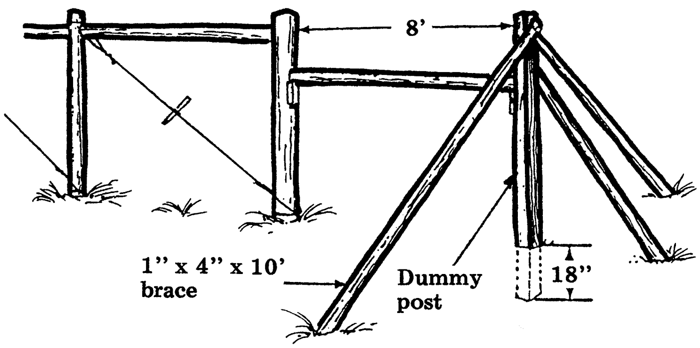


Methods of unrolling barbed wire.

Stretching Barbed Wire

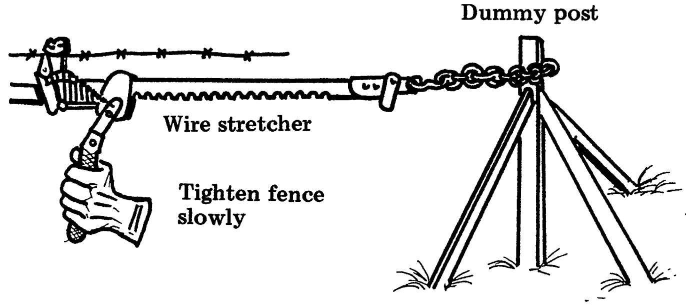
To prevent the wire from slacking when the stretchers are removed, a dummy post should be set up. The dummy post is a temporary structure used only for stretching the fencing wire.

Construct dummy post as shown:



Dummy post details.

Attach fence stretcher to dummy post. Attach barbed wire to stretcher:



Stretching barbed wire.

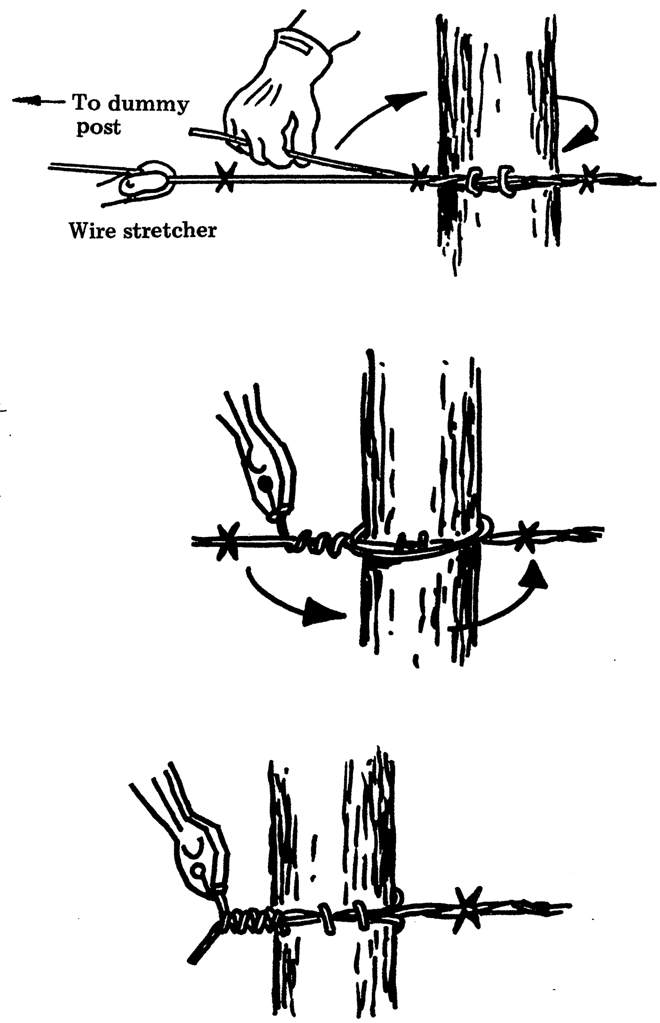
Stretch barbed wire until it is fairly taunt. Check to be sure the wire is free from any snags on the ground or the posts.

There is no method of knowing when barbed wire is properly tensioned. But, wire stretched on hot summer days should be sufficiently slack to allow contraction in cold weather without breaking.

If wire spans between brace assemblies are longer than 20 rods (330 feet, 1/16 mile), wire should be supported with smooth wire loops from the top of the posts at intervals of 8 to 10 posts during stretching. The wires of a fence should always be stretched from the top strand down to the bottom strand. It is possible to stretch barbed wire until it breaks with a hand stretcher. If this happens, anyone near the wire can be severely cut. If you have to handle barbed wire while it is being stretched, keep a post between you and the wire. Always handle the wire with pliers and leather gloves to help prevent injury.

Once the wire is properly stretched, attach it to the second brace assembly with staples. Be sure that the staples do not force the wire into the post.

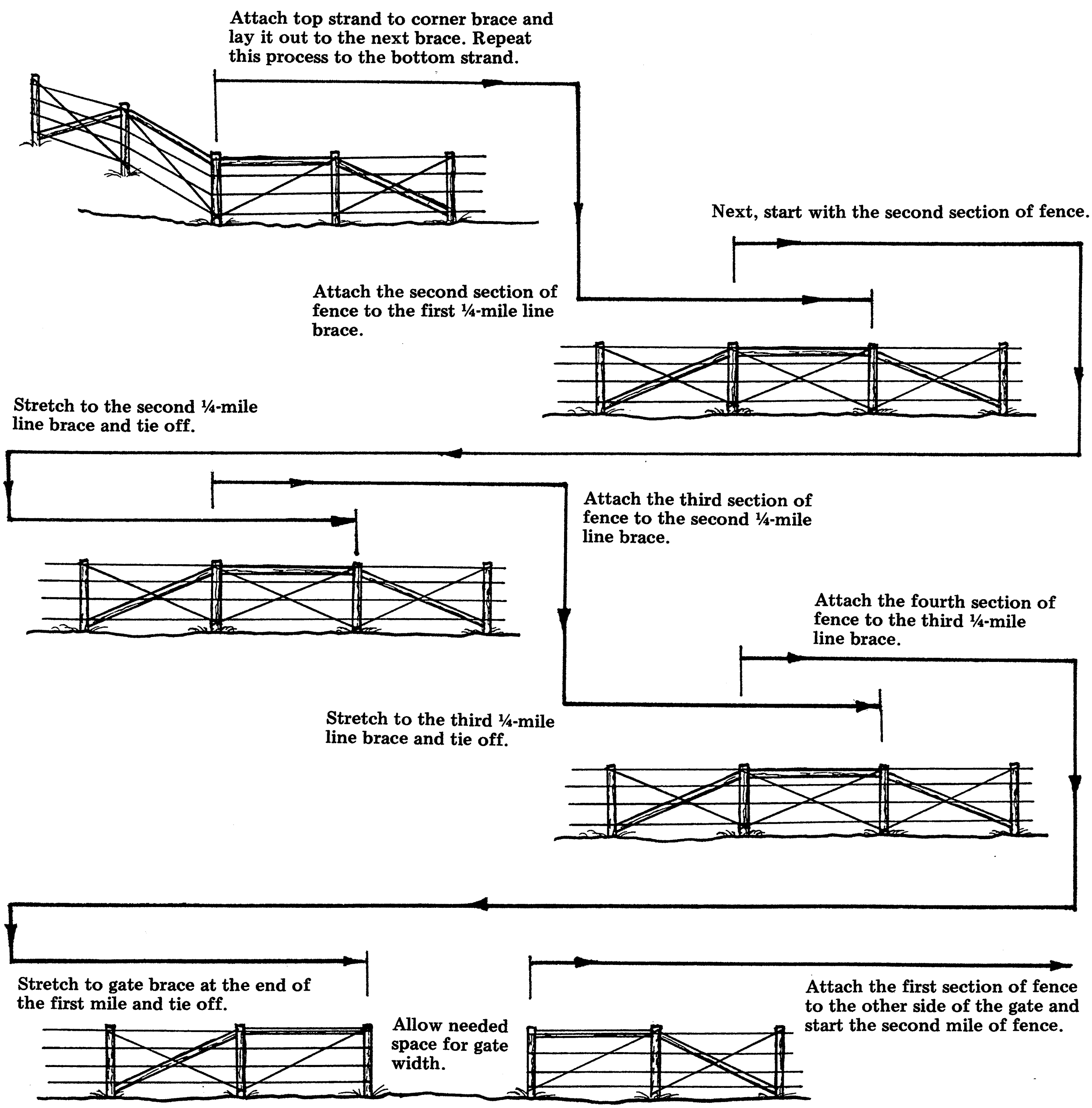
One technique for fastening barbed wire to the anchor post is to cut one of the two wires and untwist. The uncut strand still holds tension on the line wire. Extend the cut wire around the post and wrap it to the line wire. Leave a space between each wrap. Cut the remaining wire. Extend it around the post and wrap it between the wraps of the first wire.



Method of fastening barbed wire to anchor post.

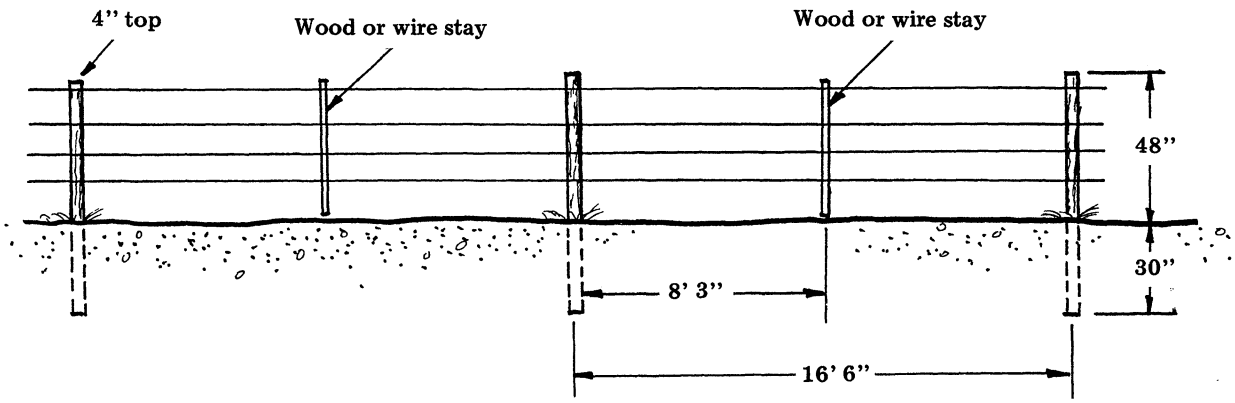
It is important to wrap the end of the wire back on itself. If using staples alone, wire-pull may rotate the anchor post when the stretcher is removed and cause the wire to loosen. It may even cause the anchor and brace assembly to come apart. This process will be repeated for all the strands between the brace assemblies.

The following schematic illustrates how a mile of fence would be constructed with brace assemblies every 80 rods (1,320 feet, ¼ mile).



Constructing a mile of fence with brace assemblies every ¼ mile.

A possible fence section between these braces is illustrated below.



Typical fence section between braces.

Attaching Wire to Posts

Wires must be securely attached to posts, but some movement should be allowed.

Staples or nails may be used to fasten 12½ gauge galvanized barbed or woven wire to any type post. Staples should be made of No. 9 gauge galvanized wire. Use 1½-inch long staples for treated woods and 3/4-inch staples for hard wood such as osage orange. Approximately seventy-two 1½-inch staples are contained in 1 pound.

Steel nails are generally used for fence building. Galvanized nails are better. Nails most used are:

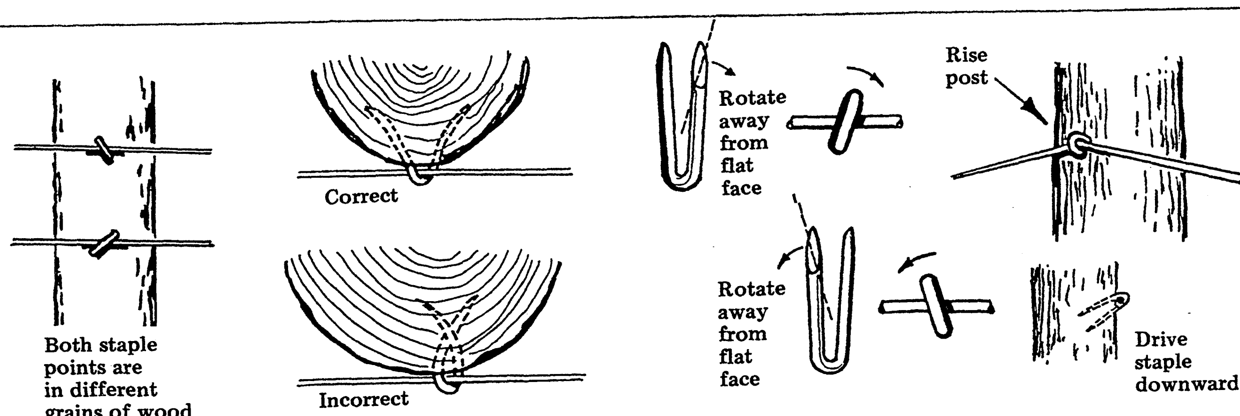
16d common	3½ inches long	49 per pound
20d common	4 inches long	31 per pound
30d common	4½ inches long	24 per pound
40d common	5 inches long	18 per pound
50d common	5½ inches long	14 per pound
60d common	6 inches long	11 per pound
7 x 5/16 inch spikes		7 per pound

Staples—Fence staples should always be driven into posts so that both points of the staple are in different grains of wood. To achieve maximum holding power, staples with slash-cut points should be driven so their individual legs curve outward, not inward. Note that the slash-cut points act as wedges that force the legs to curve away from the flat surfaces of the points as the staples are driven into the wood.

Staples driven so each leg curves away from the vertical centerline of the post have 40 percent more pull-out resistance.

When placing a staple over the wire and against the post, rotate the staple slightly (20 to 30 degrees of vertical) away from the flat surface of the point on the upper leg.

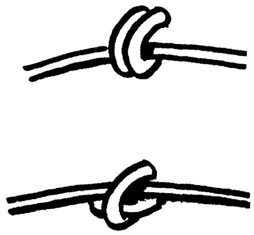
On level ground and rises, wire pressure tends to be downward. To prevent staple pull-out, staples should be angled downward.



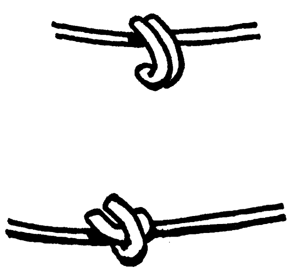
Proper methods of stapling.

When posts are set in depressions, the wire pressure is upward. To prevent staple pull-out, the staples should be angled upward.

On very steep rises or dips, where tensioned line wires exert much greater pull-out forces on staples and where it is difficult to hold the wires upward or downward against the marks on the posts, driving two staples in either of the ways shown makes the job easier and is good insurance against pull-out.

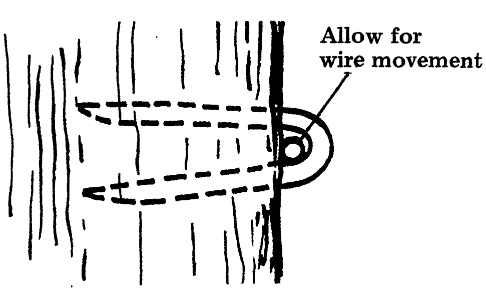


Rise post, double stapling.



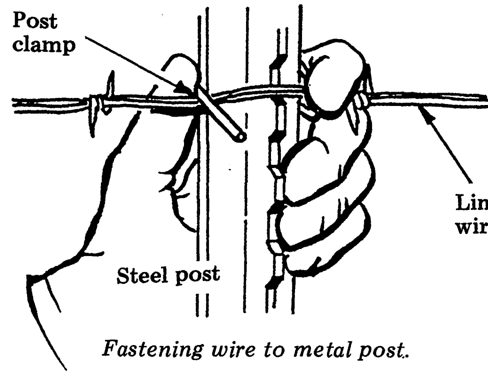
Dip post, double stapling.

Staples should hold the wire close to the post. This will allow freedom of movement due to expansion and contraction of the wire and also wire movement due to pressure against the fence itself.



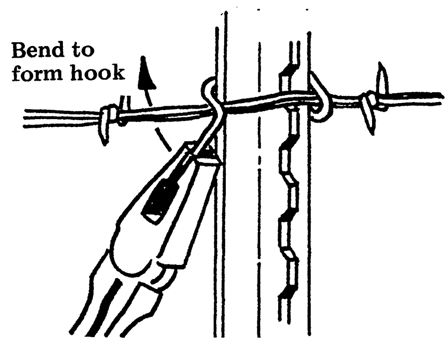
Staples should hold wire close to fence, but allow for expansion and movement of the wire.

Steel Post Clips—Hook the post clamp over the wire and snap it into position around the post.



Fastening wire to metal post.

Bend the other side over the wire to form a hook.

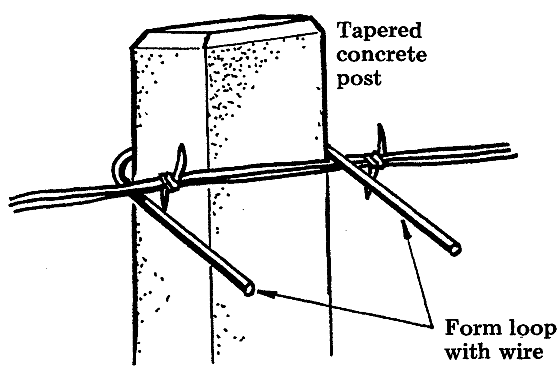


Completing fastening of wire to post.

Wire for Different Types of Posts—Extend wire around the post to form a loop and cut wire ends to desired length for wrapping.

Use 12-gauge, galvanized wire or larger.

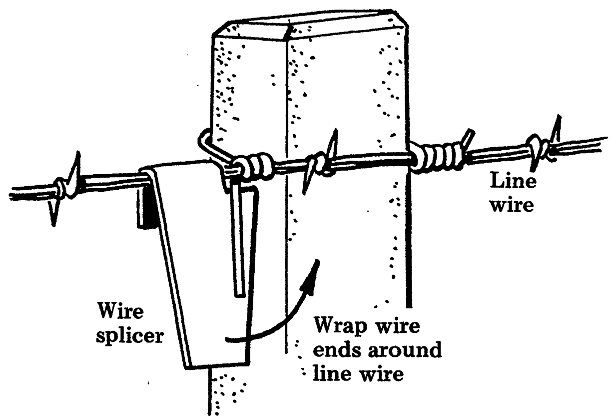
Pull the fence against the post and wrap loop ends around the wire.



Fastening wire to tapered concrete post.

To get a snug fit, tap the wire loop with a hammer before the second wire end is wrapped.

Wrap the wire with pliers or a wire splicer.



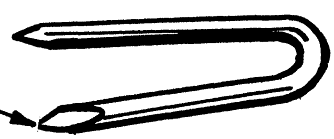
Using wire splicer to attach wire to concrete post.

Line wires over level terrain should be stapled to the line posts only after taking up preliminary tension (about 100 pounds) on each wire to prevent crossing the wires and stapling them at wrong levels on the posts. On uneven terrain, relieve preliminary tension on the line wires temporarily before stapling them to the posts in rises and dips. Tension should be restored to 100 pounds before stapling wires to posts on level terrain.

Fence staples used for fastening line wires to wood posts should never be driven all the way into the wood. Doing so not only increases friction and prevents taking up uniform tension in long runs of wire, but also causes kinks in the wires and results in too much strain on short lengths of fence when they are subjected to heavy livestock pressure. Stapling too tightly also prevents normal movement of the wires during expansion and contraction from changes in temperature. A good rule of thumb is to drive all staples on line wires only deep enough to permit removing and rethreading the wires through the arches of the staples after driving. When driving fence staples, do not use the staple to pull the wire to the post. Always push the wire tightly against its mark on the post with the side of your body or leg before driving the staple.

A major cause of failure in wire fences is staples that pull-out. There are many causes: (1) selecting improper staples; (2) stringing and stapling the wires on the side of the posts away from the livestock; (3) stringing and stapling the wires inside of posts in corners or curves; (4) excessive tension or slack in the wires; or (5) improperly driving the staples into the wood. While few things seem more elementary than driving fence staples into wood posts, tests conducted by U.S. Steel's Research Laboratory show that significant increases in the pull-out resistance of staples driven into wood posts can be achieved.

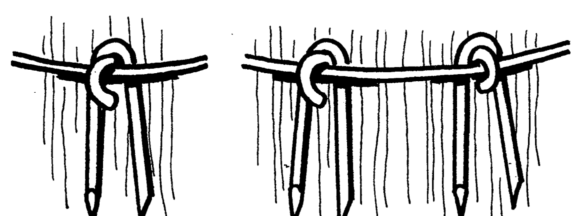
Fence staples used for fastening high tensile wires to wood posts should be longer than staples used for other types of wire fences (1-3/4 inches long, rather than 1½-inches long). Tests show that 1-3/4 inch x 9-gauge staples driven into wood posts have 50 percent more resistance to pull-out than 1½-inch x 9-gauge staples driven into the same posts. For longer resistance to atmospheric corrosion, these longer staples should be manufactured from galvanized wire or hot-dip "tumbler" galvanized after forming. Polished or bright-finished (ungalvanized) staples are not recommended. Staples should have slash-cut points. Staples with single legs or with diamond-shaped points are not recommended.



Preferred 1¾" x 9-gauge staple.

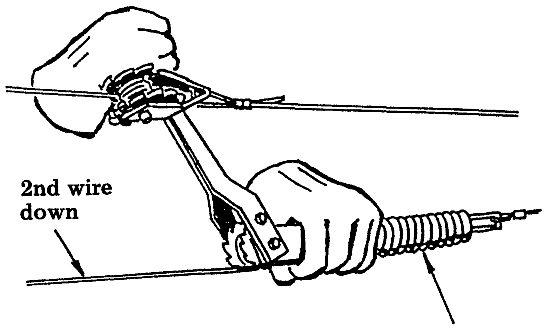
Fence staples should never be driven vertically into wood posts (with both legs parallel with the wood grain). Doing so can separate the grain and significantly reduce holding power, particularly after the posts have had long-term exposure in dry climates. Rotating the staples slightly off the vertical straddles the grain and provides more resistance to pull-out.

When stringing and tensioning line wires around the outsides of posts in corners or curves, where friction and not staple pull-out becomes important, friction can be reduced by keeping the wires from contacting the wood. Leaning the staples before driving them is unnecessary, since relatively low pull-out force is exerted on them.



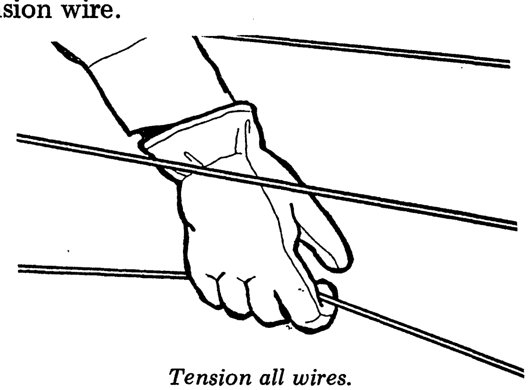
Method of stringing wire on outside corners to minimize friction.

When stapling is completed, return to the tension indicator spring on the second wire down, measure the coil, and turn up the reel until the coil is shortened an additional ½ inch to 3/4 inch, which applies approximately an additional 100 pounds tension on the wire, or a total of 250 pounds. Some fence builders just take out the slack and they do not go through the added expense of using tension springs or in-line strainers.



Tensioning wire.

Using the second wire down as a guide, increase the tension on the top wire and the lower wires to the same degree by alternately pulling the wires toward you and cranking up the ratchets until all wires pull toward you about the same distance and with the same resistance as the measured tension wire.

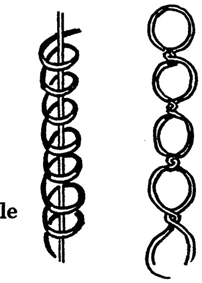


Tension all wires.

Final tensioning should be done a full day after the initial tensioning to 250 pounds. This allows the brace assemblies to move slightly and set. Increase the tension on each wire by a click or two on each ratcheted in-line wire strainer to provide the correct tension on each wire.

Since stays are attached tightly to the line wires, they should not be installed until all wires have received final tension.

Wire stays are usually constructed of No. 9½ gauge galvanized wire. There is a two-wire spiral twist design and a one-wire spiral twist with a removable straight wire design:



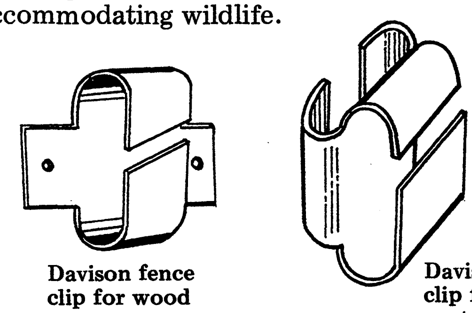
Typical wire stays.

The length of the stays should be 2 inches longer than the distance between the top and bottom wires of the fence. Wire stays are not effective visual barriers and they bend easily under pressure.

Wood stays should be constructed of treated material and be at least 1-inch thick by 1½ inches wide. Presawn angle cuts are easily installed by forcing the fence wires into these cuts. Horizontal cuts require fencing wires to be attached in the wire clips. Some wood stays have no cuts and require the fencing wire to be snuggly attached with wire clips. Wood stays are strong and rigid. They provide a good visual barrier and withstand pressure better than wire stays. However, they do add weight on wires between braces.

Fiberglass stays are available in lengths from 2½ to 6 feet. The fencing wire is attached with light-duty clips. They are light, strong, self-insulating, and long-lasting.

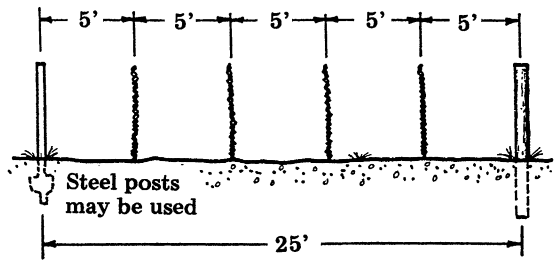
Wire clips attach fencing wire to steel posts. The Davison fence clip holds the fencing wire to both wood and steel posts and allows fencing wire to move freely through the clip. The slot in the clip allows fencing wire spacing to be removed or rearranged for a let-down design or for accommodating wildlife.



Wire clips for attaching fencing wire to steel and wood posts.

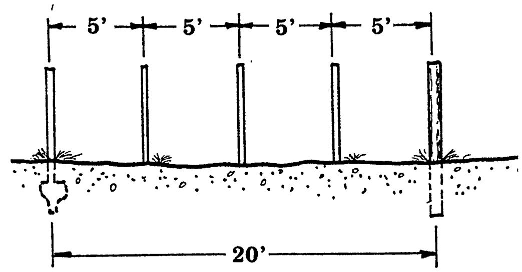
Snow conditions affect fence design. Choose the design most appropriate for your site and adjust the post and stay spacing accordingly.

LIGHT OR NO SNOW WITH STEEP TOPOGRAPHY



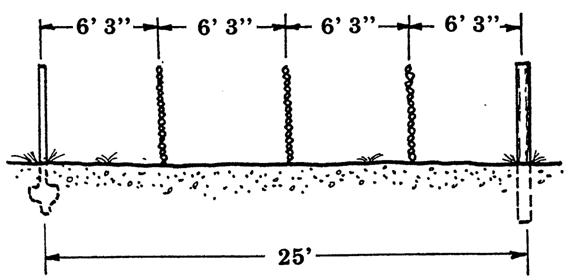
1. Wood or wire stays:
   wood 1½ inches x 2 inches x 48 inches
   wire 48 inches
2. Stays rest solidly on the ground
3. Use No. 14 galvanized stay tie wire for wood stays
4. Steel posts may be used

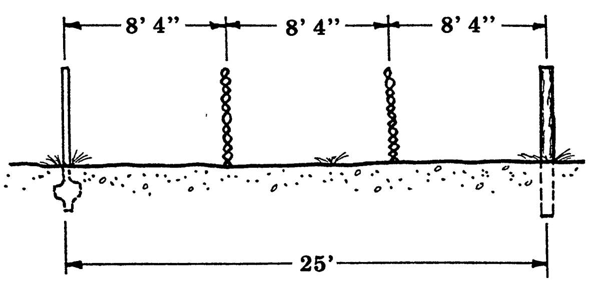
MODERATE SNOW WITH STEEP TOPOGRAPHY



1. Use wood stays only 1½ inches x 2 inches x 48 inches
2. Stays rest solidly on the ground
3. Use No. 14 galvanized stay tie wire
4. Steel posts may be used
5. Every fifth post should be wooden

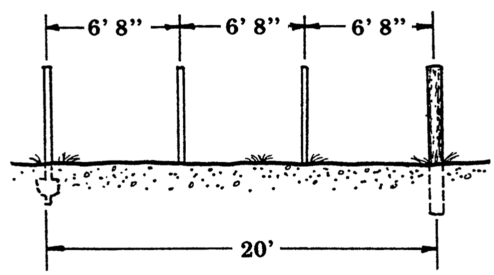
LIGHT OR NO SNOW WITH LEVEL TOPOGRAPHY





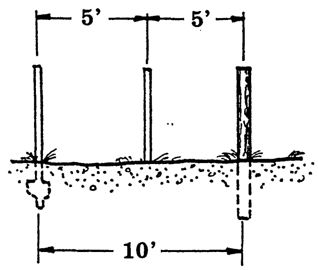
1. Wood or wire stays:
   wood 1½ inches x 2 inches x 48 inches
   wire 48 inches
2. Stays rest solidly on the ground
3. Use No. 14 galvanized stay tie wire for wooden stays
4. Steel posts may be used

MODERATE SNOW WITH LEVEL TOPOGRAPHY



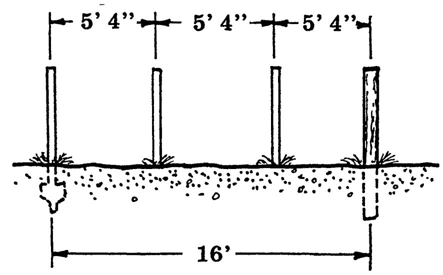
1. Use wooden stays only—1½ inches x 2 inches x 48 inches
2. Stays rest solidly on the ground
3. Use No. 14 galvanized stay tie wire
4. Steel posts may be used
5. Every fifth post should be wooden

HEAVY SNOW WITH STEEP TOPOGRAPHY



1. Use wooden stays only—1½ inches x 2 inches x 48 inches
2. Stays rest solidly on the ground
3. Use No. 14 galvanized stay tie wire
4. Steel posts may be used
5. Every fifth post should be wooden—minimum standard

HEAVY SNOW WITH LEVEL TOPOGRAPHY



1. Use wooden stays only—1½ inches x 2 inches x 48 inches
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4. Steel posts may be used
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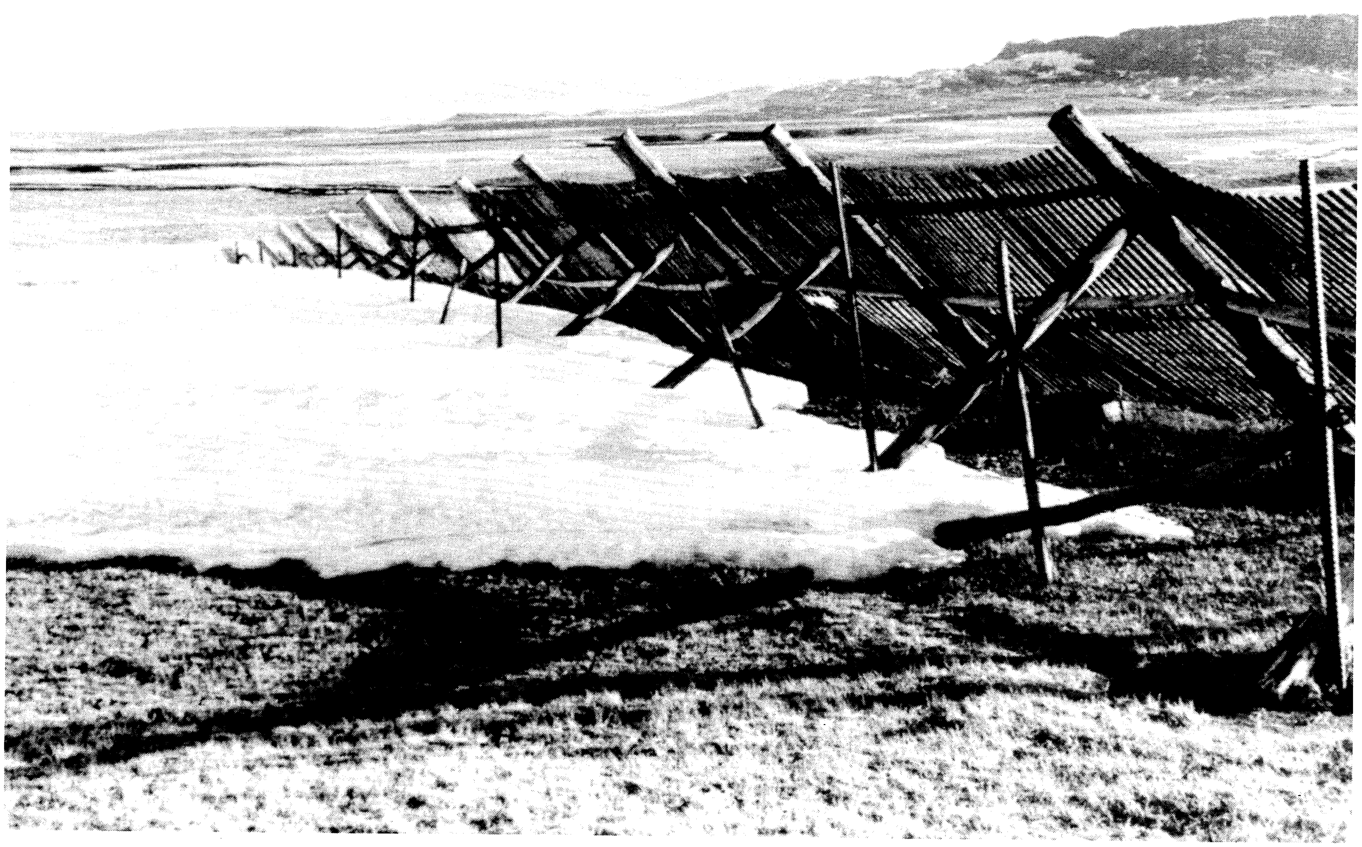


Typical snow fence.

Tensioning the Wire

All wire may break and recoil when overstretched. This may cause serious injury. Use hand and eye protection when handling high tensile fence wire. Use caution when stretching any wire.

The recommended pounds of minimum wire tension should also be regarded as the maximum. Tension levels above the recommended pounds are difficult to maintain and serve no useful purpose on the fence. Some fence builders recommended just taking the slack out of the wire.

Locating In-line Wire Strainers—One in-line strainer per wire can tension up to 5,000 linear feet of high tensile wire on a straight fence over level terrain. Longer fences or those with several corners, curves, rises, and dips, may require two or more strainers per wire, spaced about one-third of the length from each end. As a rule on fences over 600 feet long, strainers should be installed at midpoint in a fence. But, if the fence contains curves, corners, rises, and dips, strainers should be installed in the section of fence where these most frequently occur. Strainers should not be installed immediately next to rise or dip posts nor between any two posts within a corner or curve. On fences 600 feet long or less, strainers can be installed at either end of the fence. For example, they can be placed near a gate for easy accessibility. For best appearance, each in-line wire strainer should be placed in the same direction on the individual wires.

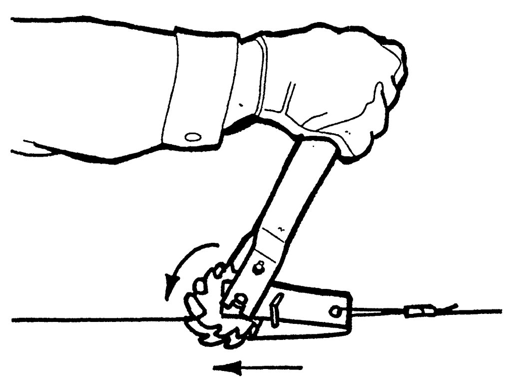
Maximum length of wire, per in-line wire strainer on level terrain:

Type Of Fence Line	Wire Length/Strainer *Feet*
Straight	5,000
One - 90 degree corner	3,000
Two - 90 degree corners	2,000
Three - 90 degree corners	1,500
Four - 90 degree corners	1,200

For uneven terrain, reduce distances by 500 feet for each major rise or dip.

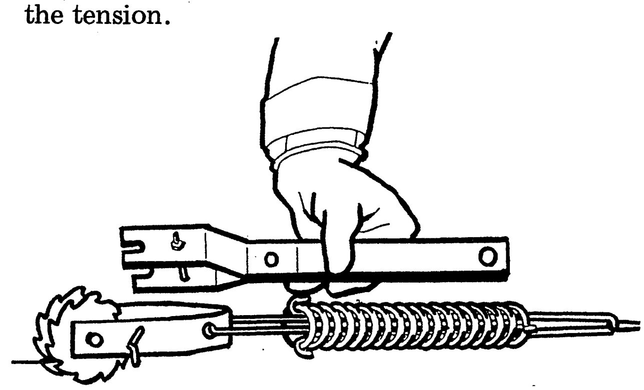
Proper tension on each wire is the essence of a high tensile wire fence. Every detail of material selection and erection is aimed toward ultimately taking up and maintaining the recommended pounds of tension on each wire. Sometimes referred to as "stretching" or "straining" the wires, tensioning is the critical test that determines the success or failure of any high tensile wire fence. Unlike stringing the wires, tensioning should be done from the top wire down for easier separation of the wires, and to provide clearance for turning the handle of the in-line ratcheted wire strainers. Having set all posts, strung and stapled all wires on the midposts, on rise and dip posts, and having installed the in-line wire strainers, proceed as follows:

Insert the handle in the uppermost in-line wire strainer and crank the wire up on the drum until the wire is hand-taut and free of other wires.



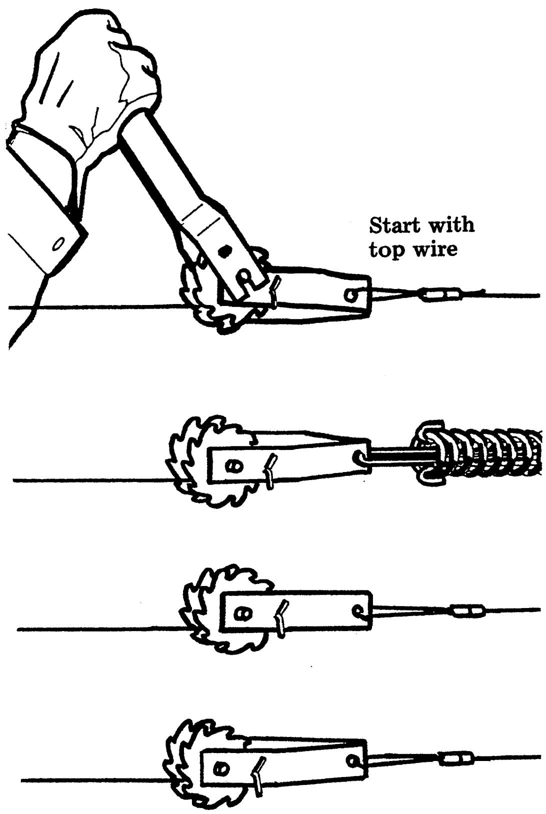
Tighten wire with in-line strainer.

Turn up the drum on the in-line wire strainer (with the tension indicator spring behind it) until the wire is free and taut. Then, measure the coiled portion of the compression spring. Continue cranking the drum until the coil on the spring is shortened by 1 inch, which means the wire is tensioned to 150 pounds. Some tension springs may have indicator marks on the cleaves to note the tension.



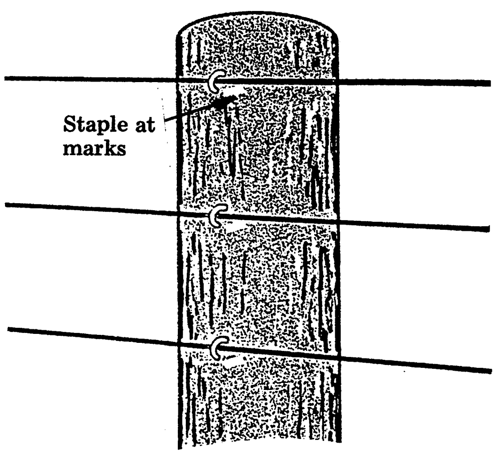
Measure tension with tension indicator spring.

Return to the top wire, increase its tension to equal that of the lower wire; then working from the third wire down, crank all remaining wires to about the same tension as was turned up on the second wire down with the tension indicator spring (approximately 150 pounds).



Tensioning wires.

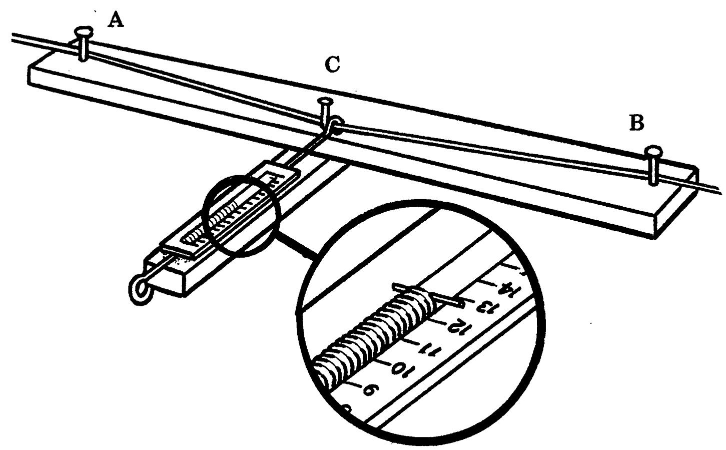
With all wires tensioned to about 150 pounds, staple all wires on their markers on the line posts.



Stapling wires.

Measuring Wire Tension

Measuring wire tension can be done in several ways: (1) With a tension indicator spring; (2) with a tension indicator handle with a pre-set "click over" release that allows tensioning the wire to the set number of pounds; and (3) with a simple homemade device. On a straight piece of 3/4-inch x 2-inch board 42 inches long, drive two nails on a straight line ½ inch into the board 40 inches apart at Points A and B. Drive a third nail ½-inch below the line from A to B, at Point C. With nails A and B touching the wire, attach a spring scale on the center of the wire and pull it toward you until it touches the nail at C. Read the number of pounds necessary to pull the wire to Point C and multiply by 20. A pull of 12½ pounds times 20 equals a tension of 250 pounds on the wire.



Measuring wire tension with homemade device.

On uneven terrain—The procedure for stringing high tensile fence wire on uneven terrain is similar to that for level terrain. Except when *paying* out wires along the fence line, stop at each major dip post and at each major rise post and, working from the bottom wire up, staple the line wires onto such posts at their appropriate marks.

On curves—Line wires should be fastened around the outsides of all posts in curves. It depends upon which side of the fence will be subject to the greater livestock pressure, whether the line wires should be strung on the inside or the outside of the last line post before a curve, as well as on the first line post after a curve.

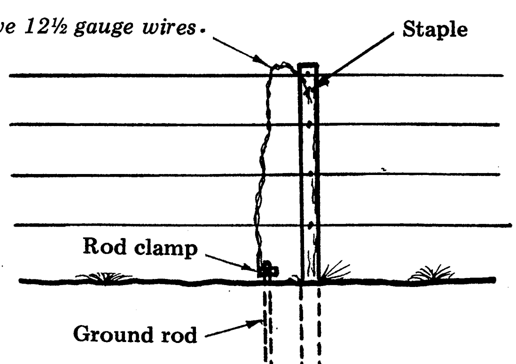
Grounding Wire Fences

All fences using steel wires on non-conductive posts must be grounded. A suitable ground should be installed in every wire fence at 300-foot intervals in moist soils, and at 150-foot intervals in dry soils.

As near as possible to the line wires at each gate post and rise post (at 300-foot intervals in moist soils, or 150-foot intervals in dry soils) drive a 6-foot length of 5/8-inch copper-coated rod or 3/4-inch galvanized new steel pipe 5½ feet deep into the soil.

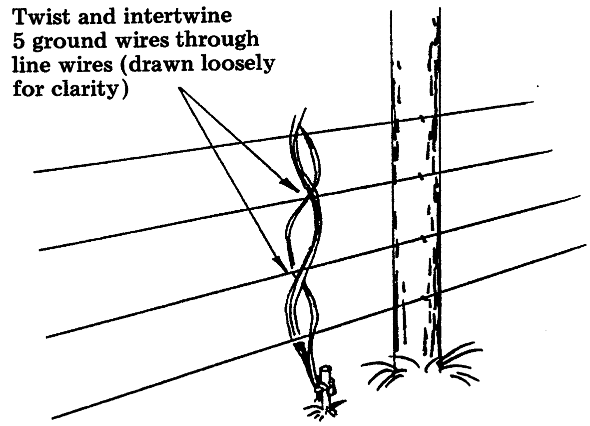
Installing a ground rod.

Attach a ground rod clamp to the rod or pipe on the side nearest to the line wires. Cut five 66-inch lengths of 12½ gauge high tensile fence wire and secure one end of all five wires to the rod or pipe with the ground rod clamp.



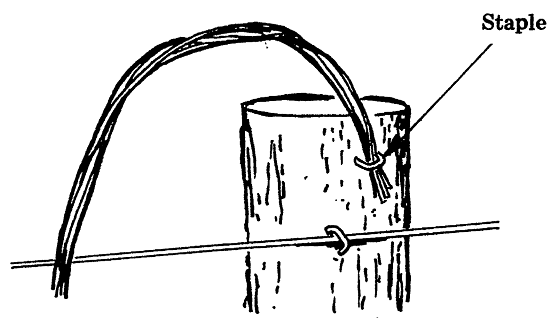
Grounding fence.

Separate the clamped wires so that two are one side of the lowest line wire and three are on the other. Working from the lowest line wire upward, twist the five clamped wires around themselves to form a continuous twisted cable. Make sure to twist them tightly just beneath and just above each next higher line wire so all line wires are twisted within and touching the cable.



Twist ground wires through line wires.

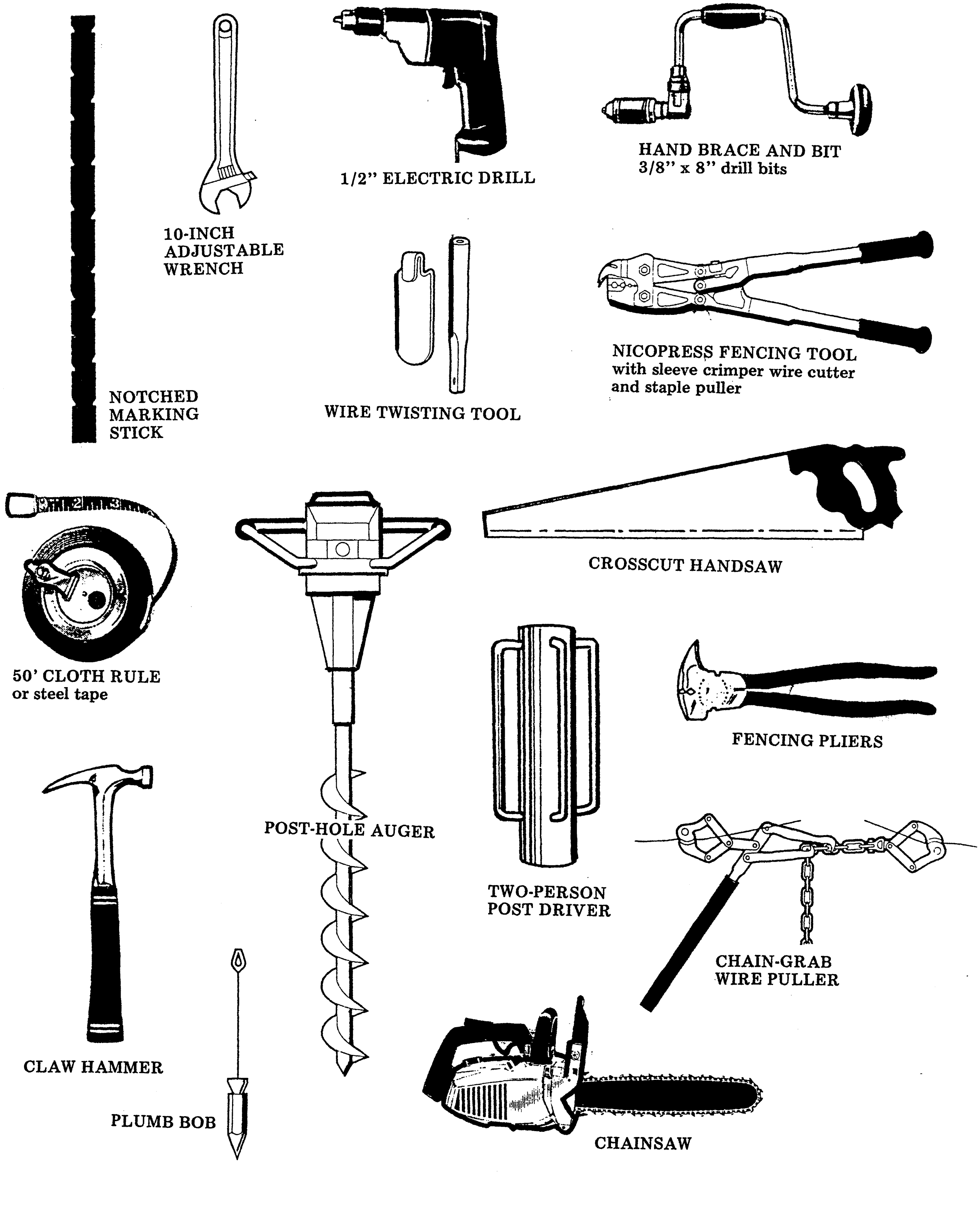
After lacing in the uppermost line wire, bring all five ground wires together and bend them into a rounded loop higher than the top of the post and insert the ends into a staple driven halfway into the post near the top. Drive this staple home to secure all five wires as shown.

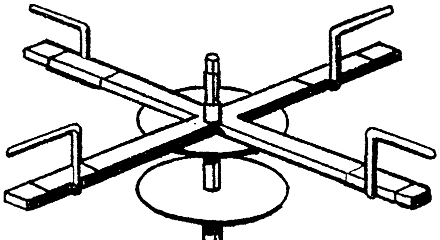


Staple ground wires near top of post.

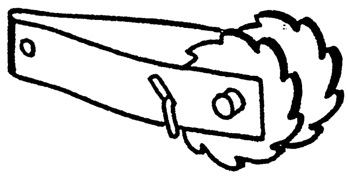
Tools

These tools are commonly used for constructing barbed wire and high tensile wire fences:

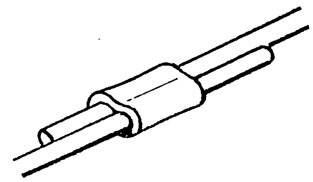




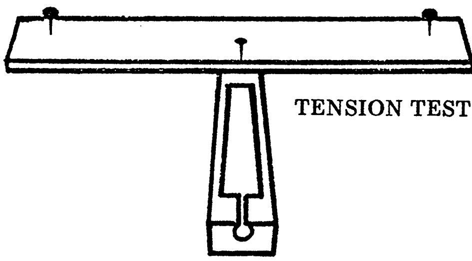
WIRE PAYOUT REEL
(Spinning Jenny)



IN-WIRE STRAINERS

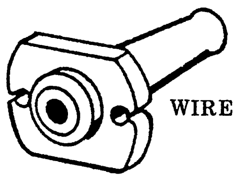


NICOPRESS SLEEVE

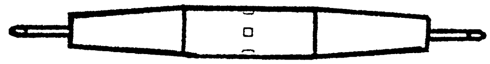


TENSION TESTER

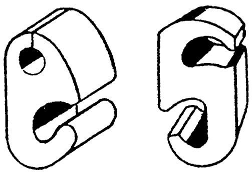
TENSION INDICATOR SPRING



WIRE VICE

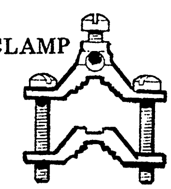


RELIABLE WIRELINK

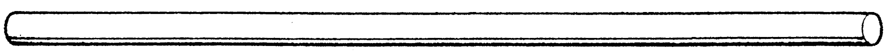


NICOTAP SLEEVES

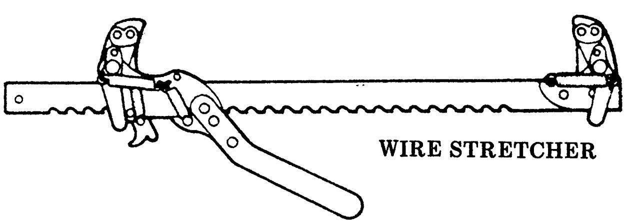
1-3/4" STAPLES



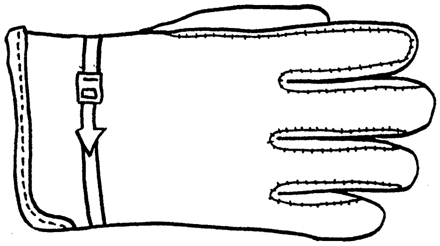
GROUND ROD CLAMP



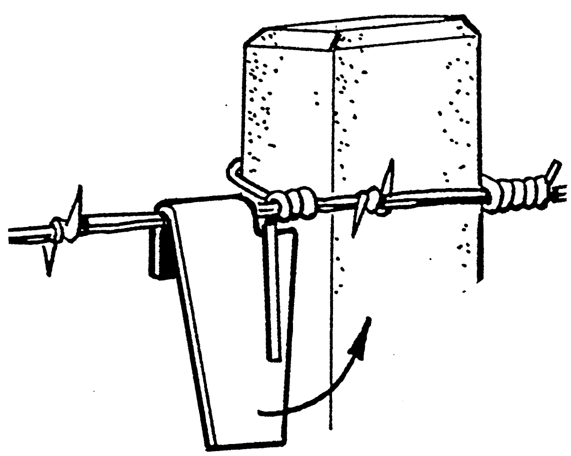
6' x 5/8" GALVANIZED STEEL ROD
(ground rod for lightning protection)



WIRE STRETCHER

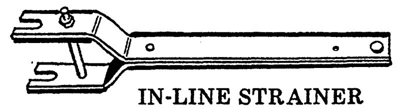


LEATHER GLOVES

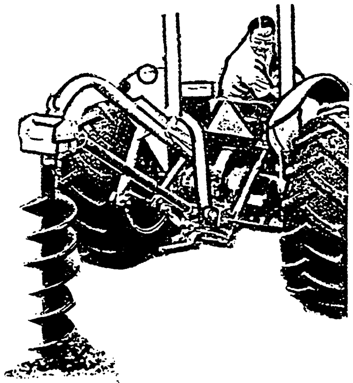


WRAPPING TOOL

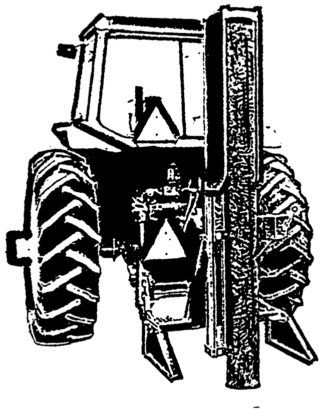
When constructing long fences the following tools reduce construction time, but cannot be used under some soil and terrain conditions.



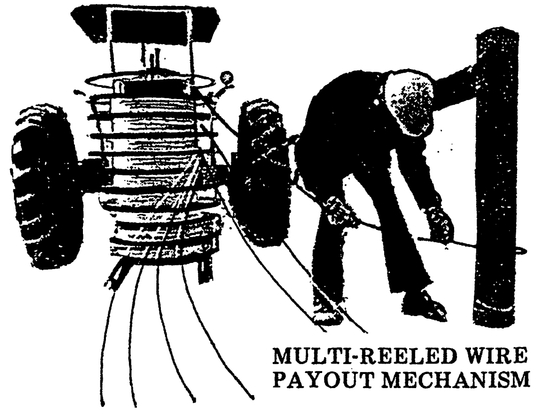
IN-LINE STRAINER TENSIONING HANDLES



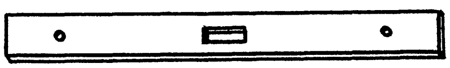
TRACTOR-MOUNTED HOLE AUGER



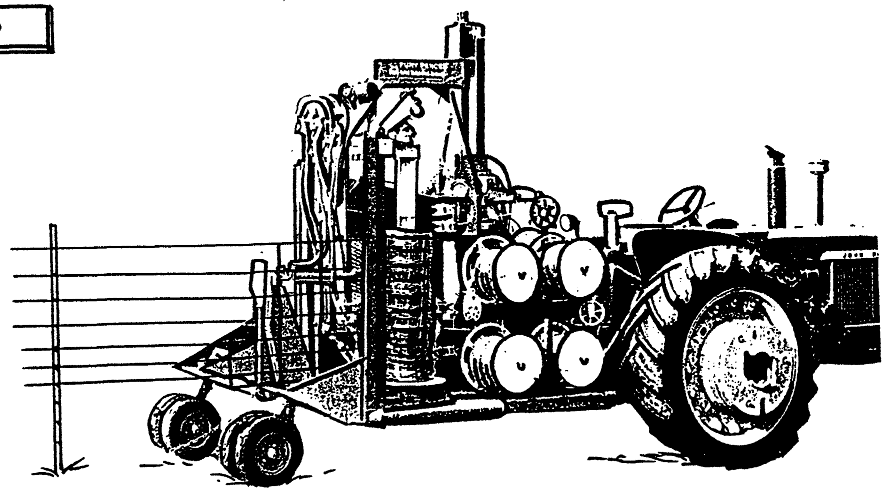
TRACTOR-MOUNTED POST DRIVER



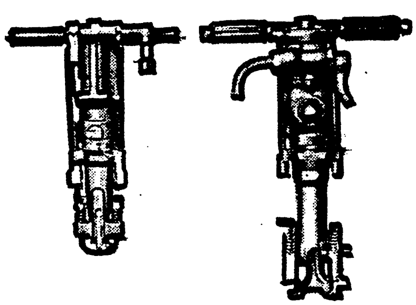
MULTI-REELED WIRE PAYOUT MECHANISM



HEBER SPEED WRENCH



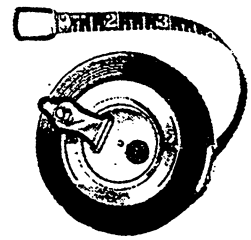
FURY FENCE BUILDING MACHINE



ROCK DRILLS

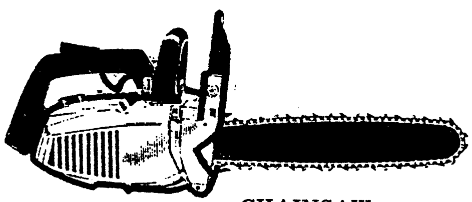
Wood Fences

All-wood fences are not widely used because of the difficulty of transporting materials, the quantity of materials needed, and the amount of labor required to construct them. However, in some situations, all-wood fences are more satisfactory than wire fences. All-wood fences stand up well in heavy snow, and they are often the most esthetically pleasing fence. They have a longer maintenance-free life than other fences, but repairs are labor intensive. If materials are available on-site, construction costs can be quite low.

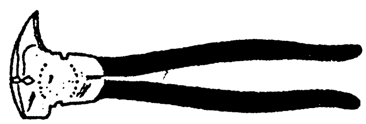


50' CLOTH RULE
or steel tape

Tools

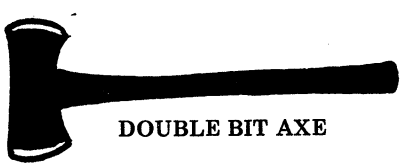


CHAINSAW



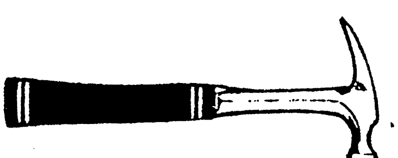
FENCING PLIERS

SINGLE BIT AXE

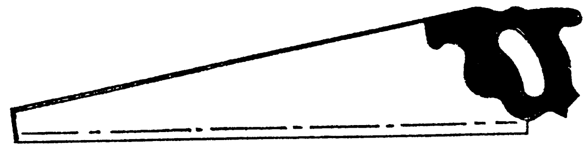


DOUBLE BIT AXE

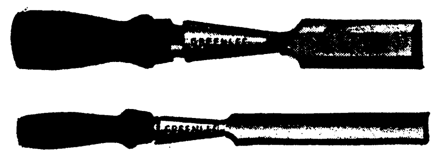
4-POUND HAMMER



CLAW HAMMER



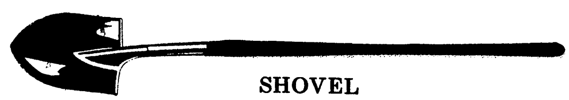
CROSSCUT HANDSAW



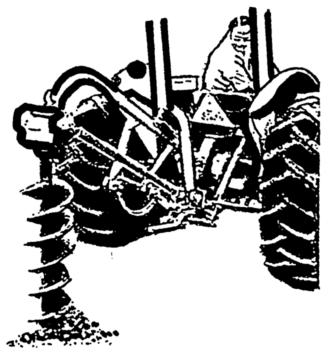
WOOD CHISELS

DIGGING & TAMPING BAR

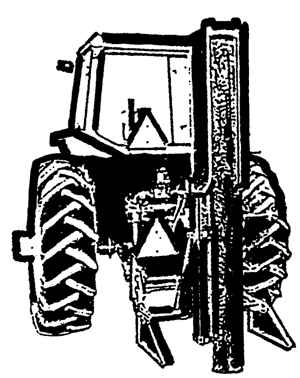
POST HOLE DIGGER



SHOVEL



TRACTOR-MOUNTED AUGER

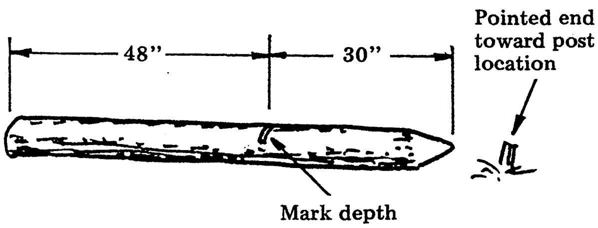


POST DRIVER

Post And Pole Fences

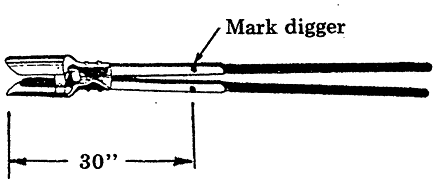
Posts can be driven or set. Driven posts should have tapered ends so they displace and compact the soil around the post. Driven posts are more stable than posts set in pre-dug holes. Posts can be driven manually in some soils or with a power driver attached to a tractor. If the posts are to be set in pre-dug holes, the holes may be dug by hand or with power diggers. Moist soils compact better and give better stability to the post. Set posts have blunt ends.

Posts are set on 8-foot centers. Mark these locations in some manner along the fence line. unload and lay each post near its marked location on the fence line with the pointed end near the mark. Posts are set 2½ feet deep. Depth should be marked on each post.



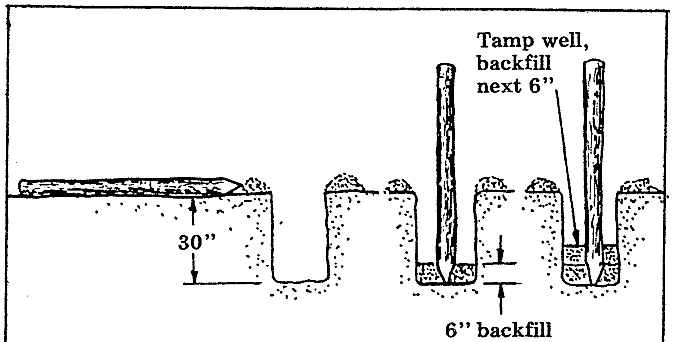
Unloading and marking fence posts.

Mark post diggers with the proper depth.



Marking post hole digger.

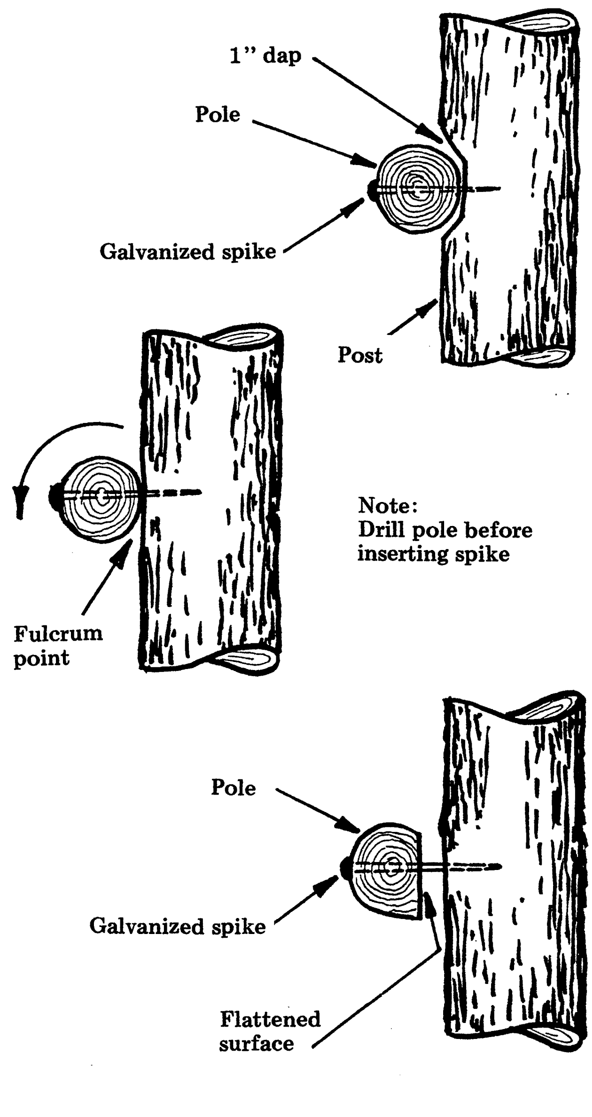
Do not backfill more than 6 inches at a time.



Backfilling post holes.

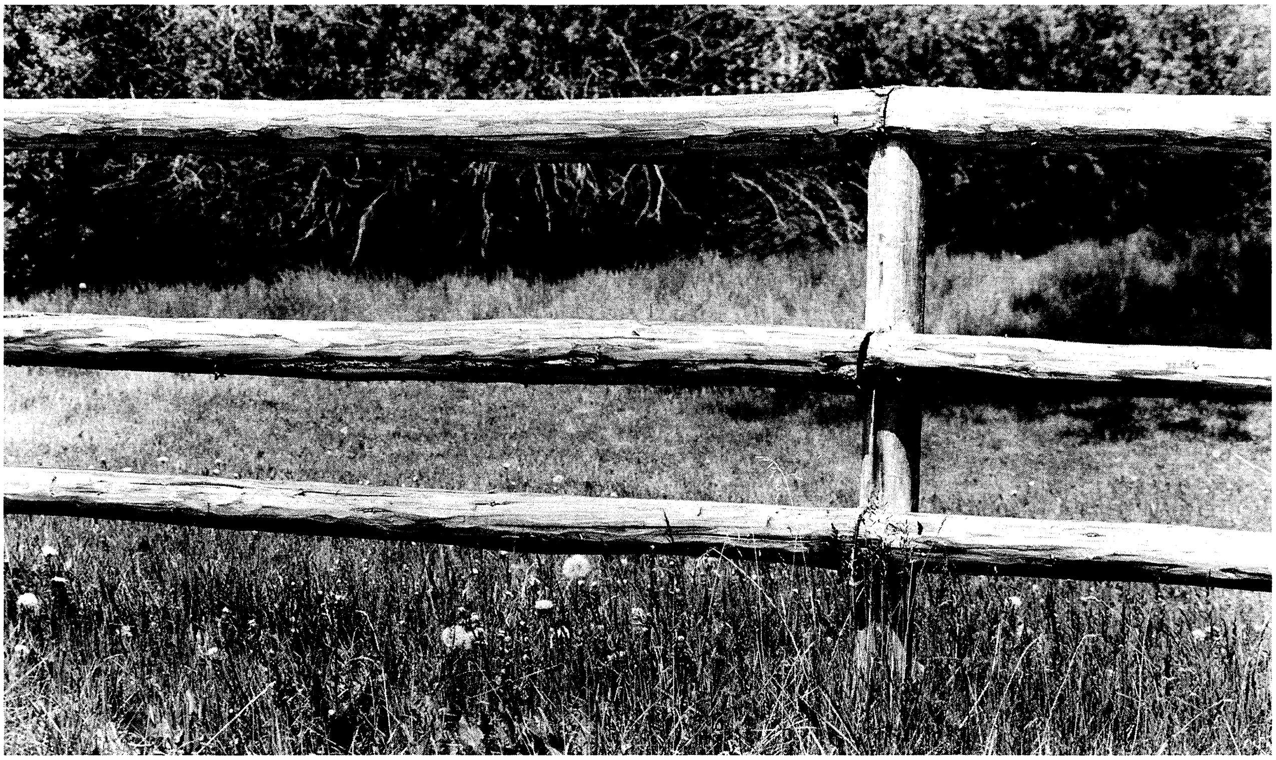
Once the posts are set, unload the poles along the fence line, where they will be used. The poles may be 8 feet or 16 feet long. If 16-foot poles are used, stagger their union so it does not occur on the same post. A top rail should have a minimum diameter of 6 inches. Notch one edge of this top rail so there is a flat surface that sets on top of the posts. The notch should be at least 1 inch deep. The number of poles and the spacing between them depends upon the materials available and the purpose of the fence.

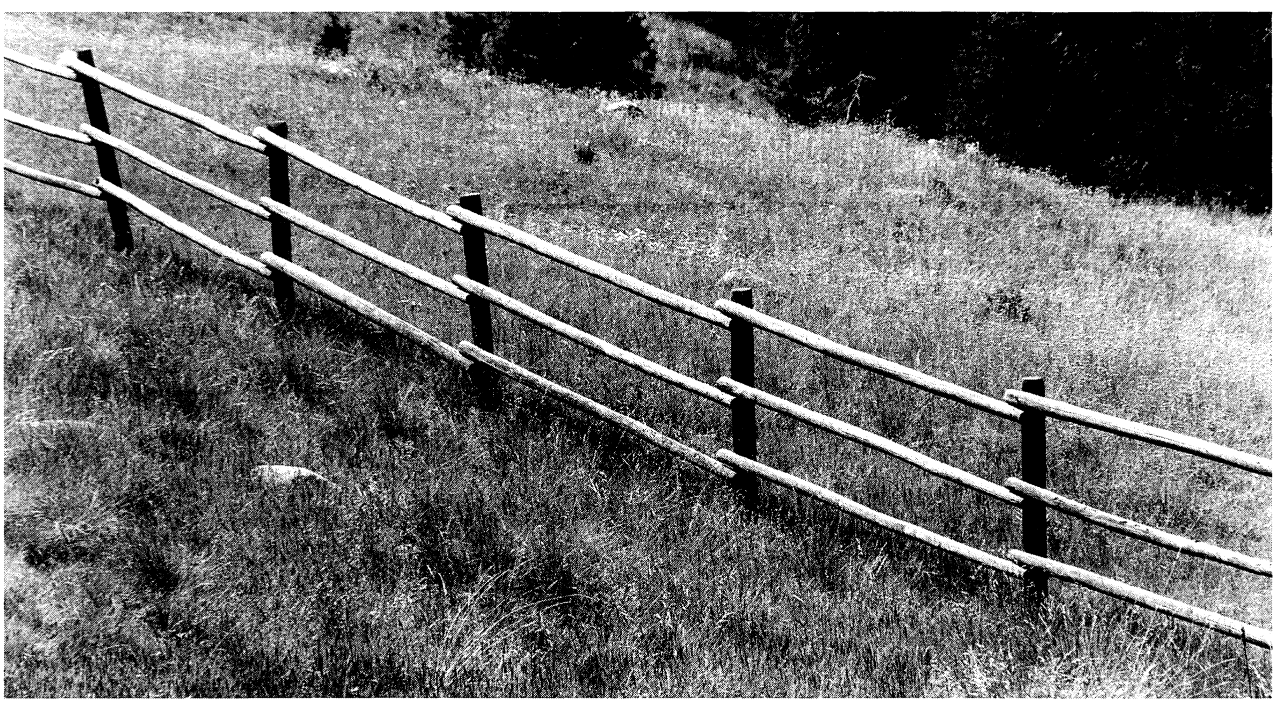
The poles should fit snuggly against the posts. This provides a wide base so poles do not rock loose.



Methods of attaching poles to posts.

Another post and pole design sets two posts side by side with the poles laid between them. Depending on the desired fence height, the posts will vary in sizes. A 4-foot high fence post should be at least 6-feet long, be buried or driven 2½ feet into the ground, and be 3 to 4 inches in diameter. A 5-foot high fence post should be at least 8 feet long, be buried or driven 3 feet into the ground, and have a diameter of 4 to 6 inches. The bottom pole rests on a rock or short piece of wood that keeps it off the ground and helps prevent wood rot.



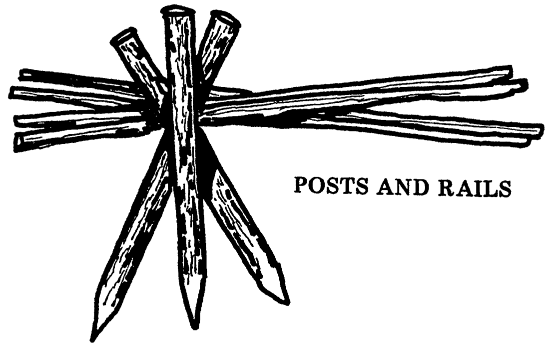


Typical post and pole fences.

Post And Rail Fences

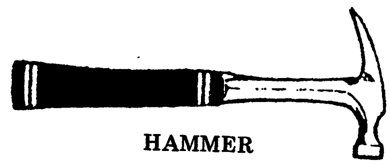
Post and rail fences are usually made from cedar products and are one of the most esthetic fence designs. Posts usually have pre-cut holes for rails. Holes can be cut at the desired heights. Rails may have to be shaped to fit into the holes in the posts.

The following materials are needed to build a post and rail fence.



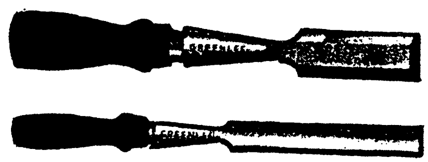
POSTS AND RAILS

TAMPING BAR



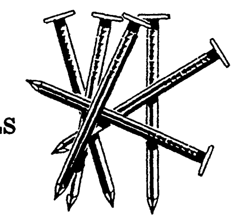
HAMMER

POST HOLE DIGGER

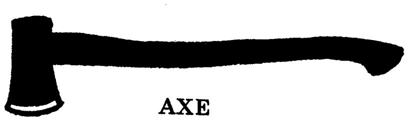


LARGE WOOD CHISEL

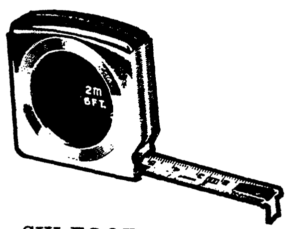
ROUND POINT SHOVEL



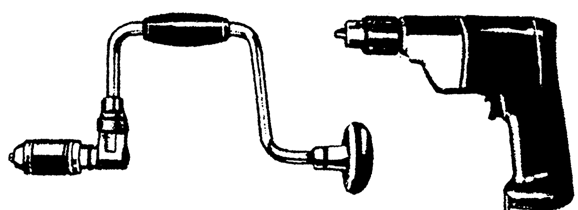
NAILS



AXE



SIX FOOT RULE

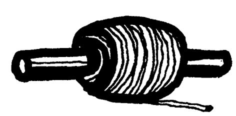


HAND OR ELECTRIC DRILL

CARPENTER'S LEVEL

NOTCHED MARKING STICK

STAKES

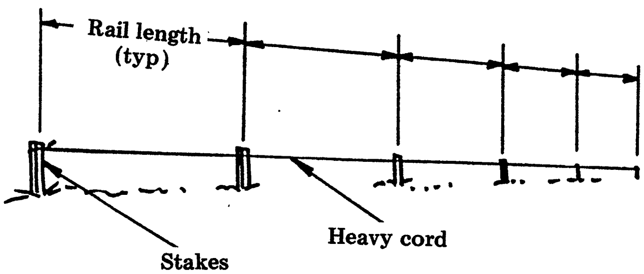


HEAVY CORD

Post Spacing

Once the fence line has been layed out, measure off the post spacings using the gage pole that equals the length of the rails.

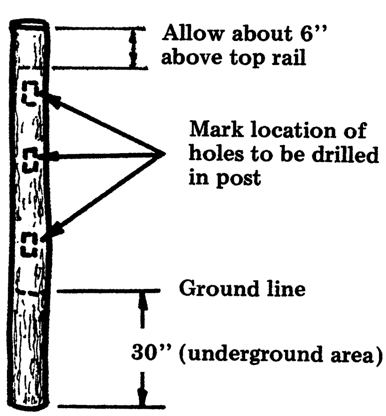
If the post spacing does not come out even, post spacing can be shortened until the last span is almost equal to the other spans of the fence.



Spacing posts.

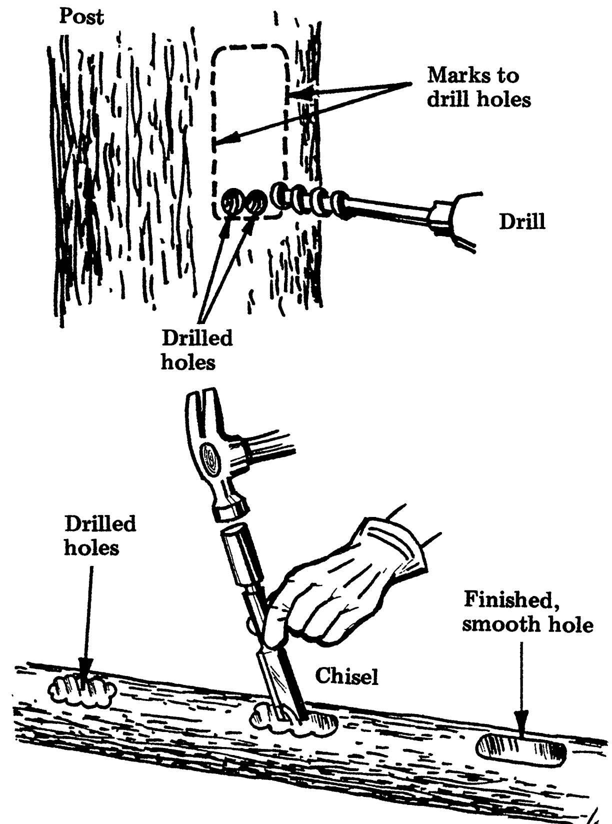
Post Holes

First mark the depth the post is to be buried (usually between 2 and 2½ feet). Then, space the rails so there is about as much space between the ground rail as between the rest of the rails. Allow at least 6 inches of the post to extend above the top rail. Keep the holes in line. Use the largest posts for the corner posts.



Marking posts for hole locations and depth in ground.

Drill holes around the marked hole for the rails. Then, chisel or wood rasp the hole smooth.

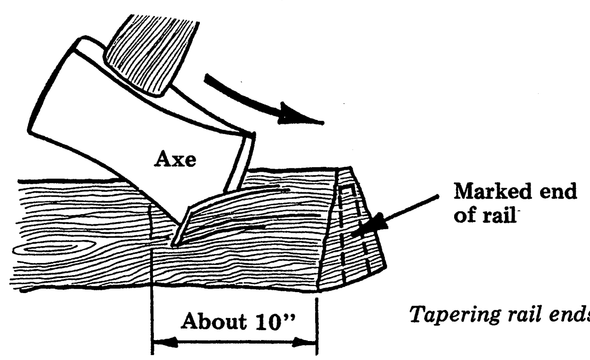


Drilling and smoothing holes for rails.

Corner posts will have two holes drilled at 90° to each other at each rail position. On corner and end posts rail holes do not go all the way through the posts.

Tapering Rail Ends

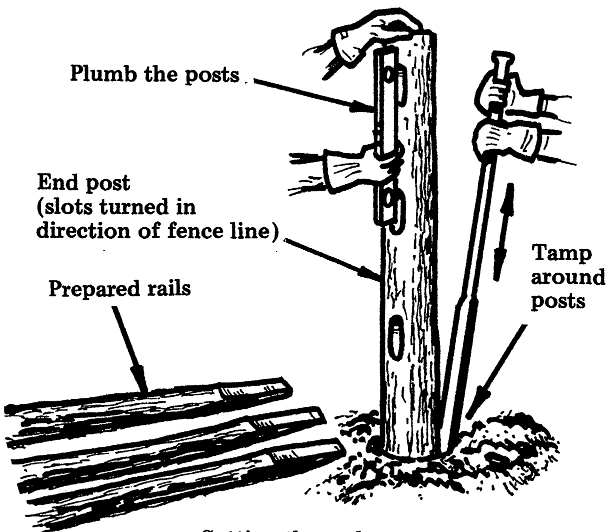
If one end of the rail is to be placed in a corner or end post, mark the end of the rail so it is the approximate size of the hole in the post. If the end of the rail is to be placed in a line post, mark the end of the rail so it is approximately one-half the size of the hole in the post.



Tapering rail ends.

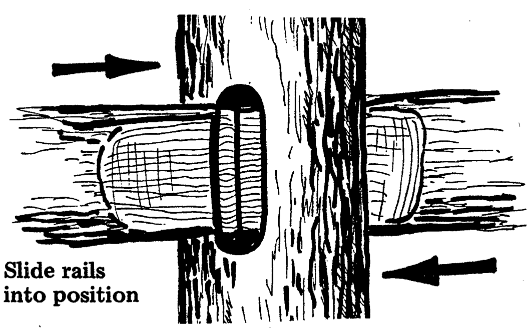
Setting the Posts and Rails

Dig a 2½ foot deep hole for a 7-foot end post. Set the end post with the rail holes in the direction of the fence line. Be sure the post is straight while back filling and tamping.



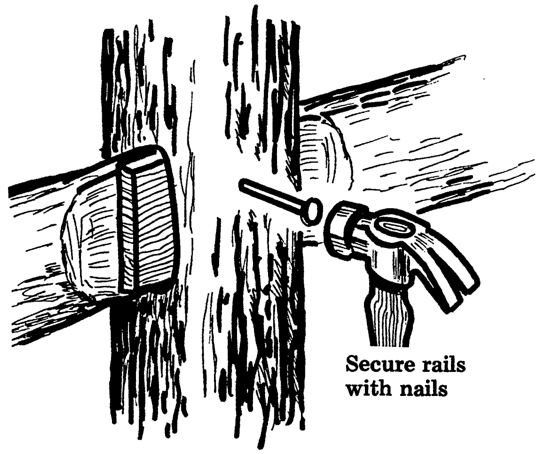
Setting the end post.

Once the end post is set, place the correct end of the rails in the holes. Use the rails to be sure the location of the next hole is correct.

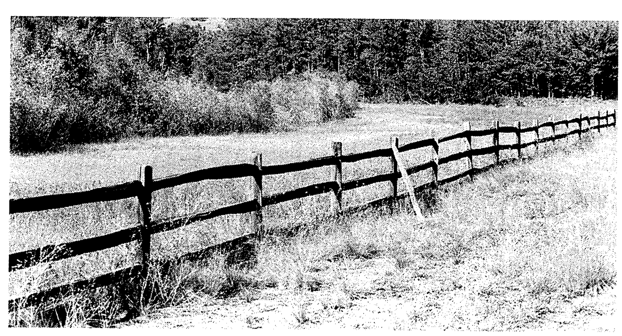


Installing the rails.

Dig the next post hole and place the post in the hole. Insert the rails into the holes and position the post in the hole so that the rail is in the correct position. Continually plumb the post as it is being back filled and tamped. Continue this procedure until the fence is completed. Rails may be secured with nails.



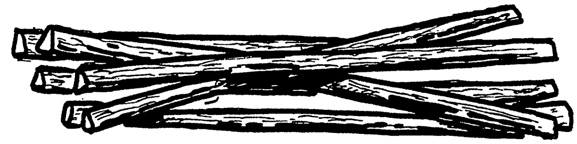
Securing the rails.



Typical post and rail fences.

Worm Fences

Worm fences are expensive to build. They are usually built around camping areas or building sites where an esthetically pleasing fence is needed to keep animals out. There are several worm fence designs.

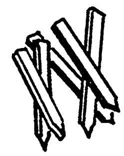


RAILS

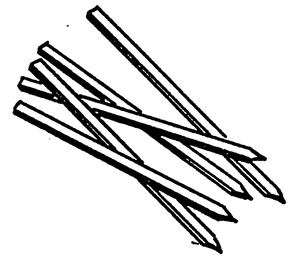
Split Rail

Materials:

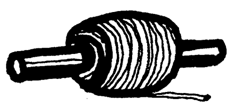
AXE



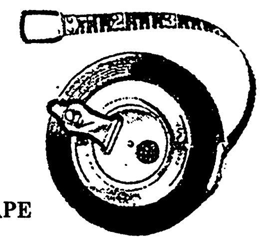
2 FOOT STAKES



5 FOOT STAKES



STRING



TAPE

CHALK

If the fence is to be placed on a property boundary line, be sure it is surveyed before beginning construction.

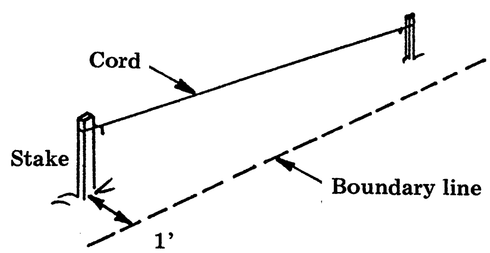
Establish a line 1 foot in from the surveyed property line and stretch a cord between the beginning and end stakes. To establish the width of the fence, determine the average length of the rails, then subtract 2 feet. This is the "effective length" of the rails and provides the overhang when the rails are stacked.

Divide the effective length by two. This will give the minimum width for stacking rails without support. See following example:

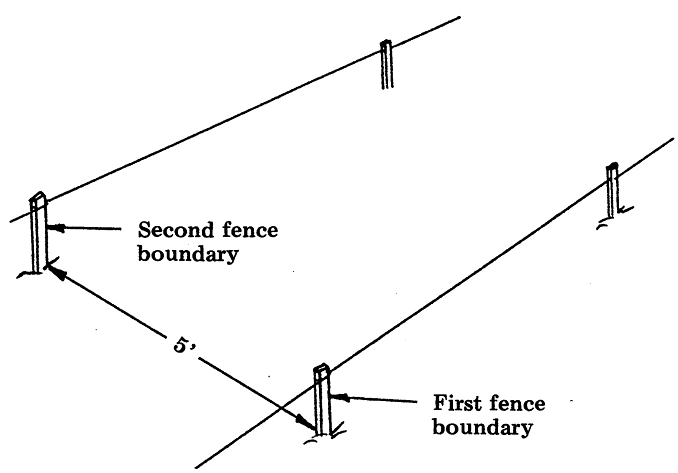
(12 ft − 2 ft)/2 = 5 ft.

The stacking width can be extended to two-thirds of the effective length of the rails. However, if the stacking width is made narrower than this, it will need buried posts to support it.

Now that the stacking width is determined, drive stakes and string a cord to mark this line also.



Establishing a boundary line.

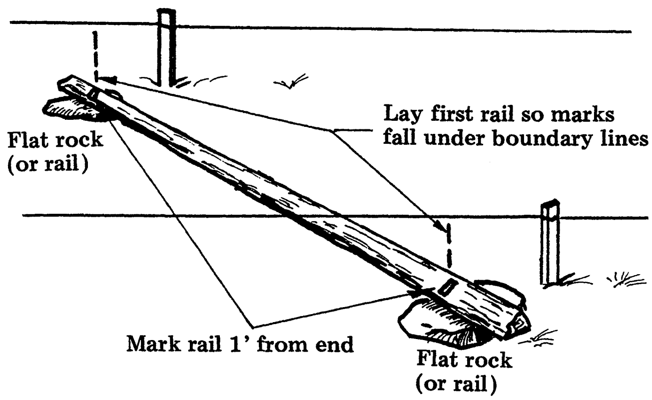


Establishing minimum width for stacking rails.

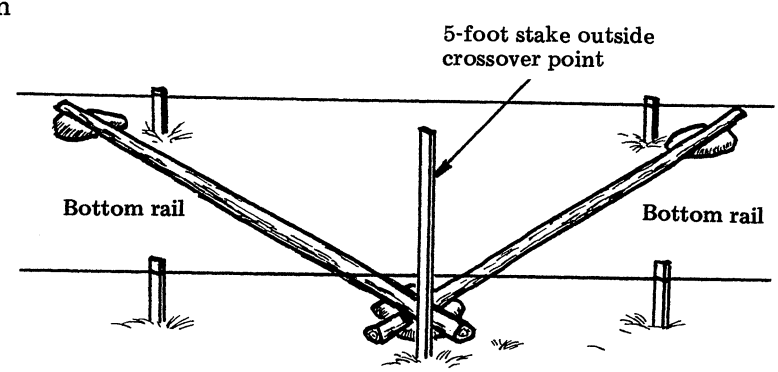
Before stacking the rails, mark 1 foot in from the end of each rail. Place these marks in line with the two cords. To prevent rot, place the bottom rail on flat rocks or short pieces of rail. Place the second rail on top of the first. Be sure the marks line up with the cords.

Continue laying down the bottom and second rails for the entire fence line. The bottom rails rest on rocks or short pieces of rail and the second rails rest on the bottom rails.

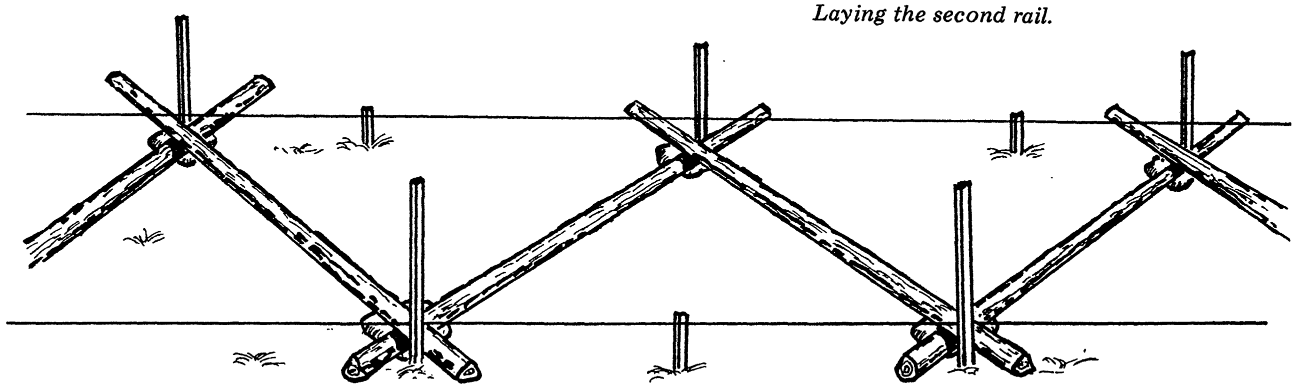
Drive 5-foot stakes at the outside point where the rails cross over. Plumb these stakes; they are used as guides for stacking the other rails. The 1-foot end marks on the rails should match the cross over points already established.



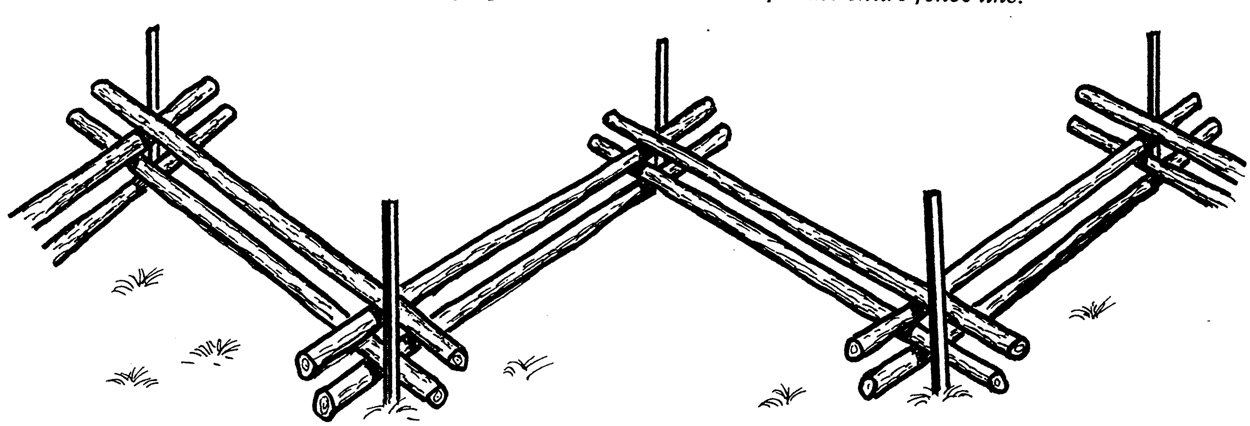
Laying the bottom rail.



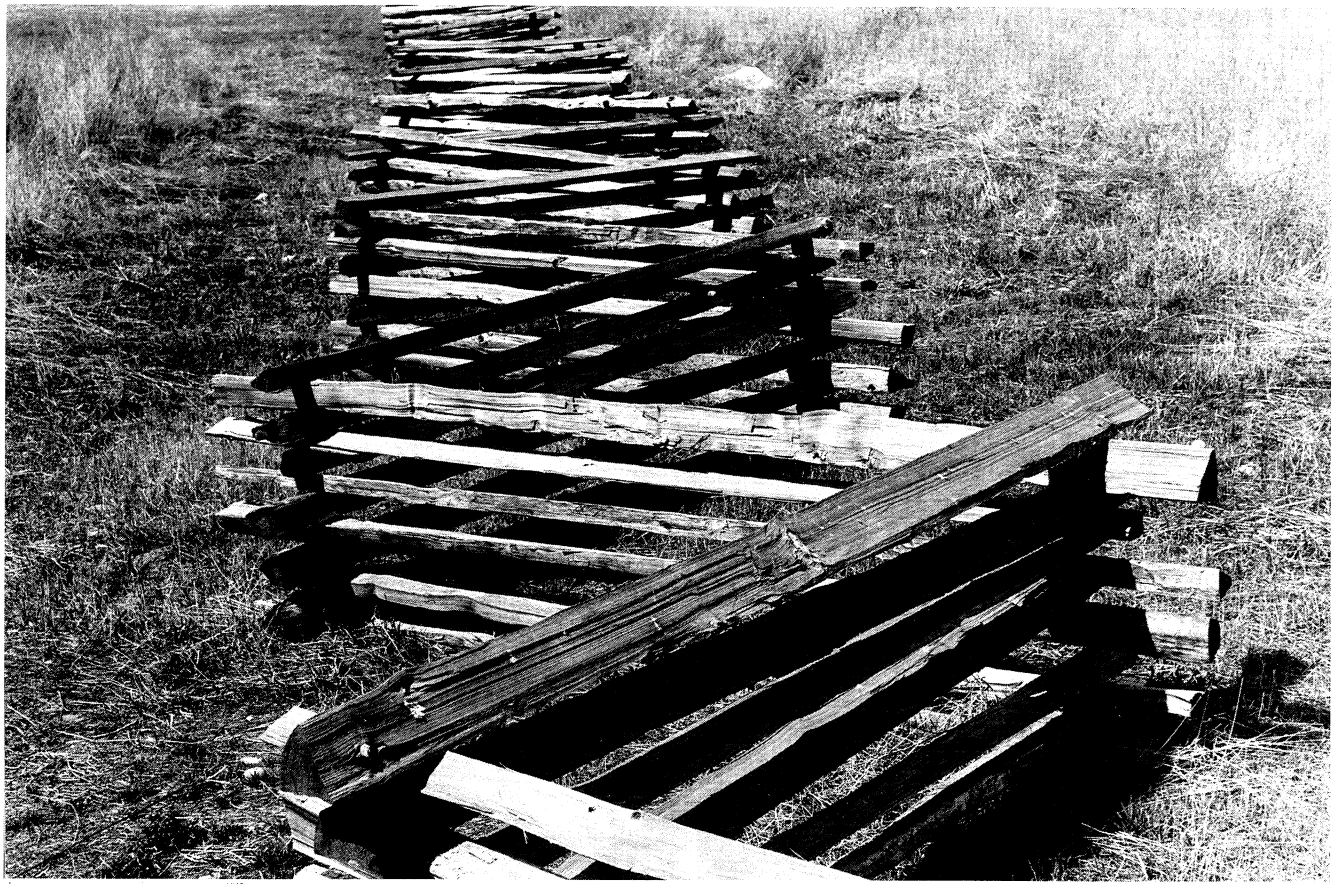
Laying the second rail.



Continue laying bottom and second rails for the entire fence line.



Stacking other rails (use 5-foot stakes for guides).

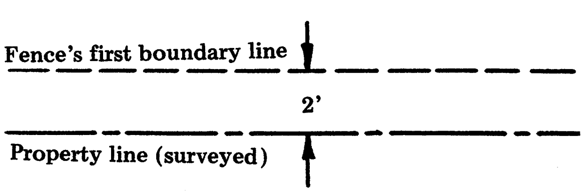


Worm (rail) fence.

Log Worm Fences

There are several log worm fence designs. These designs are affected by post size and fence width. A log worm fence can be constructed without supporting posts. In this case, the fence width is quite wide and the size of the logs is 10 inches in diameter or better.

If the fence is to be established on a property line, be sure it is surveyed before beginning construction. Once the property line is established, mark the boundary line with a cord stretched between the starting and ending points, 2 feet in from the property line.



Establishing property line and fence line.

To establish the width of the fence, a second fence boundary line needs to be established. This is done using the following method:

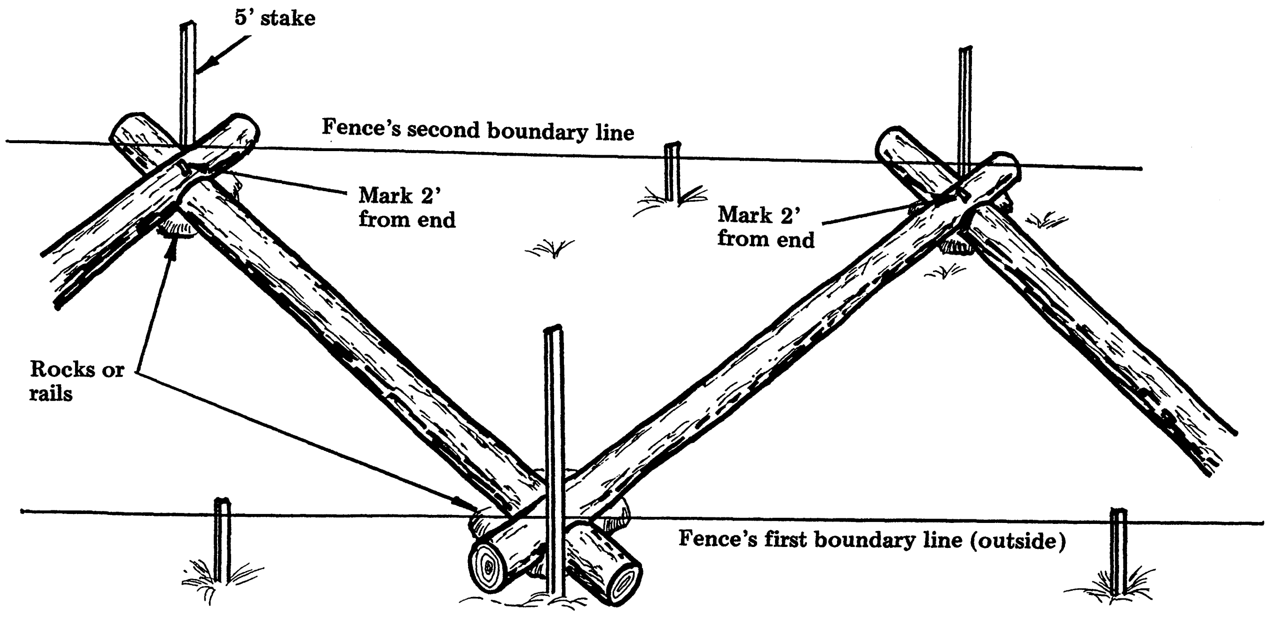
1. Determine the length of the logs to be used in the fence (usually 16 feet or 18 feet long).

2. Subtract 4 feet from the length of a log.

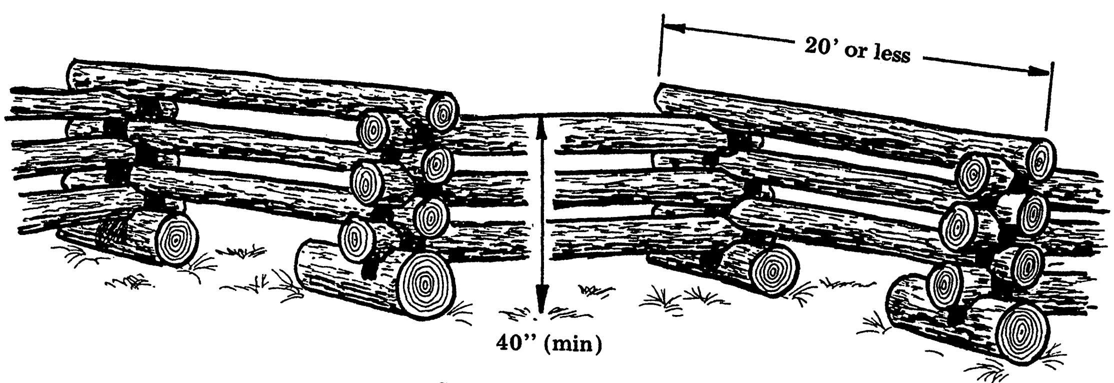
3. Multiply this number by 1/2 or 2/3.

4. Use this number to establish the second fence boundary line by measuring this distance from the first fence boundary line.

Once the two lines have been established, flat rocks or short sections of treated logs should be used to hold the bottom logs off the ground. The logs should be marked 2 feet in from the ends. These marks are then placed in line with the first and second fence boundary lines. The logs are then laid as in the split rail worm fence.



Laying a log worm fence.



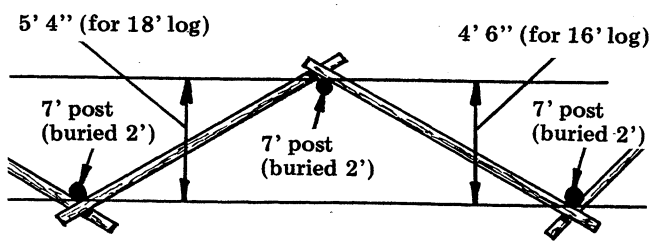
Completed log worm fence.

Another design of a log worm fence uses an 8 inch or larger diameter post 7 feet long and buried 2 feet at the inside of the log cross over point. Because this design uses buried posts, the fence width can be narrower and more of the log's length will be used along the fence line. As with the other worm fences, establish the first fence boundary line 2 feet inside the surveyed property line, if the fence is on a property line. The second fence boundary line for a 16-foot log is 4 feet 6 inches inside the first fence boundary line and for an 18-foot log it is 5 feet 4 inches inside the first fence boundary. The logs have a 2-foot overhang on both ends.

With the first and second fence boundary lines established and the length of the logs known, establish the cross over points and dig a 2-foot deep hole for the 8 inch or larger diameter posts at the inside of the cross over points.

Once the holes are dug and the posts set, the logs can be laid against them. The bottom logs should be resting on flat rocks or pressure-treated sections of logs to help prevent rot. Because of the reduced angle between the log spans, the logs need to be tied to the posts with No. 9 wire.

This fence will remain standing long after the set posts rot at the ground level.

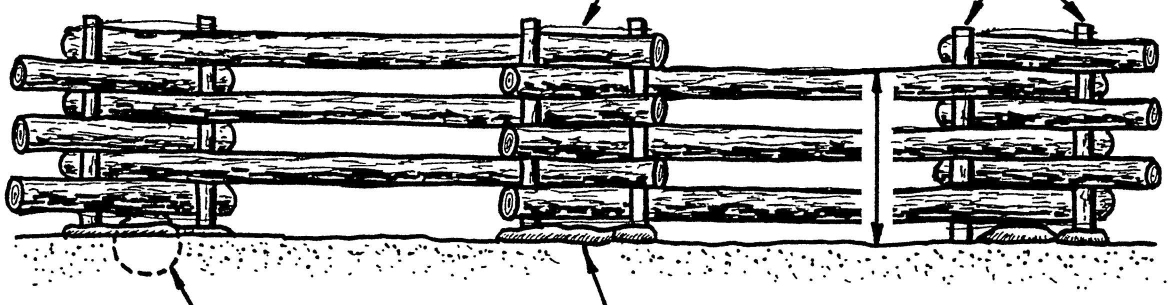


Modified log worm fence (using buried upright posts).

The last log worm fence design is similar to the design with the buried post. The width of the fence is determined in the same way. The bottom logs rest on flat rocks or short sections of logs 16 inches in diameter and 4 feet long. The logs are bound together by 6-inch posts that rest on rocks, if possible, and are tied together at the top and bottom with No. 9 gauge wire or two wraps of No. 12½ gauge wire. The tie posts may be eliminated where large, heavy logs are used or where the fence width is increased as indicated in the previous design.

Logs smaller than 8 inches in diameter may be used if larger diameter logs are not available. The number of logs used to achieve the fence height of 54 inches or higher in the lowest span depends on the size of the logs used. Place the large end of the logs toward the lowest part of a hill.

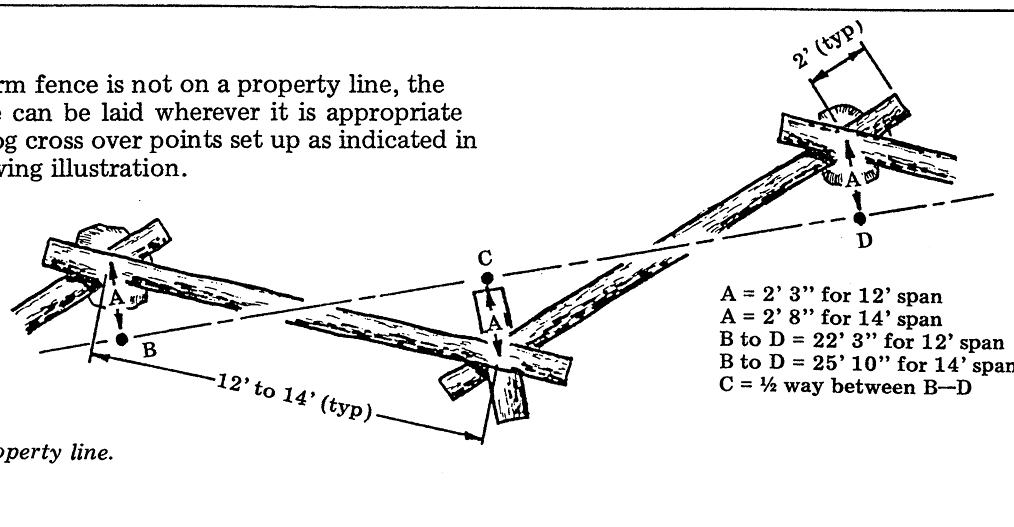
Log worm fence.



Notes:
The large end of logs should be on the lower part of the slope
Cut a shallow notch on the underside of the logs to make them more stable
Fence logs should be 8" in diameter (minimum) at the small end

A modified log worm fence.

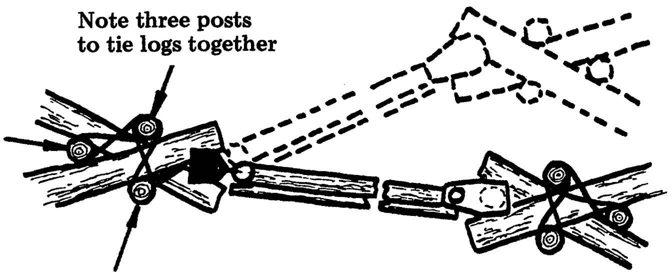
If the worm fence is not on a property line, the fence line can be laid wherever it is appropriate and the log cross over points set up as indicated in the following illustration.



Fence not on a property line.

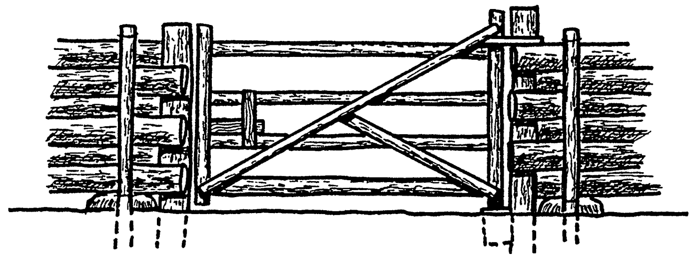
A log gate used with worm fences is shown below. It is expensive compared to other gate designs. Notice the short log segments used to build up the fence at the gate ends. Also, notice the three posts used to tie the logs together.

The position of the gate depends on the alignment of the fence.



A worm fence log gate.

Once the worm fence is ended as indicated above, any type of gate may be set between the gate ends.



Log worm fence gate.

Log worm fence gate.

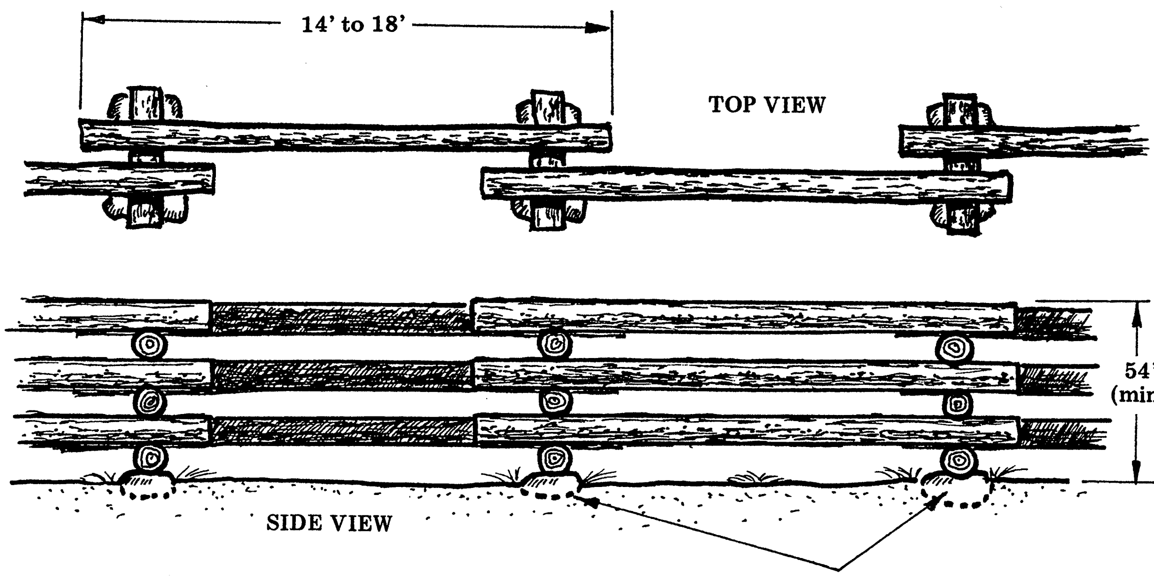
Log And Block Fences

This fence is similar to the worm fence. It is expensive to build, but once built it is virtually maintenance free. The minimum height of the fence should be 54 inches. The number of logs and blocks used will depend on their size.

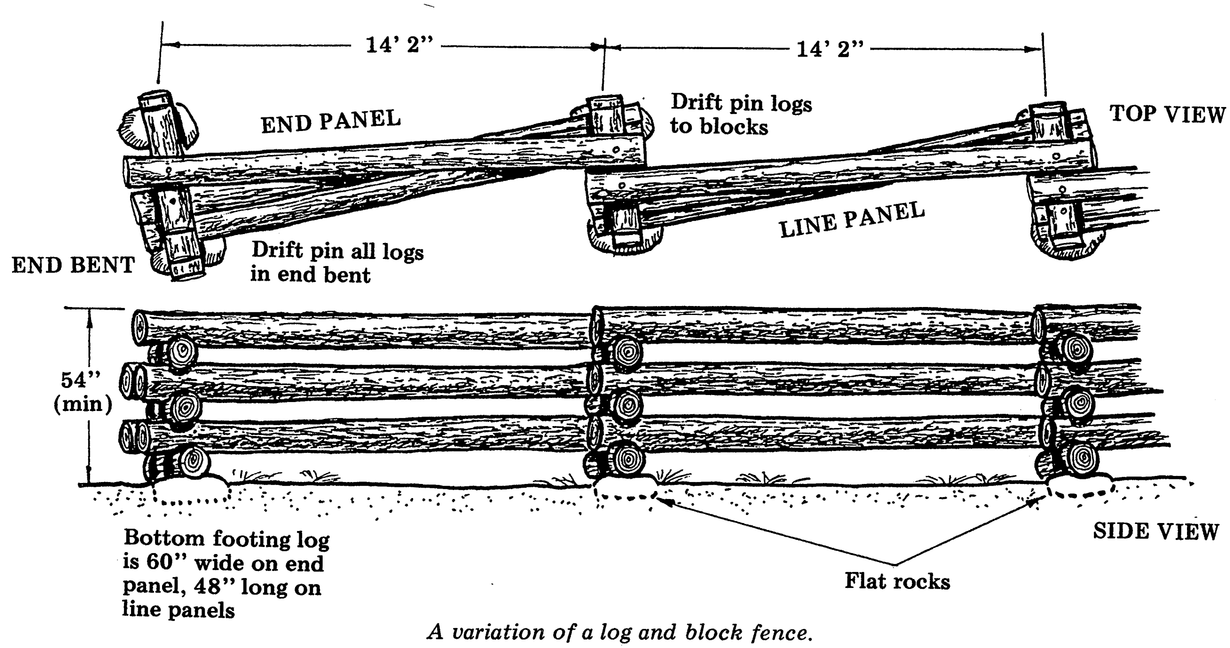
Plans for building log and block fences are illustrated:

As illustrated, the bottom cross logs may have to be notched to set on the rocks used. The top logs may be wired to the cross blocks or the lower logs or, holes can be drilled through the logs and blocks and rebar driven through them to keep them from moving.

As with the worm fence, once the log and block fence is ended, any type of gate can be built between the fence ends.



A log and block fence.



A variation of a log and block fence.

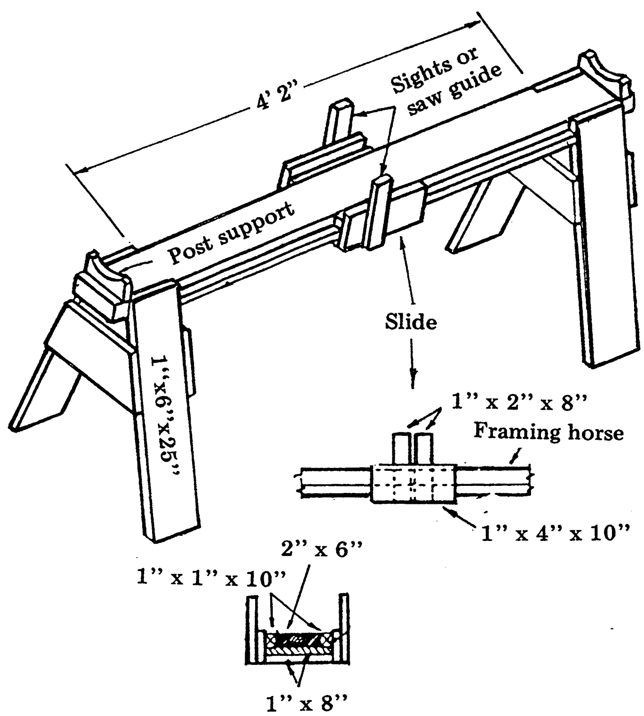
A log and block fence using small-diameter logs.

Buck And Pole Fence

Buck fences are sometimes called jack leg fences.

The first step in building a buck and pole fence is to gather the materials. Ideal buck sticks are between 5 inches and 12 inches in diameter. Eight-inch diameter are most common. Poles or rails vary in length from 10 to 20 feet and in diameter from 4 to 6 inches. Seasoned or green poles may be used, but green poles are heavy to handle. Thin poles tend to split when nailed and bend or break under snow pressure. A 60d common nail is preferred; 40d common nails can be used for the extra small pole ends.

The next step is to cut the mortice joint into the buck sticks. Generally two angles are suggested — 60° for standard bucks and 80° for bucks in severe wind areas. The following drawings illustrate how to make this mortice joint:



Framing horse for jack leg of buck mortice joints.

Both legs are cut the same.

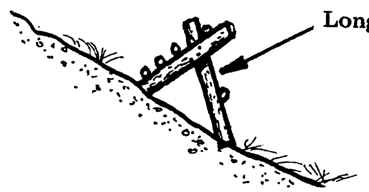
The notch width of a post is determined by the diameter of the post it is to match. This fit should be snug. The notch should be made one-third to one-half way through the post.

The pattern board is a guide to gauge notch width.

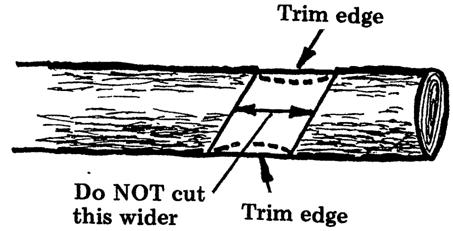
To fit the mortice joint together, place the high point of the cut on each leg together.

For steep hill sides a longer leg is needed for the low side of the hill.

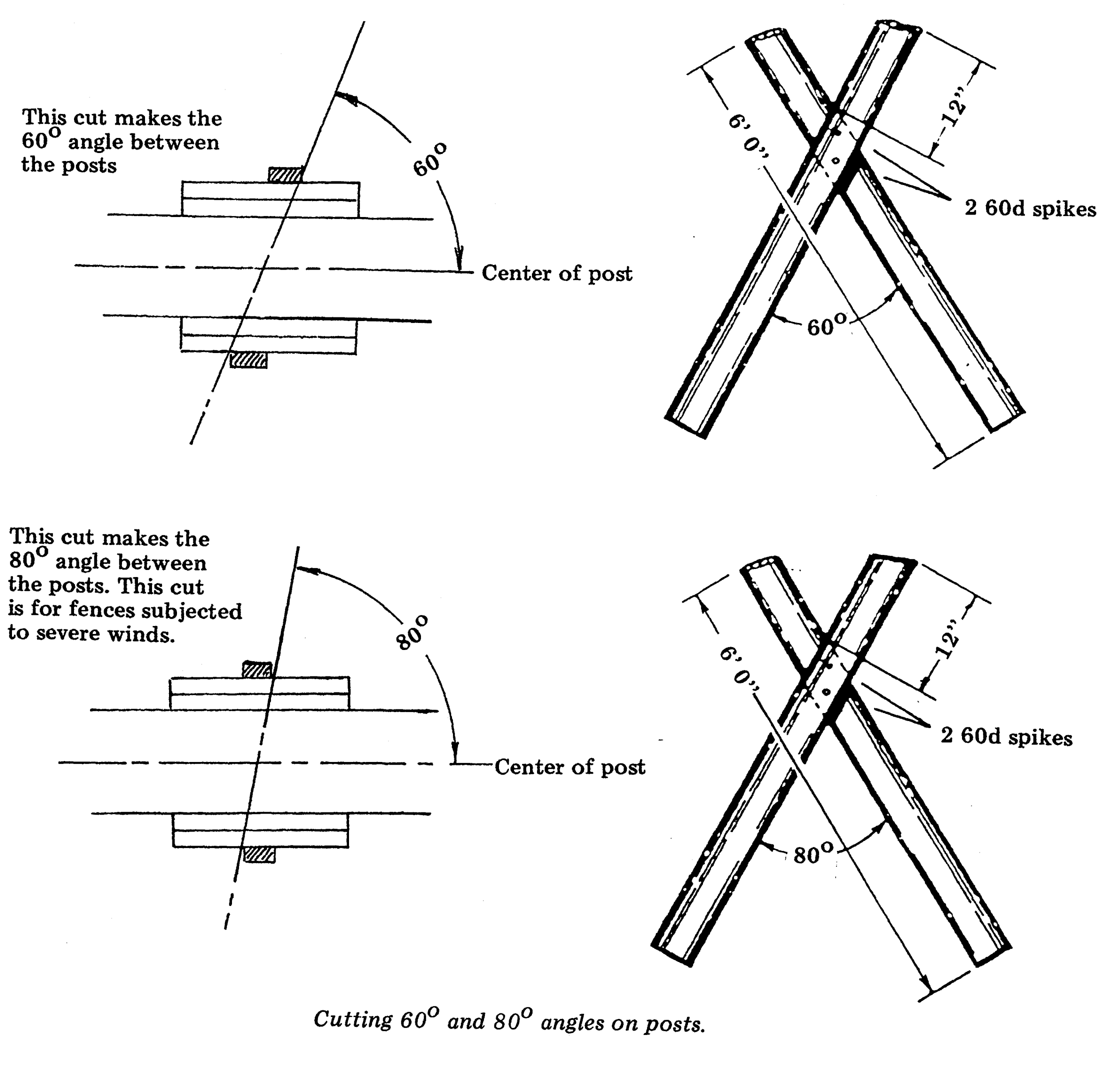
Once the materials are laid out, the bucks must be fitted and nailed if this was not done as they were being made. If the buck sticks do not fit together, trim the outside edges of the mortice joint rather than cut the joint wider.



On steep hill sides, a longer leg is needed on low side.

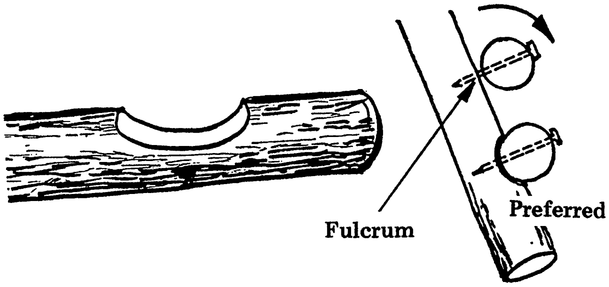


Widening tight post notch width.



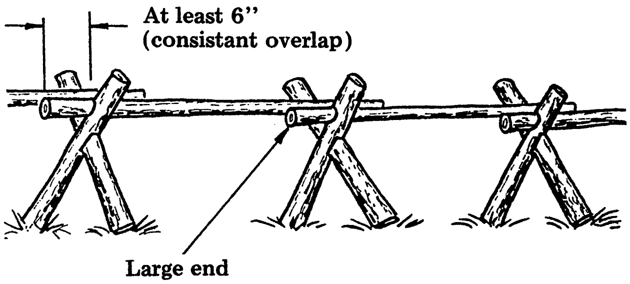
Cutting 60° and 80° angles on posts.

Next, hew out a shallow notch on the poles where they will contact the buck. The small end of a pole need not be notched. The notch helps the fence in two ways: First, by helping to stop rotation or twisting of the bucks; and second, by helping keep the weight of snow, people, or animals from rolling the poles downward and actually levering the nail out of the buck.



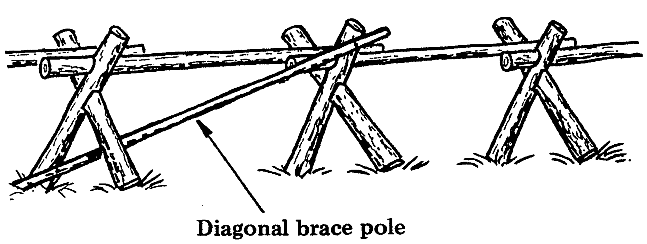
Notching poles to make a stronger fence.

Next, raise the bucks, position the top pole in the upper "V" of the buck, and nail it into position. The poles should have a consistant overlap of at least 6 inches. Be sure the large ends of the poles are all in the same direction.



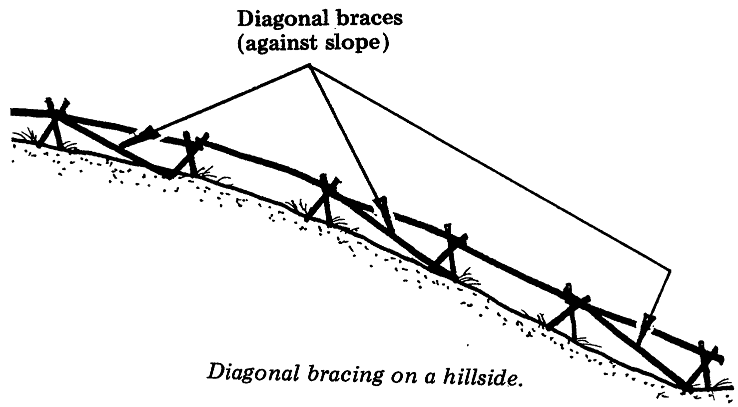
Positioning top pole.

Once the fence is standing, brace poles need to be added for rigidity. A single diagonal pole, an inside double pole, or an outside double pole brace may provide needed bracing. Opposed diagonal braces add extra rigidity.



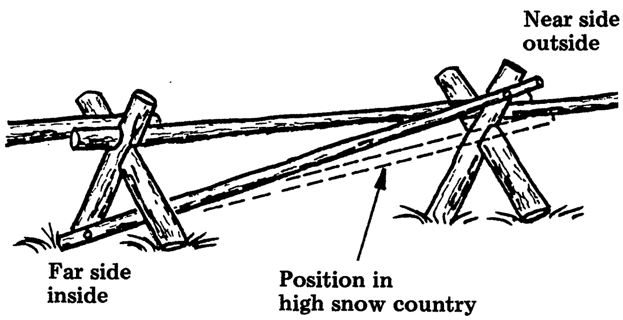
Adding diagonal brace poles for rigidity.

When facing a slope, brace against it, then return to opposed braces when on the level.



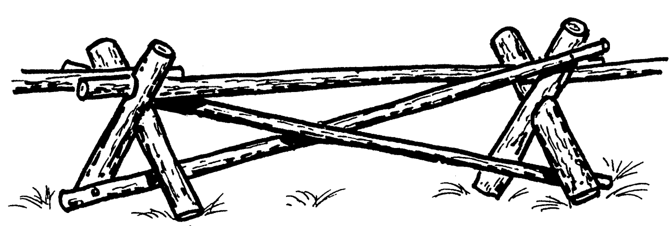
Diagonal bracing on a hillside.

The following illustration shows how the diagonal brace should be attached to the bucks.



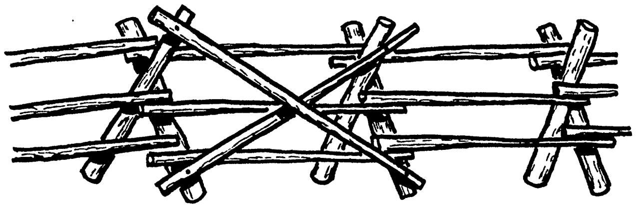
Method of attaching diagonal brace to the bucks.

A double pole inside "X" brace may be used instead of two opposing diagonal braces.

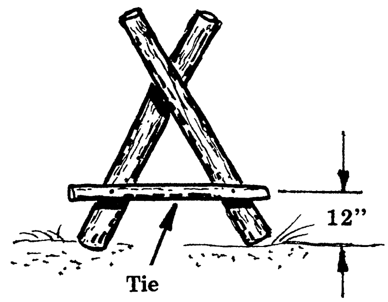


A double pole inside "X" brace.

A double pole outside "X" brace may be added after the poles have been attached to the bucks.



After fence has been completed, a double pole "X" brace may be attached for reinforcement.



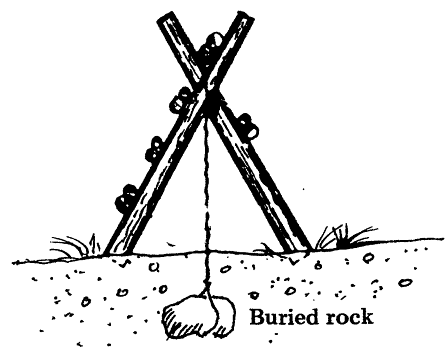
Using a reinforcing tie to prevent legs from spreading.

Once the inside diagonal or double pole "X" braces are attached in the appropriate locations, attach the poles to the bucks. On level terrain plan a brace for every tenth pole length. The number and height of the poles will vary according to the animal pressure expected. The standard pole pattern is shown; however, one to six poles to one side of a buck have been used. One to two poles are used on the opposite side.

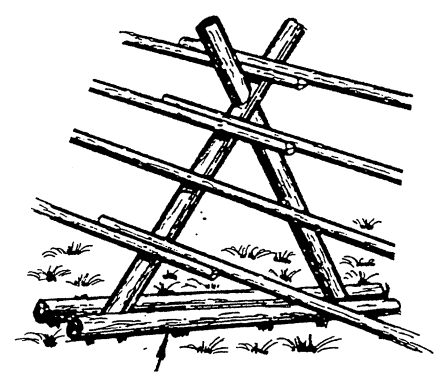
If more than four poles are placed on one side of the buck, a tie may have to be added to keep the weight of the poles from causing the legs to spread out. The tie is usually around 3 inches in diameter and placed 1 foot above ground level.

In high wind areas, every tenth buck should be anchored.

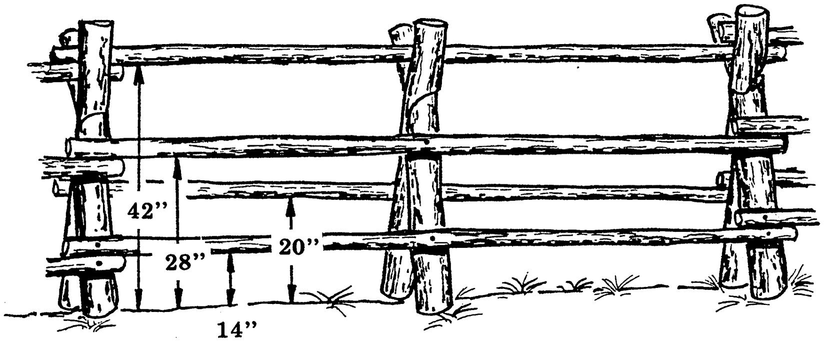
In swampy areas, mud sills should be added to the bottom of the bucks to prevent them from sinking into the soft soil.



In high winds, every tenth buck should be anchored.



Using mud sills in swampy areas.



Standard pole configuration. However, many variations are used.

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