Installation and Operation Of Electric Fences, Cow Trainers and Crowd Gates

A SELF-HELP GUIDE FROM...

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Introduction

Electric fencers, cow trainers and crowd gates have been used on farms for many years to help manage animals. These devices are designed to produce an annoying or painful shock when the animal comes into contact with an energized object causing the animal to avoid the energized object. Electric fencing technology has progressed over the years and improved animal control in both grazing and confinement systems. Like any technology, however, if not installed properly or used incorrectly, problems can occur. One potential problem is when the fencer shock appears in locations where it is not intended. Field studies in Minnesota, Wisconsin and Australia have shown that improperly installed fencer systems, are a common cause of short duration or transient stray voltages on dairy farms.

This publication provides a review of basic electrical and wiring concepts and their application to electric fencer systems along with guidelines to make sure your energizer is installed properly. Information is presented in a question and answer format and is designed to address common questions and problems encountered by users and installers of these devices.

Electrical Circuits & Energizers 4

1. How do energizers work?

An energizer converts 120-volt electrical power or power from a battery into high voltage, short duration electrical pulses. These electrical pulses typically range from 2000 to 10,000 volts with durations of 1/1000 to 3/10,000 of a second. These short duration pulses cause avoidance behavior but are not harmful to the animal.

There are two different electrical circuits involved in the operation of a typical energizer (Figure 1). The power circuit (60Hz) carries 120-volt electrical power from a service panel to the energizer. Most fencers are plugged into a receptacle. As with any electrical circuit, the electric current must flow in a loop. The current path for this power circuit is out through one 120-volt (hot) wire and back on the neutral wire. The primary function of the grounding system is to conduct fault current and quickly operate protective devices.

The second circuit is between the energizer and the fence. The low voltage power coming into the energizer is converted to very short duration electrical pulses. The energizer pulse flows out through the high voltage lead-out from the energizer to the fence only if an animal or something else touches the wire to complete the circuit back through the earth. Once the current is in the earth it flows to an earth return rod and earth return wire back to the energizer. The energizer circuit is the same for battery powered energizers, except a 120-volt power circuit is not used.

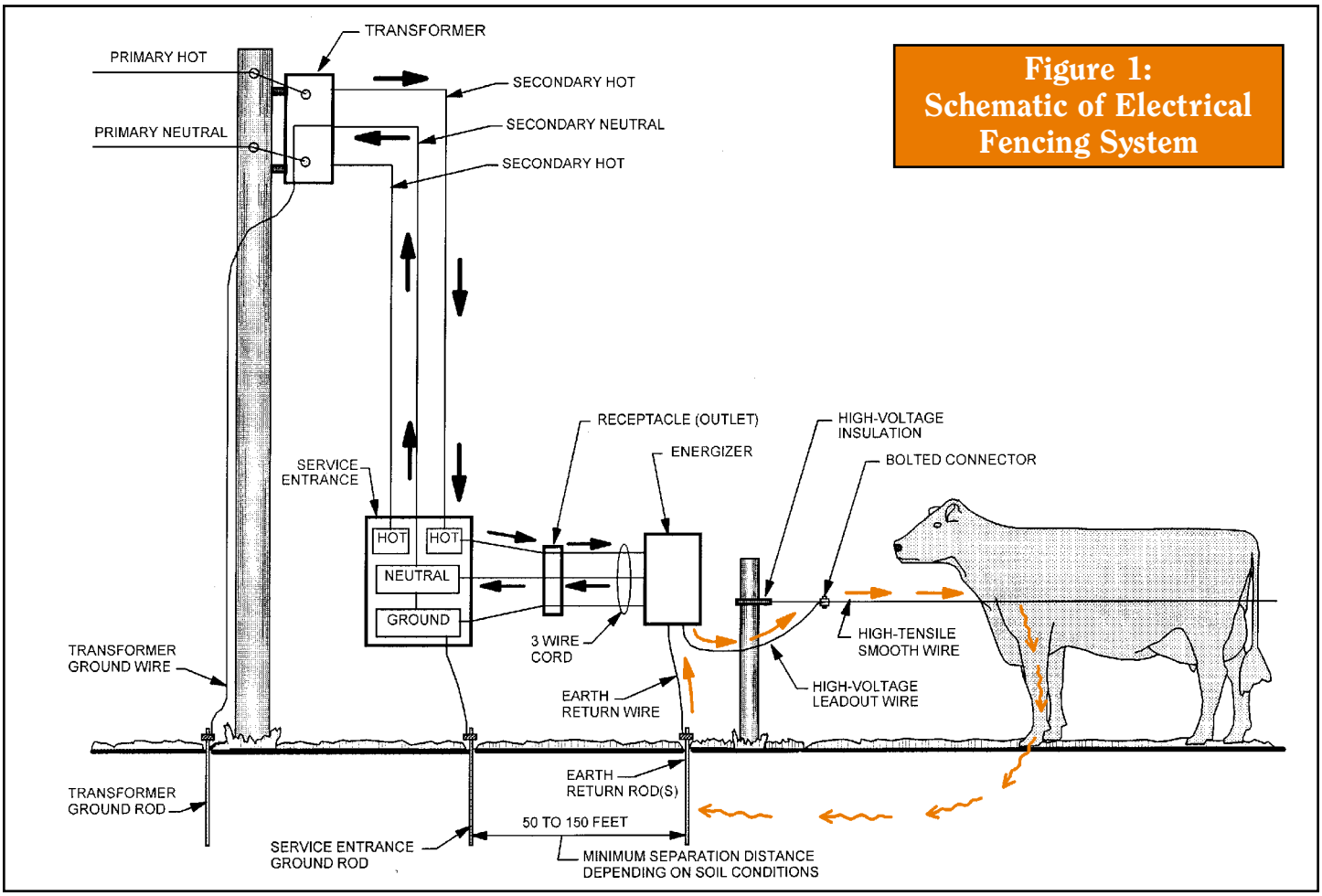


Figure 1: Schematic of Electrical Fencing System

2. What is the difference between an earth return rod and a ground rod?

An earth return rod is like an antenna that collects the high voltage energizer current from the earth and returns it to the energizer (Figure 1). They are active only when an animal or other conductive object completes the electrical circuit by touching the energized wire.

A ground rod (also shown in Figure 1) is meant to be part of a different circuit. The purpose of the grounding system is to protect people, animals and the farm wiring from failures in the electrical power system. The grounding system is designed to carry fault current to ground so that circuit breakers can trip or fuses blow and shut off power. Electrical faults are caused by shorts, or an unintended contact between a 120-volt (hot) wire and any conductive object.

It is important to separate fencer earth return rods from the farm grounding system so that fencer pulses will not appear in undesirable locations.

3. What is the most common reason for failure of an electric fence, cow trainer or crowd gate?

Improper earth return systems are the most common cause of energizer problems. Two common installation problems are undersized and improperly located earth return systems. Tips on correct installation will be covered later in this publication.

4. How can an earth return system cause stray voltage?

An inadequate earth return system can cause the energizer pulse that goes out on a fence to find other routes back to the energizer. If the earth return is connected to a metal building or pipes, they can become a significant part of the return path. Any conductive object, such as an electrically heated water trough can become part of the return path if the earth return system is not properly installed.

5. What is the most important thing to remember about the fencer earth return and farm grounding?

The two grounding circuits are doing two different things and should not cross paths. The energizer's earth return system needs to complete the fencer circuit and return short duration pulses, whereas the farm grounding system provides a low resistance path for fault current. The high voltage lead of the energizer and earth return circuit must never come in contact with the power delivery and grounding circuit. If these two circuits are connected, the energizer pulses may occur in undesired locations. Interconnection can occur either on the hot or return parts of the energizer circuit.

High voltage insulation must be used on the high voltage lead-out wire from the energizer to make sure that the energizer pulse does not leak onto conductive objects, such as

"The energizer's earth return system needs to complete the fencer circuit and return short duration pulses while the farm grounding system provides a low resistance path for fault current."

metal wall material and metal pipes. To prevent interconnection on the ground side of the circuit, make sure that there is plenty of separation between earth return rods and any grounded object. This includes the ground rods and any other object connected to them such as equipotinetial planes, grounded metal conduit, and grounded cases of electrical equipment. The recommended separation for earth return rods ranges from 50 to 150 feet depending on the soil conditions. If 50 feet is not possible for your fence, use the maximum available separation distance, especially for wet soil conditions.

Selecting an Energizer 6

Selecting an energizer is often confusing because different manufacturers may use different terminology or ratings for their devices. The following questions will help the buyer identify which energizer is best for their needs.

1. What is a low impedance energizer?

Low impedance energizers, often called "New Zealand" style energizers, emit high amperage and high voltage electrical charges in very short bursts. These high voltage, short duration pulses are less likely to short-out when objects such as grass or brush come into contact with the energized wire, thus allowing installation of a longer fence. Shorts through alternate paths such as grass will reduce the shock felt by the animals. A good earth return system is essential to make sure this electrical circuit functions properly.

2. How much power do I need for my electric fence?

The power of the energizer will depend on many factors, such as the area to be fenced, the number of wires energized, the type of animal being controlled, the use of higher resistance temporary fencing and the expected weed pressure. Provide a reputable energizer dealer with a description of your intended task, and it is likely that the recommended energizer will be sized correctly. Using a much more powerful energizer than required increases the likelihood that the pulses may be found at unacceptable levels or unintended paths.

3. How is power measured?

There are two common ways energizers are advertised. One way is according to the miles of fence the energizer can power. This is not a very accurate rating system because of the factors mentioned above. A 25 mile energizer will not necessarily power 25 miles of fence, but it will power more than a 15 mile energizer. Another common rating system is in joules, which is a measure of electrical energy delivered by the energizer. This is also only a relative comparison; not all 5-joule energizers are exactly alike. The impulses produced may vary in voltage level and duration.

4. What voltage should I use?

For most animals, the optimal voltage range is generally considered to be between 2000 and 6000 volts. An energizer that delivers 10,000 volts is not necessarily more effective than a 6000 volt model. Some energizers that deliver more 'energy' or joules are actually lower voltage. Most domestic animals respect any low impedance fencer that is over 2000 volts. The key to making any energizer work correctly is proper installation.

5. Should I use the same voltage for a fencer and cow trainer/crowd gate?

No. Higher voltages should only be used for electric fences. Voltages for cow trainers and crowd gates should stay below 2500 volts. Do not use energizers intended for fencing inside buildings. They deliver far too much power and increase the likelihood of problems.

6. Why are energizers for cow trainers and crowd gates easier to size than for a fencer?

The barn environment does not vary as much from farm-to-farm; thus, the range of criteria used in sizing the energizer is less.

"If you install the energizer outside, make certain it is rated for outdoor use, and try to keep it at least 10 feet from the building to help protect against lightning strikes."

7. Where should I install the energizer?

Although it is more convenient to place fence energizers in a building, it may in fact be safer to find a place outside. Not only will it eliminate the need to install wires through the walls of a building, it will be easier to segregate the electric currents on the fence from the farm's other electrical circuits. If you install the energizer outside, make certain it is rated for outdoor use, and try to keep it at least 10 feet from the building to help protect against lightning strikes. Adding a little protection from the weather will also increase an energizer's life.

8. What type of electrical receptacle should be used?

Energizers can be powered by batteries, solar, 120 volt or 240 volt AC power. If you are using a 120-volt AC unit plug it into a three-wire 120-volt receptacle wired in accordance with the National Electric Code. The National Electric code specifies separate neutral and grounding conductors from the point of use to the service entrance panel. A surge suppression receptacle or single plug surge suppressor is strongly recommended.

9. What about the UL rating?

Buying an energizer with a UL rating is a good idea; however, there are many units made outside of the United States that are not UL approved. These may be some very good energizers, but it is a "buyer beware" market. Standards used in Canada may be useful.

Connecting an Energizer to a Fence

1. How do I get electricity from the energizer to the fence?

The safest way to get electricity from an energizer to the fence is with lead-out wire that has high voltage insulation (Figure 2). Never use standard electrical wire. The insulation is not rated to handle the high voltage pulses produced by an energizer. Most common wire is designed to carry 120 or 240-volt power and the insulation is commonly rated for 600 volts. Energizer voltage is much higher than the 600-volt rating on most common wire.

If you are going to bury the wire, place it in non-corrosive, non-metallic electrical conduit to reduce the possibility of electrical leakage and to prevent physical damage. A wire size of 12-gauge or larger is recommended.

2. Do I need a cut-off switch?

A cut-off switch (Figure 2) that is easy to reach is a good idea but is not required. Most energizer manufacturers do not recommend continually unplugging a fence. The use of a cut-off switch that is easy to see from a distance (i.e., whether it is on or off) will save time in maintaining the fence.

3. What is the best way to connect a lead-out wire to a fence?

There are several different devices sold for connecting lead-out wires to fence wire. The most important consideration is to make sure the connection is good and will not corrode easily. A poor connection such as twisting the wires will reduce the effectiveness of the fence. It is a good idea to have a connection that can be removed for cleaning; or, to be able to change which wires on a fence are energized. Bolted connections perform well.

"A poor connection such as twisting the wires will reduce the effectiveness of the fence."

4. How many fence wires do I need?

The number of fence wires depends on the intended use of the fence. Figures 2 and 3 show two basic fence styles. Figure 2 shows a standard single wire fence that works

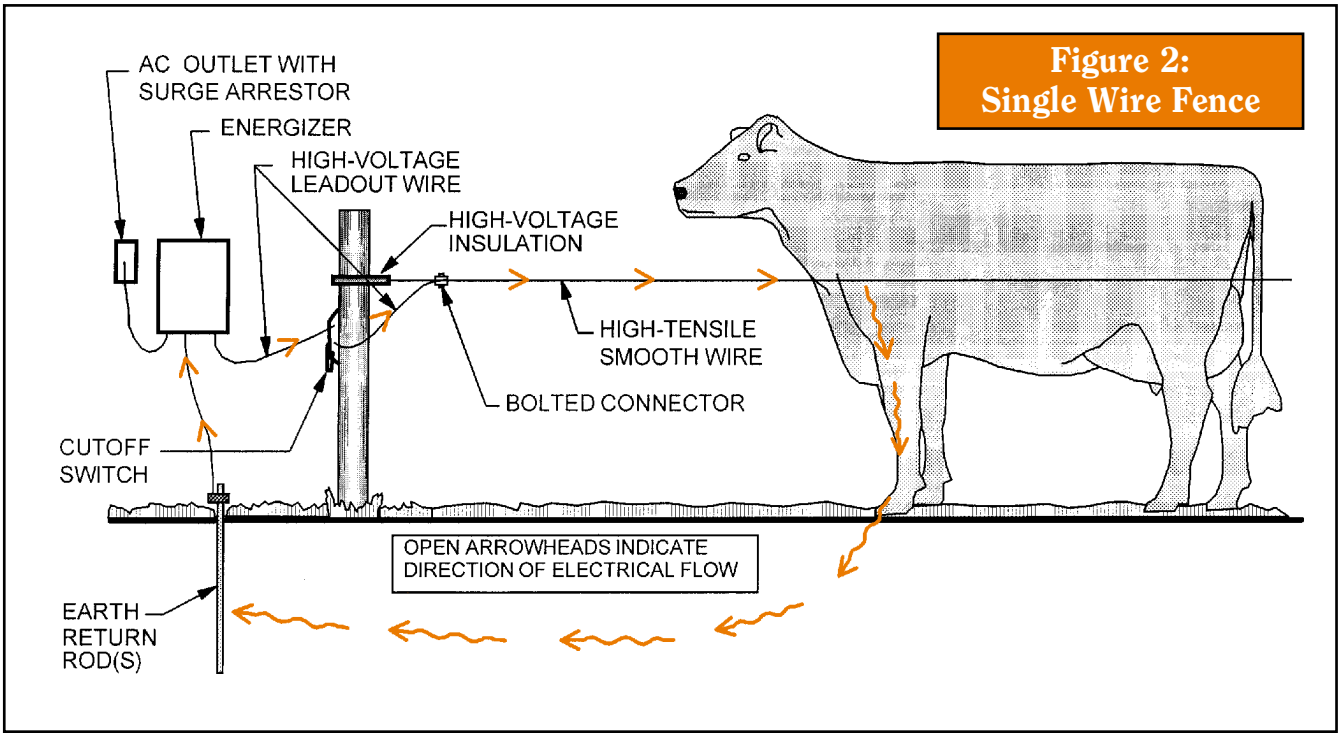


Figure 2: Single Wire Fence

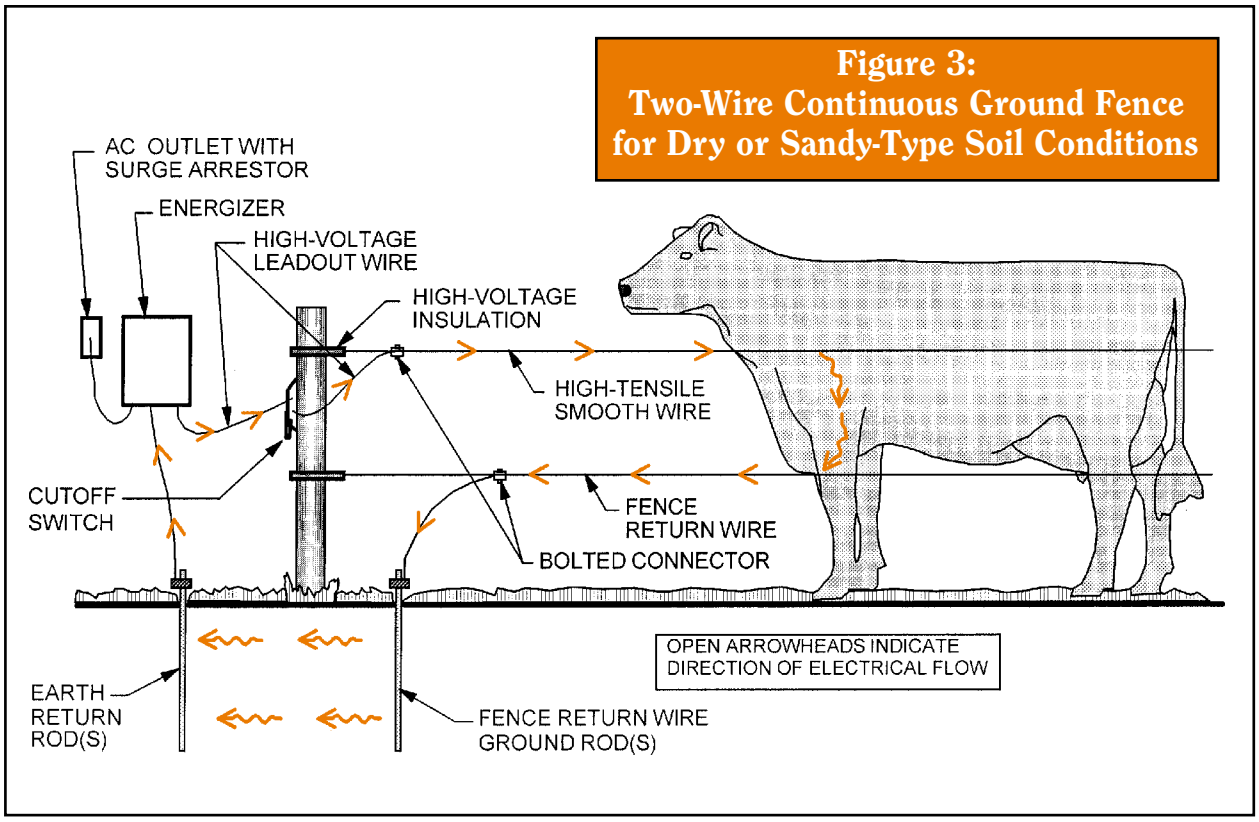


Figure 3:
Two-Wire Continuous Ground Fence for Dry or Sandy-Type Soil Conditions

fine for older dairy cattle, horses, etc. If smaller and/or younger animals need to be controlled, additional energized wires may be required. Figure 2 shows a two-wire continuous ground fence. This type of fence is suggested in dry conditions or where electricity may not flow very well through the earth. Only one energized wire is shown in the figure but more energized wires can be added if needed. In general, cattle and horses seldom need more than 3 energized wires. Sheep and goats never need more than 5.

5. What is the difference between a standard and continuous ground fence?

A continuous ground fence (Figure 3) is commonly used in dry or sandy soil conditions. In a continuous ground fence, the animal needs to touch both a hot wire and a return wire. The intended return path is through the return wire rather than the earth. When the animal touches both wires the electricity flows from the hot wire, through the animal and back toward the energizer on the return wire. If any animal touches only the energized wire, it will experience a lower intensity shock depending on the soil conditions.

6. Are there any disadvantages of a 'continuous ground fence'?

There are two main disadvantages to continuous ground fence:

- If an animal touches only the return wire, it will not get shocked. If there are only two wires on the fence and if the bottom wire is not hot, the animals will eventually learn that they can go under the wire.
- Should the hot and ground wires ever come in contact with each other, a short will occur. This may occur due to a branch falling on the fence or a deep snow bank holding down the wires.

Building an Earth Return System 10

1. Where should an earth return system be placed?

As discussed earlier, an earth return system is like an underground antenna for picking up the electricity that is sent out on a fence by an energizer. Place the earth return system near the energizer to keep the return lead short and reduce the possibility of interaction with the farm grounding system. Make certain, however, that the earth return system is 50 to 150 feet from all other conductive objects (e.g. water lines, ground rods, and conduit) buried in the earth. If possible, the earth return system should be located as shown in Figure 4.

2. How many earth return rods do I need?

The number of earth return rods depends on the power the energizer can deliver and how well the soil conducts electricity. Energizer manufacturers suggest anywhere from 3 to 6 feet of earth return rod for every joule of energizer power.

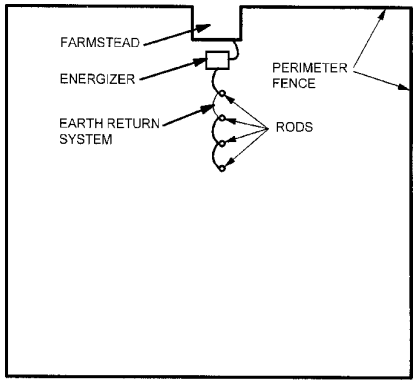


Figure 4: General Position of an Earth Return System

So a 10-joule energizer will need anywhere from 30 to 60 feet of rod driven in the ground. This equals 4 to 8 eight-foot long ground rods.

3. How far apart should the rods be placed?

Earth return rods should be spaced a minimum of 10 feet apart (Figure 5). Maximum effectiveness is attained when rods are placed twice the rod length apart. For example, eight-foot ground rods should be placed 16 feet apart.

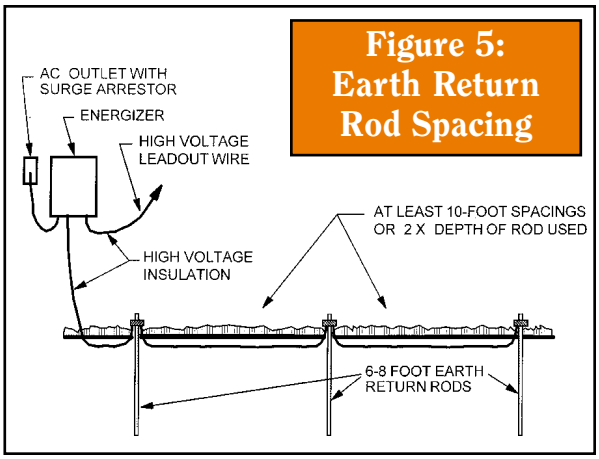


Figure 5: Earth Return Rod Spacing

4. What material should be used for an earth return system?

Most electric fence manufacturers suggest using ½ to ¾-inch diameter, six to eight-foot galvanized rods and clamps. Copper-clad ground rods are recommended because they are more resistant to corrosion. Both types of metal will work. It is recommended, however, that different types of metals not be used within the same system.

5. How do soil conditions affect the performance of an electric fence?

Dry soil is not as conductive as wet soil. Sandy or rocky soil does not conduct the very short duration impulses of an energizer as well as dry soil. Soils with low conductivity will likely require more earth return rods. Additional earth return rods reduce the resistance of the energizer circuit and improve its effectiveness. Alternatively, the soil conductivity may be increased by using a ground enhancement material around the ground rods; e.g., GEM®, coke or bentonite clay. Another way to solve this problem is by using a continuous ground fence.

6. How do I know if my earth return system is working?

An earth return system can be checked as follows:

- Turn the energizer off, ground the fence somewhere away from the energizer, then turn the energizer on.
- Measure the voltage between one of the earth return rods and another metal object stuck in the earth but not connected to the fence system, using a voltage tester designed for high voltage fences.
- If the voltage meter measures the energizer pulse, the earth return system must be improved.

1. Why should an electric fence system be protected against lightning?

An electric fence is a large antenna. During an electrical thunderstorm, it can provide a direct route for lightning to reach the earth – possibly through your energizer. It is essential, therefore, that measures be taken to protect the energizer, and other electrical equipment on the farm, from a lightning strike.

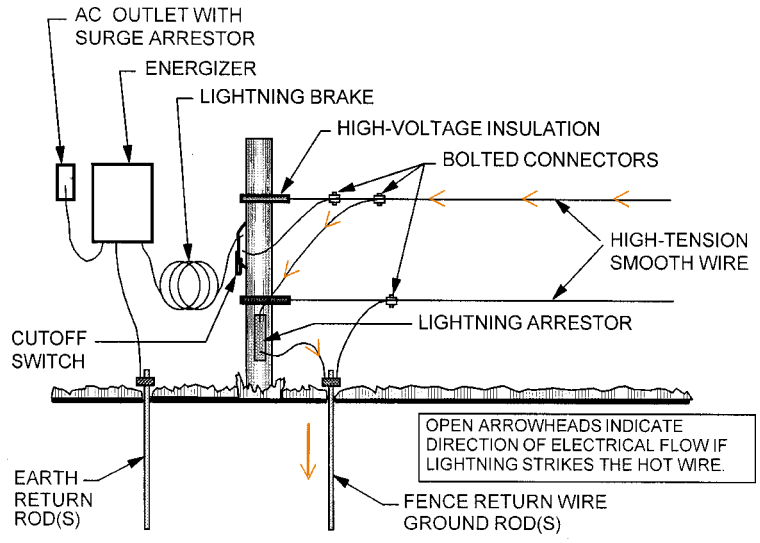
2. What is a lightning arrestor?

A lightning arrestor (Figure 6) protects the energizer from lightning strikes entering from the fence side. It is a simple device that is hooked between the energized wire of the fence and a ground rod. In the middle of the arrestor there are two metal leads that are kept at a specific distance apart so that electricity will not jump across the gap under normal voltages. If lightning hits the fence, the electricity will arc across the gap and flow to the earth through the ground rod.

3. What type of lightning arrestor is preferred?

It is recommended that you purchase an arrestor that allows you to see whether it has been hit by lightning. These models are generally a little more expensive, but they save time in determining which fence post has been hit by lightning.

Figure 6:
Lightning Protection on a Two-Wire Continuous Ground Fence



4. What is a 'lightning brake'?

A 'lightning brake' is a device that directs the lightning to the ground rod rather than through the energizer. The 'lightning brake' consists of a coil of wire that develops an electromagnetic field when electricity flows through it (Figure 7). This electromagnetic field acts as a 'brake' that provides a high resistance path between the lightning and the energizer. This encourages the lighting to follow the lower resistance path through the arrestor and to the ground rod.

"Lightning can destroy the energizer due to improper installation of the earth return system."

5. What can be done to protect the power supply side of the energizer?

The energizer is a natural 'sink' for electricity from a lightning strike anywhere on the power supply side of the circuit, because it is connected to ground rods, earth return rods, fence wires and posts. Conversely, the energizer can be easily protected from the service side using a surge suppressor (Figure 6). All sensitive

electrical equipment should be protected with one of these devices.

6. Can lightning enter the energizer from the earth return system?

Lightning can destroy the energizer due to improper installation of the earth return system. Specifically, if anything above ground is connected to the earth return system (e.g., fences, silos or anything made of steel), a lightning strike to any of these structures provides a direct route to the energizer.

7. How many lightning arrestors should I install on my fence?

The number of lightning arrestors is related to the size of the energizer and earth return system. It is recommended that each lightning arrestor be attached to an 8-foot ground rod and that the number of feet of ground rods be at least equal to–but preferably greater than–the length of earth return rods. For example, if you have a 10-joule energizer and 32 feet of earth return rods, you will need to install 4 lightning arrestors around the fence.

8. Where should I install the lightning arrestors?

One lightning arrestor should be installed where the energizer is connected to the fence. The other arrestors should be placed evenly around the fence in places that are easily accessible for inspection. Other recommended locations include near gates and on the corner of a fence that runs along a hill–a place where lightning would be likely to strike.

9. Is it possible to be totally protected against lightning strikes?

Proper installation of an electrical fence system, along with protective measures in front and in back of the energizer, will greatly reduce the probability of severe damage from a lightning strike. Unfortunately, it is not possible to be completely protected. Lightning strikes that occur very close to a farm may overpower all safety measures. The probability of this occurring is small when compared to lightning strikes over a wider area that can result in lower power surges for which these protective measures are effective.

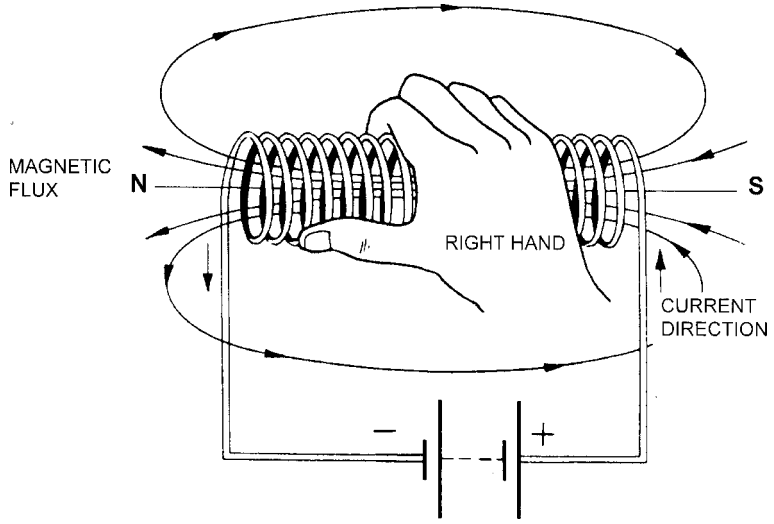


Figure 7:
Electromagnetic Fields Around a Wire Carrying Electricity

Cow Trainers & Crowd Gates

Cow trainers and crowd gates present several unique problems. A cow trainer (Figure 8) is designed to train cows not to arch their back while defecating or urinating so that waste falls in the gutter. In order to be effective, they must be adjusted for each individual cow. If cows cannot avoid the trainer, a great deal of stress and agitation will be produced. With most cow trainer circuits, the barn floor is part of the earth return path. It is likely, therefore, that the trainer pulses will appear at all locations in the barn whenever any cow touches a trainer bar. It is especially important that trainers be adjusted properly so that cows contact the trainers infrequently.

Electric crowd gates (Figure 9) are designed to train cows to enter a milking parlor. These devices should be fitted with a bell or buzzer so the cows know when it will be moved. The potential for misuse of these devices is great. If an inattentive or overly aggressive operator makes it impossible for cows to avoid the crowd gate they will be frightened and agitated before being milked.

These devices work in a similar way to electric fence systems; however, extreme care must be taken in their installation, because the high voltage pulses are flowing in and around a barn. Special attention must be paid so that these pulses do not appear on the milk pipeline, waterlines, or other conducting surfaces in the animal confinement areas.

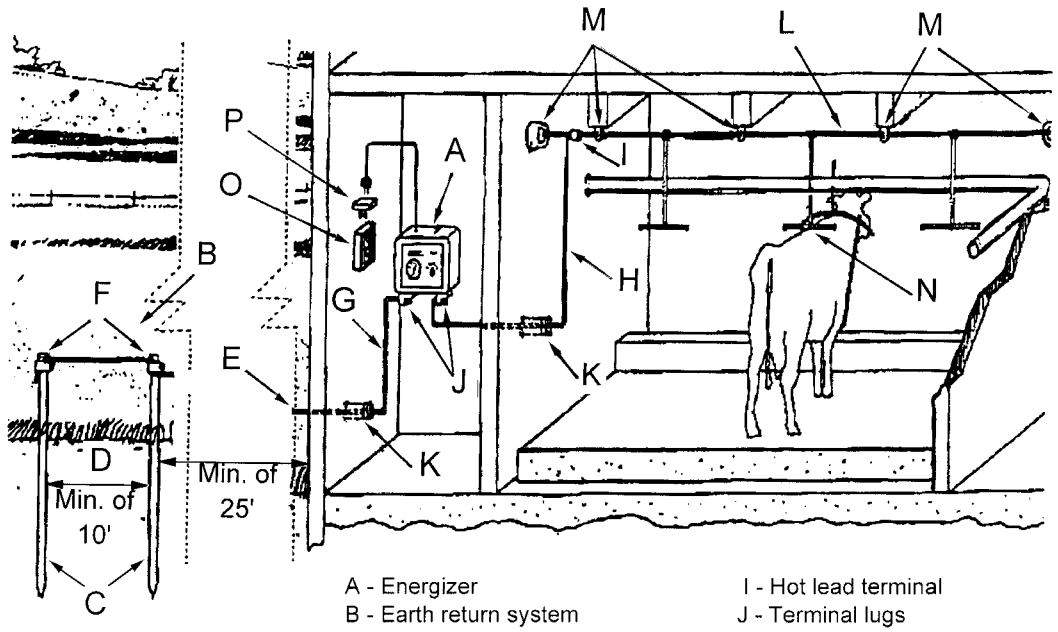
1. What size energizer should be used?

Never exceed a 2500-volt energizer for trainers or crowd gates. Too much power may cause excessively nervous behavior in animals. Furthermore, higher voltage increases the likelihood of the energizer pulses traveling to undesired locations.

2. What type of wire should be used?

Always use wire with high voltage (10,000-volt or higher) insulation to connect the energizer's hot lead terminal to crowd gate and trainer connections. Do not connect

Figure 8: Suggestions for Installing and Maintaining Cow Trainers



A - Energizer
B - Earth return system
C - Earth return rods
D - Spacing between ground rods
E - Earth return wire
F - Ground rod connector
G - Ground lead wire
H - Insulated wire
I - Hot lead terminal
J - Terminal lugs
K - Insulated lead wire
L - Trainer wire
M - Supports for trainer wire
N - Trainer hangers
O - AC Outlet
P - Surge arrestor

the high voltage output terminal to anything not associated with the energizer.

3. How can I improve the safety of an electric crowd gate?

To improve the safety of electric crowd gates, use a energized wire alternating with a return wire (Figure 9) similar to a continuous ground fence as described earlier in this publication. There are several electric fence supply companies that manufacture plastic/metal tape combinations that have both hot and return wires woven right into the same material. By keeping the electrical flow in the wires, the chances of energized pulses contacting unintended surfaces are reduced.

4. How should cow trainers be adjusted?

Adjust the trainer bars so they are approximately 3 inches above the cow's shoulders, or until they are effective in training the cows to drop their manure in the gutter. [Note: This may be as close as 1½ inches in some cases.] It is essential that the trainer be fastened securely to eliminate the possibility of the unit sliding down onto the cow's back. It is also important to make sure cows get back into their own stall which has had the trainer bar adjusted for them. If this cannot be done then the bars must be adjusted every time cows return to the barn.

5. Where should earth returns be installed for cow trainers and crowd gates?

Figures 8 and 9 show the suggested installation for either a crowd gate or trainer. If an electric fencing system is in place on the farm, do not combine the two return systems. However, many of the same principles that were discussed in the section on building earth return systems apply here, including such things as size, number and placement of rods.

6. Why should cow trainers and crowd gates be separated from electrical and water systems?

It is essential that cow trainers and crowd gates be electrically separated from all grounded objects so that the high voltage pulses do not occur in undesired locations. Water systems are the most likely place for earth return currents to appear, because they are usually part of the farm grounding system.

7. Why should the fencer (or a cow trainer) not be placed parallel with large metal equipment?

A metal object parallel to an energized were will pick up some of its voltage. This will depend upon the magnitude of the voltage, distance between the energized wire and the metal object, and the length of the parallel run. If a large separation is not possible, limit the parallel run to less than 10 feet.

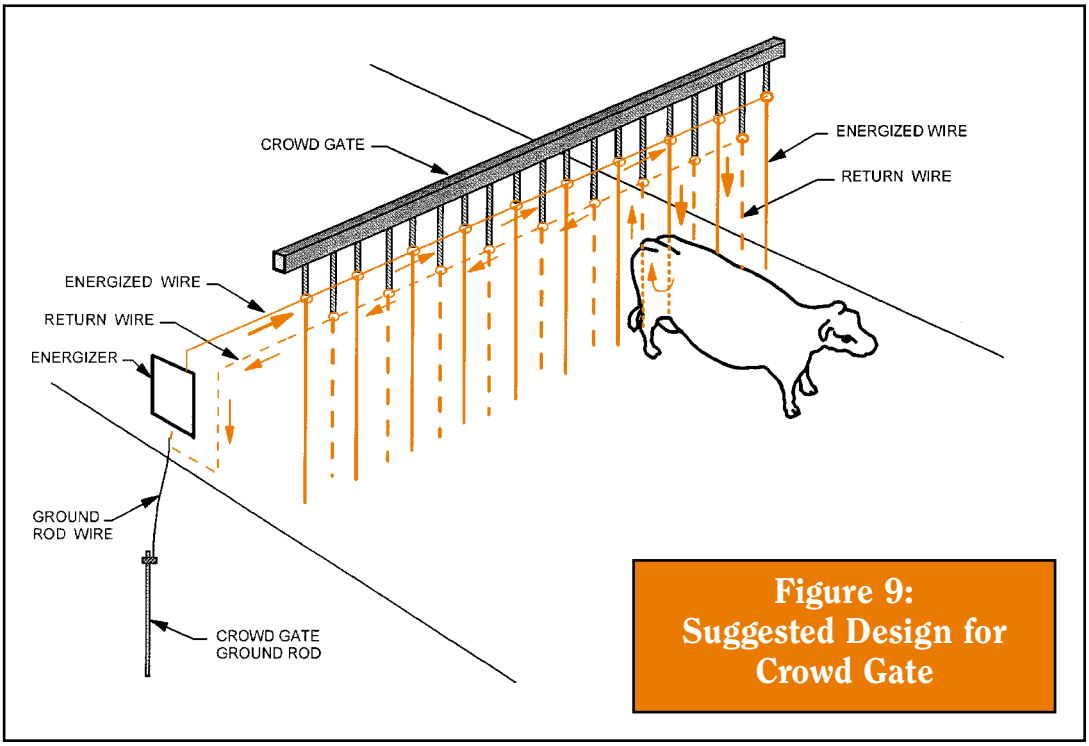


Figure 9: Suggested Design for Crowd Gate

Insulators

1. What is the best type of insulator?

There is not a "best" type of insulator. There are many new models and styles on the market. Both porcelain and plastic insulators may perform adequately as long as they are kept clean. The most important differences have to do with things such as strength and durability.

2. Do wooden posts need insulators?

Yes, in wet or humid climates wooden posts should be fitted with insulators. Wood, especially treated and/or wet wood, can conduct electricity. It is recommended that insulators be installed on wooden posts located in temperate regions of the country.

3. Do fiberglass posts need insulators?

Some types of fiberglass posts require insulators and some do not. If the posts were manufactured specifically for electric fencing, they generally do not require insulators.

4. What can cause electricity to flow through an insulator?

It is very common within barns to have electricity flow along the surface of an insulator that is covered with dirt, white wash or bird droppings. The worse the contamination, the more electricity that will flow. Bird droppings can also be a problem on fences.

5. What type of post works best for electric fencing?

Any type of post will perform well provided the fence wire is insulated. Each type has advantages and disadvantages. Most important, the post must keep the wires where you want them and the wires must be insulated properly.

Safety Tips

1. How often should I test the fencer system?

It is recommended that the fencer be tested twice each year during the driest period. Use a digital electric fence voltmeter to check the voltage output at the power unit and at various points along the fence. If the voltage is abnormally low, a short may exist. This may be an indication that unwanted pulses are occurring.

2. How often should I inspect the electric cow trainer and crowd gate?

These systems should be inspected every six months to ensure their proper operation.

3. Can electric fences cause death or injury?

Any type of wire fence has the potential of causing death or injury. The primary danger occurs if an animal becomes entangled in the fence. Smooth wire, high-tensile fences are recommended for permanent electric fences for three reasons. First, they are relatively easy to install and maintain. Second, they can handle animals and equipment running into them without breaking. And lastly, animals are not as likely to become entangled in them. Owing to this last reason, it is highly recommended that BARB WIRE NEVER BE USED IN AN ELECTRIC FENCING SYSTEM.

4. Can electrical transmission lines cause problems with a fence?

Any type of conductive fence that is running parallel to a high voltage transmission line may pick up voltage. If a fence is installed next to a transmission line and a current can be detected even when the fence is turned off, it may have to be moved or replaced with a different type of fence. If you are receiving shocks from a fence that is not energized, and the fence is located near a transmission line, call your utility and discuss this with a field representative.

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The mission of the MREC is to initiate, develop, support, and coordinate education, research, and communication programs on significant and emerging rural energy issues for the consumer, energy suppliers, and allied industries through cooperative efforts of council members.

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