

## Constructing High-tensile Wire Fences

*Susan W. Gay, Extension Engineer, Biological Systems Engineering, Virginia Tech*

*Richard D. Heidel, Extension Agent (Retired), Animal Science, Augusta County*

High-tensile wire fence is an effective barrier for controlling and protecting livestock. Some advantages of this type of fence include ease of handling, minimal maintenance, and high strength. High-tensile wire fence can be easily electrified and will outlast most other fences.

Building a high-tensile wire fence that will provide years of service requires proper construction techniques. Unfortunately, many farmers consider fence building a low priority. The result is a poorly built fence that is a waste of time and money. Every fencing job presents slightly different problems. However, the application of a few basic principles of fence construction can result in well-built fence. This publication discusses the basic components of high-tensile wire fence construction.

### Fencing Laws

Landowners should have a solid understanding of the body of law on the legal rights and responsibilities of using fencing to manage stock. This knowledge can help prevent costly legal disputes between neighbors. Virginia Code § 55-299, which defines a lawful fence, appears at the end of this publication. Keep in mind that high-tensile wire fencing was not available when the code was written.

### Clearing Fence Lines

Establish fence boundaries on a map or aerial photograph of your farm prior to clearing the fence line. Maps and aerial photographs are available from your local Farm Service Agency. Make sure of the exact location of property lines if the fence is to be located near them. Building a fence on neighboring property can be a costly mistake. More information on planning fencing systems and establishing fence boundaries is available in *Plan-*

*ning Fencing Systems for Controlled Grazing*, Virginia Cooperative Extension publication 442-130.

Locate underground utilities prior to clearing the fence line. This can be done by calling Miss Utility of Virginia at (800) 552-7001. Miss Utility is a free service that notifies participating utilities of upcoming excavation work. This service allows utilities to locate and mark their underground facilities in advance to prevent possible damage to underground utility lines, injury, property damage, and service outages. The "Miss Utility Law" (Virginia Underground Utility Damage Prevention Act) requires that Miss Utility be called at least **48 business hours** in advance of the planned work to allow time for marking utilities.

Once the utilities have been located, remove brush, loose rocks, trees, and tall grass from the fence line. Fence construction time is considerably reduced when the fence line is well cleared ahead of time. Fence appearance is also improved. Do not leave trees to use in place of fence posts. Fence strength is compromised when trees become diseased and rot or are damaged by lightning. Use a bulldozer or a tractor and a disk harrow to smooth and level the fence line once obstructions have been removed. If the fence is to be located on a property line, discuss the cost of clearing and handling debris with neighbors.

### Laying Out Fence Lines

Stake out the fence line before setting posts to ensure a straight or uniformly curved fence. This procedure is an easy two-person job.

### Level Ground

On level ground, install an end post at each end of the fence run. Stretch a string or a single strand of wire between the two posts to establish the fence line.

*Reviewed by Bobby Grisso, Extension specialist, Biological Systems Engineering*

## Rolling Ground

On rolling ground, where hills are too high to sight from one end post to the next, surveying equipment can be used to establish the location of intermediate points on the line. Alternatively, intermediate sighting stakes can be driven at the tops of hills. Two of these stakes should be driven about 8 to 10 feet apart at the approximate position where the line will cross the crest of the hill (Figure 1a). If both stakes appear to be lined up when sighted from each end post, they represent a true midpoint of the line. If not, the stakes can be moved back and forth until they are properly aligned (Figure 1b). Stretch a string or a single strand of wire between the two stakes to establish the fence line.

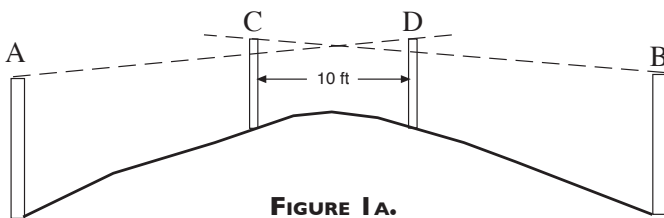


FIGURE 1A.

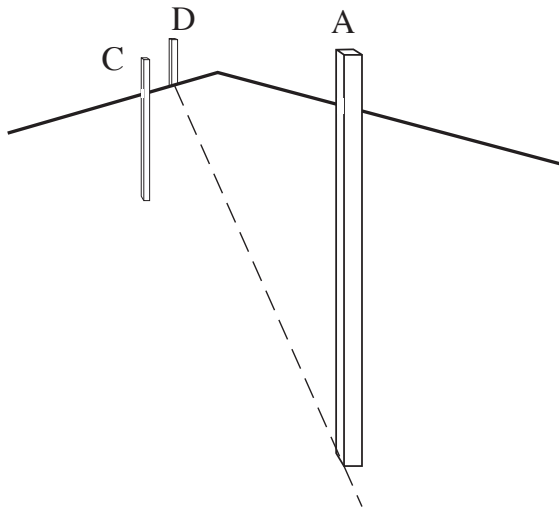
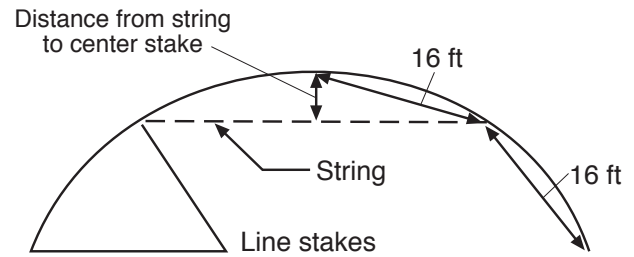


FIGURE 1B.

**FIGURE 1.** Aligning the fence line on rolling ground: (a) place two stakes about 10 feet apart on the top of the hill so both are visible from either end stake and align the two center stakes (C and D) from one of the end stakes; and (b) check alignment of center stakes from other end stake.

## Contours

When the fence must go around a curve, set stakes every 16 feet around the smooth curve. If following a terrace ridge, place stakes below the ridge so the terrace can be maintained. Select any three adjacent stakes and stretch a string between the first and third stake (Figure 2). Measure the distance from the center stake to the string and reset stakes to the spacing given in Table 1.



**FIGURE 2.** Fence post spacing around curves.

Line posts will eventually be placed where these stakes are set. Check by sight to see that no single stake is out of line from a smooth curve. Repeat these steps wherever there is much curvature along the proposed fence line.

**Table 1.** Post spacing for contour fences.

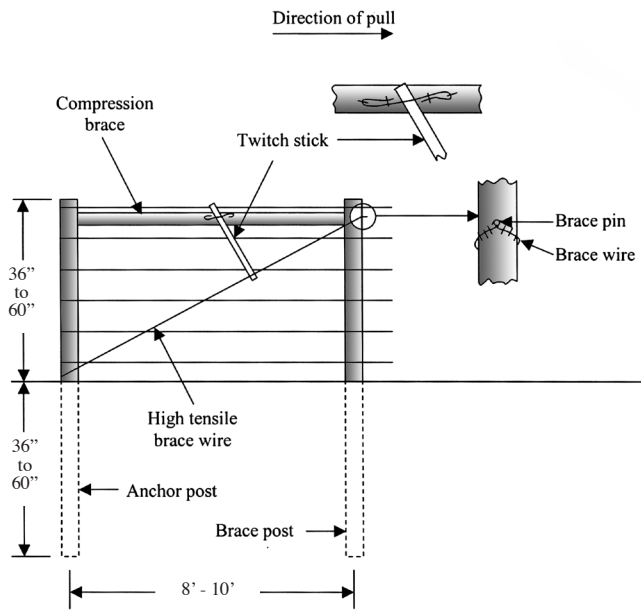
Distance from Center Stake to String (in)	Post Spacing (ft)
4 or less	16
4 – 5	15
5 – 6	14
6 – 8	12
8 – 14	10
14 – 20	8

## Fence Construction

### Brace Assemblies

Brace assemblies are the most important structures in the entire fence. Properly tensioned fence wires put a tremendous pull on these assemblies, so they must be strong enough to withstand the force of the pull. Installation of brace assemblies frequently requires up to half the total fence construction time. However, properly constructed assemblies are the foundation of a strong fence that will provide years of service.

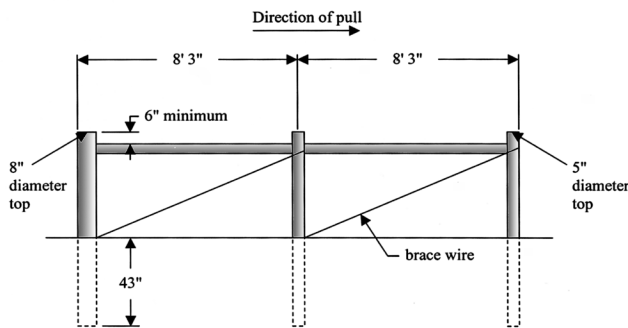
The H-brace assembly is the widely used brace assembly due to its strength and relative ease of construction (Figure 3). A double span H-brace assembly is more than twice as strong as a single span and is used at specific locations along the fence line (Figure 4). Steel brace assemblies can also be used, although both posts and braces must be set in concrete anchors. Steel posts and braces require 20-inch square concrete blocks that extend 3-1/2 and 2 feet into the ground, respectively.



**FIGURE 3.** H-brace in a corner brace assembly.

### Types of Brace Assemblies

The type of brace assembly to be constructed depends upon the direction of pull on the assembly. Corner construction is used when pull on an assembly is from two or more different directions. End-brace assemblies are used when fence pull is from only one direction. Gate and line-braced post assemblies are similar to corner and end-brace assemblies, but are used under special circumstances.



**FIGURE 4.** Double-brace assembly used for fence lengths greater than 200 feet.

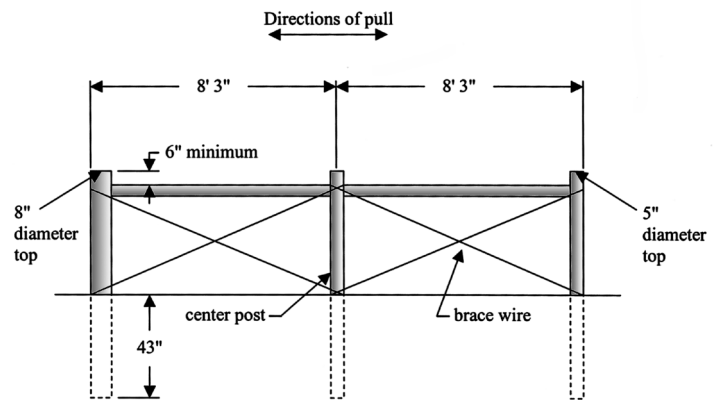
### Placement of Brace Assemblies

Determine the location of brace assemblies prior to erecting them. Be sure to allow space for gates. Gates should be wide enough for harvesting combines, hay balers, and other machinery. To determine gate width, measure the widest piece of equipment, in transport position, to be moved through the gate and add 25 percent.

Place gates at corners or fence intersections. Livestock tend to follow the fence line when herded and will eas-

ily walk through a corner gate. Placing gates at corners or fence intersections also limits the number of brace assemblies that will be needed.

A corner post will need a brace assembly for each fence line leading to it. A double span H-brace assembly should be used when the fence span exceeds 200 feet. Fences that span more than 650 feet require line-braced post assemblies every 650 feet. A line-braced post assembly is built to resist fence pull from either direction. These assemblies are similar to double span H-brace assemblies except that two brace wires are used per span (Figure 5). Also, the fence is ended and the line wires wrapped around the center post of each line-braced post assembly to take fence tension from either direction. Figure 6 illustrates proper locations for various brace assemblies.



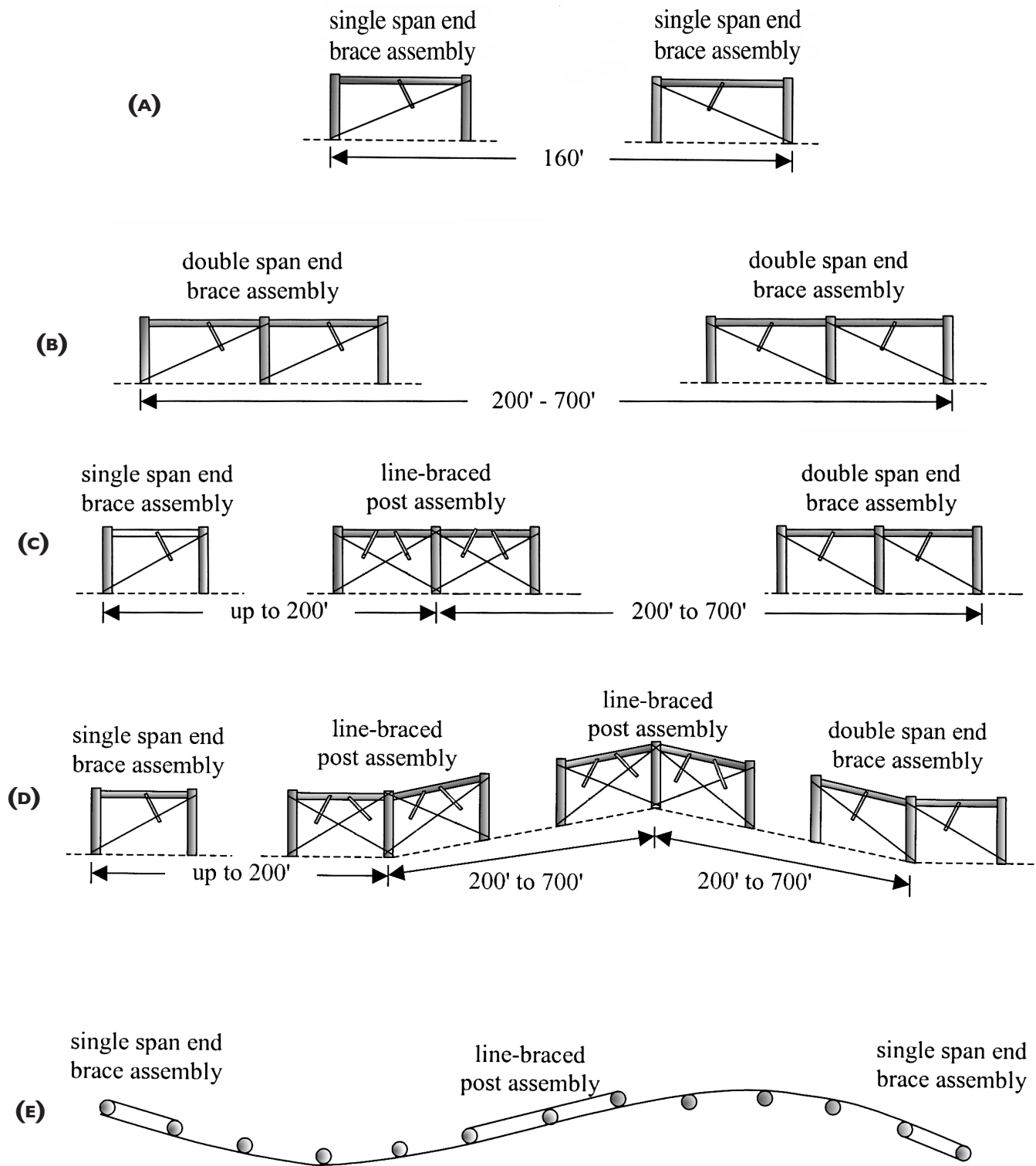
**FIGURE 5.** Line-braced post assembly used for fence lengths greater than 650 feet. The assembly has a brace wire in each direction since there may be an unbalanced pull from either direction.

### Anchor Posts

An anchor post is the post to which all fence wires are securely attached. The four types of anchor posts are the corner, end, gate, and the center post of a line-braced assembly. Fence wires should never pass an anchor post without being cut and tied around the post. Each anchor post also requires a brace assembly for each fence line leading to it.

### Sizes of Anchor Posts

Minimum sizes for wood posts used in brace assemblies are presented in Table 2. Wood posts should be made of treated wood or from a species such as osage orange or black locust, which have a lifespan of 20 to 25 years. If steel is used, angle iron should be a minimum of 2-1/2 inches x 2-1/2 inches x 1/4 inch in size and tubing should have a 2-1/2-inch minimum inside diameter.



**FIGURE 6.** Types of brace assemblies: (a) single-span end brace assemblies for fence lengths of 160 feet or less; (b) double-span end brace assemblies for fence lengths of 200 to 700 feet; (c) braced line-post assemblies to divide fence lengths for fences more than 700 feet long; (d) braced line-post assemblies at the foot and top of each hill; and (e) single-span end brace assemblies and double-span end brace assemblies for contour fences more than 350 feet long and 200 feet long, respectively.

**TABLE 2.** Minimum size for wood posts used in brace assemblies.

Post Position	Top Diameter (Top Width if Square) (in)
Corner post	6 – 8
End post	5 – 6
Gate post	5 – 8
Line post	5
First corner post brace	5
Other brace posts	4

### Anchor Post Settings

Anchor posts can be tamped into place or driven in the ground with a manual or tractor-powered post driver. However, a driven post is 1.7 times as strong as a tamped post. Wood posts larger than 4 inches in diameter should be sharpened to a dull point if a post driver is used. Large unsharpened posts will not set in the ground as firmly as sharpened posts since soil compacts more tightly around the sharpened end. An auger-drilled pilot hole about 3 to 4 inches smaller in diameter than the post can also improve post setting. Mark the digging tool or post to the desired depth for uniform post depth. Wood posts can be packed with either soil or concrete. In either case, place two or three shovels full of gravel in the bottom of each hole before the post is placed into position.

Anchor posts should be driven at a slight angle away from the direction of pull so they will be straight when the fence wire is tensioned. Set anchor posts at least 3-1/2 feet deep and line posts at least 2 feet deep. Use deeper settings for sand or wet soil conditions. Wood posts should be driven with the small end down to minimize damage to the post during the driving process. Studded-steel T posts need to be driven only until the anchor plate is beneath the surface. If posts are to be tamped, place them in the center of the hole to provide the tightest possible soil-pack around the post.

### H-Braces

The H- or compression brace bears the force from the fence's pull on the brace assembly. This brace is extremely important to the strength of both the assembly and the fence. An H-brace usually consists of a standard wood post that is pressure treated or made of durable wood (e.g. osage orange or black locust), fairly straight, and free of splits or imperfections that may cause it to break under pressure.

An anchor post is less likely to pull out of the ground as brace member length increases. The recommended minimum size for wood H-braces is 4 inches. Steel pipe should have a 2-inch minimum inside diameter and steel tubing should be at least 2 inches square if used for H-braces. Do not use tubing or pipe that is badly scaled or rusted. Angle iron used for H-braces should be a minimum of 2-1/2 inches by 2-1/2 inches by 1/2 inch. All H-braces must be 8 feet long.

Brace pins are used to hold a wood H-brace in place between the anchor post and the next brace post. To install the H-brace, mark a hole for the brace pin at 8 to 12 inches from the top of the anchor post. Drill a 3/8-inch diameter hole 2 inches deep into the anchor post and insert a 4-inch long brace pin of the same diameter. Drill a 3/8-inch diameter hole 2 inches deep into the end of the H-brace.

The next step in the installation of the H-brace is to drill a hole through the brace post for a 10-inch long, 3/8-inch diameter brace pin. Install the H-brace onto the stub of the 4-inch brace pin. Drive the 10-inch brace pin into the other end of the H-brace until a 2-inch stub remains.

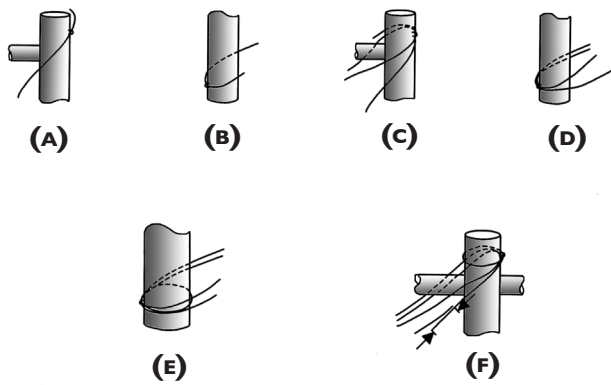
### Brace Wire

Brace wire provides the brace assembly with rigidity. Twisting brace wire removes slack and puts pressure on the H-brace. The brace then pushes against the anchor post, which prevents the post from being pulled over when the fence is stretched. Nine-gauge, smooth, galvanized wire is commonly used for brace wire. Do not use barbed wire; it is difficult to work with and has half the lifespan of regular brace wire.

To install the brace wire, drive a staple at the bottom of the anchor post to prevent the bottom wire from shifting up the post. Wrap the brace wire around the brace pin stub on the brace post and diagonally to the staple at the bottom of the anchor post. Repeat this procedure and make sure that the wire is wrapped tightly (Figure 7). Insert a twitch stick 2 inches between the diagonal brace wires and twist eight to ten times. Secure the twitch stick to the H-brace with a piece 20-in long, high-tensile wire. Use caution when twisting a twitch stick; serious injury may occur if you lose your grip on a tightly twisted stick.

### Line Posts

Recommended post spacings for high-tensile wire fences are 24 to 48 feet. Use the minimum recommended spacing for steel posts or wooden posts with top diameters less than 3-1/2 inches. Line posts can be driven with either a manual

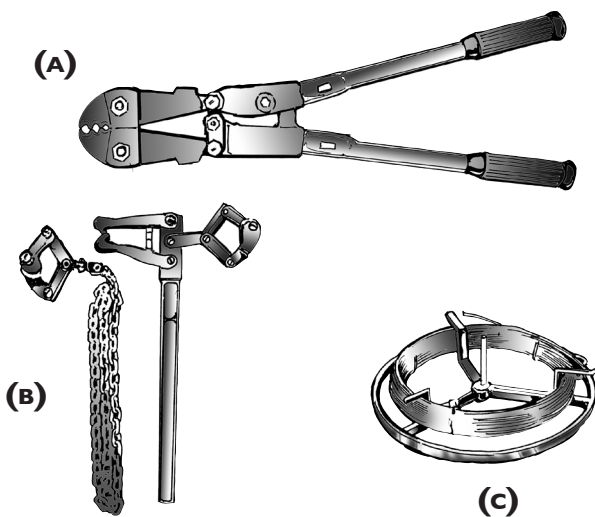


**FIGURE 7.** Correct procedure for threading the 9-gauge smooth wire used as the diagonal in the brace assembly: (a) thread end of brace wire through staple on brace post; (b) thread end of brace wire through staple on anchor post; (c) and (d) repeat to form three wire strands; (e) remove slack from wire, wrap wire around anchor post, and return toward brace post; and (f) cut brace wire from roll allowing enough wire to wrap around brace post and extend 6 to 12 inches past other wire end.

or tractor-powered post driver. Use a power driven auger if more than a few hundred feet of fence is to be built. Set line posts to a minimum depth of 2-1/2 feet.

## Installing Wire on Fences

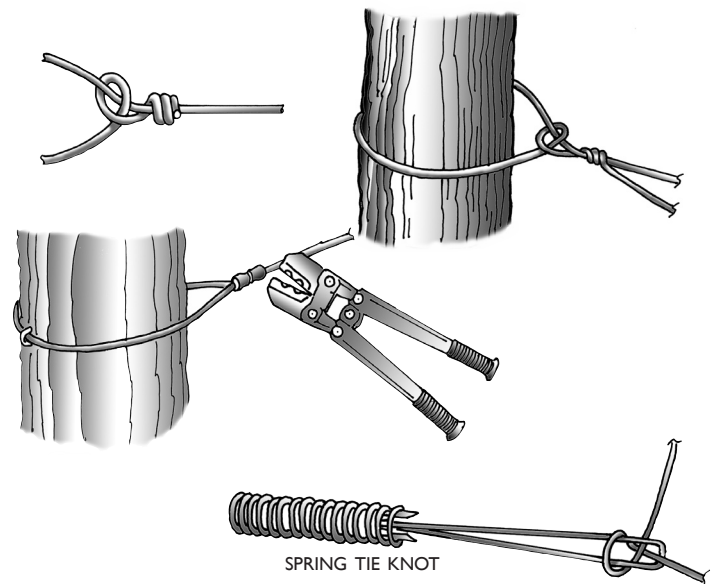
High-tensile wire fencing is no more difficult to erect than other kinds of fencing. However, special equipment, including crimping tools, wire pullers, and wire wheels (spinning jennies or payout spinners), is needed for efficient fence construction (Figure 8). The decision to electrify the fence should be made before stringing the first wire. An electric fence will require some extra components that are not used with non-electrified fences.



**FIGURE 8.** Some fence tools used in high-tensile wire fence construction: (a) crimping tool; (b) smooth-wire puller; and (c) spinning jenny

## Stringing High-tensile Wire

High-tensile wire is packaged in various size coils. Wire can be run from the coil one wire at a time using a spinning jenny or several wires at a time using a multiple-wire fencer. Install the bottom wire (guide wire) first by securing the wire to the anchor post with crimping sleeves or knots and running the wire out to the next anchor post. If the wire is to be electrified, thread an insulator for each post on the starting end and push them along as the wire is being strung. Once the guide wire is strung, use a batten as a template and mark the spacing for the remaining fence wires on each post with a carpenter's pencil. Repeat the same wire installation procedure used for the guide wire for the next highest wire until all wires are strung. In-line strainers and ten-



**FIGURE 9.** Common wire connections used for high-tensile fence.

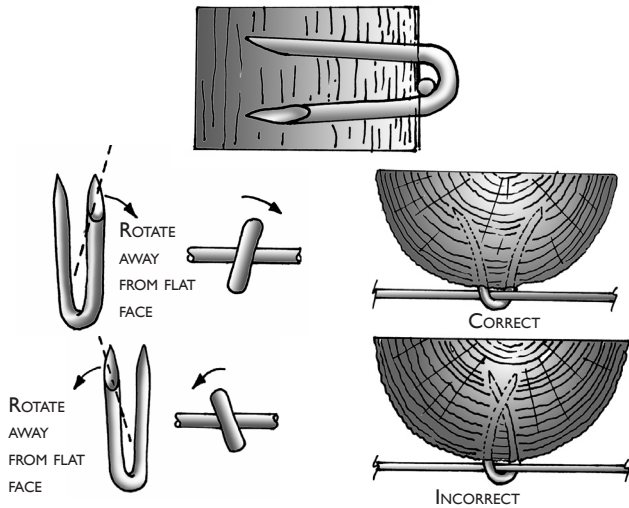
sion springs will be installed later. Figure 9 shows some common knots used to tie off wire.

## Attaching High-tensile Wire

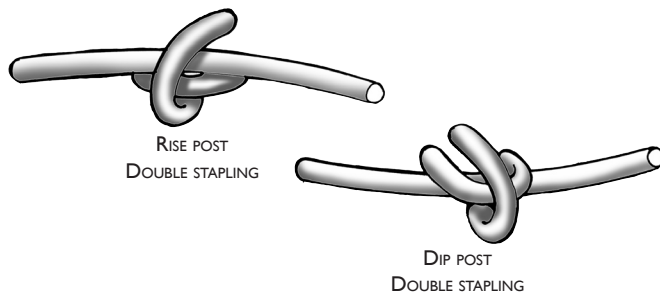
On straight fence runs, attach the wire on the side of the post nearest the livestock. Attach the wire to the opposite side of the line posts where the fence curves. Use galvanized staples to attach wire to wood posts and wire clips to attach wire to steel posts.

Fence staples should be 1-3/4 to 2 inches long. Drive staples so they straddle the wood grain. Slightly rotate staples away from the flat surface of the point while driving them into the posts. This spreads the staple legs and minimizes staple withdrawal. Drive staples at an upward angle into posts set in dips and at a downward angle

into posts set on rises (Figure 10). For more strength and less friction use the double stapling method shown in Figure 11. Do not drive staples in too deeply. Wires must be able to slide through the staples during tension adjustment. Reducing friction between the wire and the



**FIGURE 10.** Proper techniques for stapling high-tensile wire to fence posts.



**FIGURE 11.** Double stapling method used to decrease friction between wire and fence post.

post is especially important when tensioning wires on the outside of a post in corners and curves.

## In-line Strainers and Tension Springs

In-line strainers and tension springs are used to adjust fence-wire tension. To calculate the number of in-line strainers needed for a fence, add 500 feet for each corner, dip, rise, or curve in the fence to the total linear feet of fence. Divide this number by 4,000 and round the answer up to the nearest whole number (e.g., 1.3 = 2). Multiply this number by the number of fence wires.

**Example 1.** Calculate the number of in-line strainers needed for a 5-strand, high-tensile wire fence. Total fence length will be 1,420 feet. There are three corners, two rises, and one major curve in the fence line.

**Step 1:** Determine the additional footage needed for corners, dips, rises, and curves:

$$500 \text{ ft/corner} \times 3 \text{ corners} = 1,500 \text{ ft}$$

$$500 \text{ ft/rise} \times 2 \text{ rises} = 1,000 \text{ ft}$$

$$500 \text{ ft/curve} \times 1 \text{ curve} = 500 \text{ ft}$$

**Step 2:** Add the additional footage to the total linear feet of fence:

$$1,420 \text{ ft} + 1,500 \text{ ft} + 1,000 \text{ ft} + 500 \text{ ft} = 4,420 \text{ ft}$$

**Step 3:** Divide by 4,000:

$$4,420 \div 4,000 = 1.2$$

**Step 4:** Round up to the nearest whole number:

$$1.2 = 2$$

**Step 5:** Multiply by the number of wires on your fence:

$$2 \text{ in-line strainers/wire} \times 5 \text{ wires} = 10 \text{ in-line strainers}$$

Two sets of in-line strainers are needed for the fence in Example 1. Therefore, two tension springs are required.

Tension springs and in-line strainers can be located anywhere along a 600-foot fence run. If the fence exceeds 600 feet, place in-line strainers and tension springs at the friction center. This is at the center point between the anchor posts on long straight runs. The friction center will be in the curved section rather than in the straight section on long runs with a straight section on one end and a curved section at the other end.

## Tensioning High-tensile Wire

Always wear heavy gloves and eye protection when tensioning wire. Start from the top wire to the bottom wire to provide clearance for turning the in-line strainer handle. Attach a grab wire puller about 4 feet from the middle post and pull the slack out of the wire. Wire pullers with serrated jaws are not recommended as they can damage the galvanized coating and permanently score and weaken the wire. Apply the recommended tension up to each wire with the in-line strainer.

Use a tension indicator spring on one wire, preferably the top, to obtain the proper wire tension. Tighten all other wires by feel to match the tension on the wire with the tension spring. The fence will “set” after a day or two and the tension in each wire should be checked and corrected.

## Fence Maintenance

A properly maintained fence will provide trouble-free service for many years. Regular fence maintenance programs should include the following:

- Repair or replace brace assemblies when signs of weakness show.
- Refasten loose wires to posts and splice broken wires when necessary.
- Keep the fence wires properly tensioned. This will be needed once or twice per year for high-tensile fences.
- Keep weeds and brush cleared from the fence line.
- Plan and follow a regular inspection routine for any needed maintenance.
- Plan for the event of a fence failure including who to contact in case confined animals escape. Having such a plan may reduce your liability if damage by escaped animals should occur.

## Acknowledgements:

The authors would like to express their appreciation for the review and comments made by Lori S. Marsh, Associate Professor and Extension Engineer, and Robert “Bobby” Grisso, Professor and Extension Engineer, both of the Department of Biological Systems Engineering, Virginia Tech; Scott Baker, Extension Agent, animal science, Bedford County; Scott Reiter, Extension Agent, crop and soil science, Campbell County; and Eric Eberly, Extension Agent, farm business management, Appomattox County.

## For Additional Information on:

### Code of Virginia

Virginia General Assembly Website at <http://legis.state.va.us/Laws/CodeofVa.htm>

### Fence Construction

NRAES-11 “High-tensile Wire Fencing” (\$4.00)

To order MWPS or NRAES publications, contact your local Virginia Cooperative Extension office.

### Fence Materials

*Fencing Material for Livestock Systems*, Virginia Cooperative Extension publication 442-131

### Planning Fences

*Planning Fencing Systems for Controlled Grazing*, Virginia Cooperative Extension publication 442-130

## Publication Modified from:

Turner, J.H. 1997. *Planning Fences*. American Association for Vocational Instructional Materials (AAVIM): Winterville, Ga.

Turner, J.H. and G.W. Smith. 1974. *Building Fences*. American Association for Vocational Instructional Materials (AAVIM): Winterville, Ga.

Bushermohle, M.J., J.B. Wills, W.W. Gill, and C.D. Lane. 1996. *Planning & Building Fences on the Farm*. PB 1541, University of Tennessee Agricultural Extension Service, Knoxville, Tenn.

Worley, J.W. 2000. *Fences for the Farm*. Circular 774, The University of Georgia Cooperative Extension Service, Athens, Ga.

## Code of Virginia § 55-299. Definition of Lawful Fence

Every fence shall be deemed a lawful fence as to any stock named in § 55-306, which could not creep through the same, if

- (1) Five feet high, including, if the fence be on a mound, the mound to the bottom of the ditch,
- (2) Of barbed wire, forty-two inches high, consisting of eight strands of barbed wire, firmly fixed to posts substantially set in the ground at intervals of sixteen feet, with a substantial stay or brace halfway between such posts, to which such wires shall be also fixed, when such wires are placed as follows: The first wire 2 1/2” above the ground, the second 5 1/2”, the third nine inches, the fourth 13 1/2”, the fifth nineteen inches, the sixth 26 1/2”, the seventh 34 1/2”, and the eighth forty-two inches,
- (3) Of boards, four feet high, consisting of five boards not less than five inches wide and firmly attached to posts placed at intervals of eight feet, or
- (4) Three feet high within the limits of any incorporated town whose charter does not prescribe, nor give to the council thereof power of prescribing, what shall constitute a lawful fence within such corporate limits.

A cattle guard reasonably sufficient to turn all kinds of livestock shall also be deemed a lawful fence as to any livestock mentioned in § 55-306.

Nothing contained in this section shall affect the right of any such town to regulate or forbid the running at large of cattle and other domestic animals within its corporate limits.

Any wire fence of any kind whatsoever, except as above described, and except in the case of incorporated towns as above provided, shall be forty-four inches high and of such construction that stock named in § 55-306 cannot creep through the same.

(Code 1950, § 8-869; 1977, c. 624.)