M A N U A L

Model 251

PARABOLIC PINPOINTER

RADAR ENGINEERS INC
9535 NE COLFAX STREET
PORTLAND, OR 97220

ABBREVIATED FIELD INSTRUCTIONS
MODEL 251

1. **SAFETY:** The 251 is Not Insulated and is Not a Voltage Sensor. Maintain safe working distances.
2. First use RF receivers with directional antennas to find the pole with a spark. **THEN USE THE #251 ULTRASONIC TO PINPOINT THE SPARKING HARDWARE.**
3. **BEGIN CLOSE TO THE POLE:** Start search about 20 feet from the base of the pole. The #251 is not a long range locator.
4. **START WITH GAIN KNOB AT "10" AND TOGGLE SWITCH ON "HIGH" –** Focus the sight on each device on the pole and hold for 3-4 seconds. Do not scan rapidly. When the #251 detects a powerline noise source the red light over the meter will come on and stay on. If the meter pegs or noise appears to come from several locations, back the gain down until only one piece of hardware turns the red light on. (Ultrasonic energy from the source can splatter off nearby hardware.)
5. **LINE OF SIGHT REQUIRED:** The ultrasonic energy from a spark will be blocked by wood or hardware. Line of sight is required. Usually you can obtain line of sight by moving around the base of the pole reevaluating each device on the pole from a different angle. However, sometimes the spark will simply not be detectable. For example, Sparks inside coil washers or inside defective lightning arrestors can sometimes be blocked.
6. **TRIANGULATE:** Confirm the source from several directions.
7. SEE THE MANUAL for additional information.

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I. SAFETY NOTE

The Model 251 Parabolic Pinpointer is Not Insulated**.** Safe working distances must be maintained from electrical conductors as electricity may try to jump to the instrument.

This Instrument is Not a Voltage Sensor.

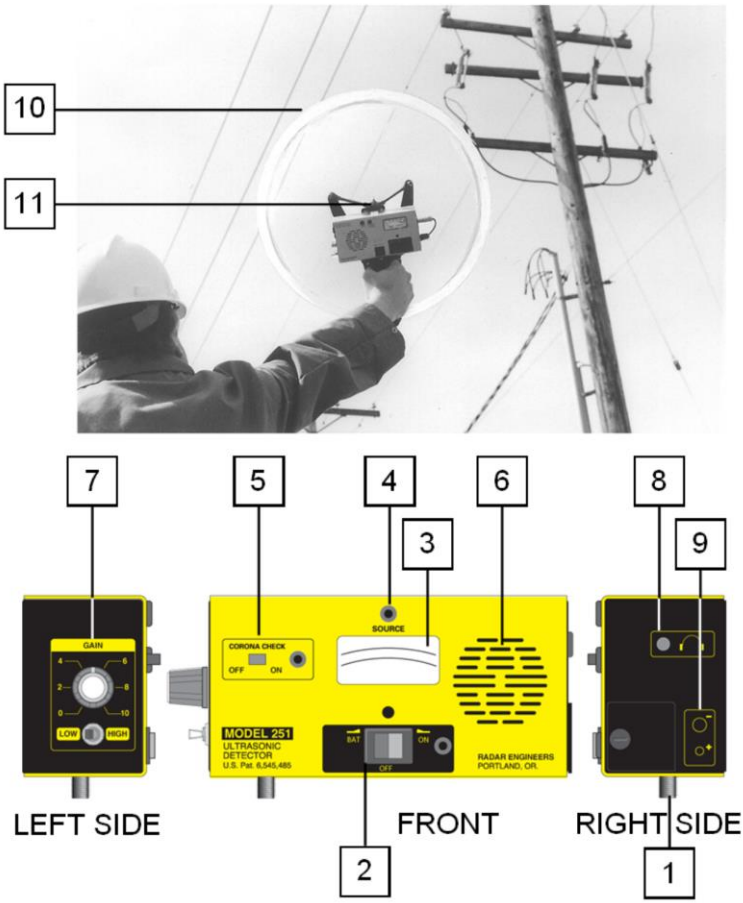
Exercise Caution At All Times. Be particularly aware of safe working distances if using the Model 251 from a bucket. Also, always be alert to traffic, especially if using headphones with the Model 251.

II. INTRODUCTION

The Model 251 Parabolic Pinpointer was designed primarily to help utility crews efficiently locate the sources of power line caused radio and TV interference (RFI/TVI). Because it is designed to locate the ultrasonic component of sparking energy it is very accurate and efficient at pinpointing spark sources on a pole.

The Model 251 consists of an ultrasonic transducer mounted on a parabolic dish together with a receiver, amplifier, speaker, and meter. The circuitry in the receiver has been maximized to detect and pinpoint sparking hardware. However, first locating the pole that contains the sparking hardware is best accomplished using other RF style equipment such as Radar Engineers Inc. Model 243 Broadband RFI locator or M-330 Mini RFI locator.

III. FEATURES OF THE MODEL 251



1. **INPUT** BNC connector for transducer input.
2. **ON/BATT CHECK** Switch pushed to the left allows the operator to read the battery level on the meter. Switch pushed to the right turns the instrument ON. The green LED next to the switch lights up when the unit is ON.
3. **METER** Relative signal levels of detected ultrasonic sources can be observed on the meter.

4. **SOURCE** This LED distinguishes the ultrasonic noise caused by a spark or corona from the ultrasonic noise caused by wind or passing cars. When the LED TURNS ON AND STAYS ON the Model 251 is pointing at a power line noise source (spark or corona). The LED might turn on briefly for the ultrasonic noise caused by wind or a car but the LED will only stay on for a power line source with a meter level above 15 or 20. For low level sources that produce a weaker meter reading, use your ear to distinguish sparks from other ultrasonic sources.
5. **CORONA CHECK** When in the ON position the corona check LED distinguishes sparks from corona. Sparks and corona may sometimes produce similar ultrasonic energy, therefore the corona check is not always definitive. Leave this switch OFF unless you are trying to distinguish a spark from a corona source on a transmission level structure of at least 115KV.
6. **SPEAKER** Allows the operator to hear the noise detected by the ultrasonic sensor.
7. **GAIN:**
   A. Toggle Switch: Selectable High or Low. The High gain position is for maximum sensitivity. This is the default setting. The Low gain position reduces sensitivity (about 50db) for those sparking sources that are extremely strong.
   B. Knob: This knob adjusts a pot that is a combination volume and sensitivity control. It is used for adjusting sensitivity for either the High or Low gain setting.

8. **HEADPHONE JACK** A mini jack is available for headphone use. Be alert to traffic when using headphones. Only one side of the headphones is active.
9. **BATTERY** The Model 251 uses one 9 volt alkaline battery. Battery life under normal usage is about 8 hours.
10. **PARABOLA** The 18" plastic parabola captures and reflects ultrasonic noise to the sensor mounted in the tripod. The sensor is sensitive to jarring. Exercise care not to jar and damage it.
11. **SIGHT** To pinpoint a spark, line up the ridge at the top of the sensor horizontally and vertically inside the slotted sight. The slotted sight is centered on the black frame.

IV. LOCATING WITH THE MODEL 251

A. Pole Locate with RF Techniques:

Use an RF receiver and antenna to locate the pole on which the noise is located. RF antennas are more efficient than the ultrasonic instruments for locating the pole. This is because RF receivers with directional antennas have much greater range than ultrasonic locators. In addition, RF antennas do not need to be pointed exactly at the source to detect its presence. To learn more about RF receivers and antennas contact Radar Engineers.

B. Pinpoint with Ultrasonic

1. Background

To pinpoint a source the Model 251 ultrasonic sensor is better than RF receivers and antennas. RF signals can couple onto adjacent hardware and mislead the operator as to the true location of the spark. The ultrasonic energy from a spark will not couple on to adjacent hardware. This means that when the Model 251 detects a source your confidence will be high that you have identified the actual spark.

2. Technique

a. Be Close: The ultrasonic energy from a spark varies but usually does not travel very far. As a general rule you should be within 30 feet from the base of the pole that you are investigating. In some cases you may need to perform your search right at the base of the pole pointing straight up: for example, when the spark is between two cross arm braces or between a pole gain and a thru bolt.

Start with Gain Knob on “10” and Toggle Switch on “HIGH”. Adjust as necessary. In cases of extremely high signal level, set the Toggle

Switch to “LOW”.

b. Be Methodical: The Model 251 is extremely directional. When you scan a pole the dish and sensor may only be investigating an area on the pole about the size of a volleyball. This means you must use the sights on the Model 251 to perform your investigation. You must literally point at each device on the pole that could be sparking.

We suggest that you slowly scrutinize each device on the pole and cross arm(s). Sight each device on the pole and hold for 3-4 seconds. Look at splices, trash on the line, and every other piece of hardware that can spark, especially dead end bells. See page 10.

Every pole is different so it is essential to be methodical and to take your time.

c. Circle the Pole: Line of sight required. Ultrasonic noise usually cannot be detected unless the Model 251 has direct line of sight to the source. For example, if the source is a washer on a cross arm you will need to be on the same side of the pole as that washer in order to pick up the spark with the ultrasonic detector. If your RF equipment has identified a source pole and you are unable to detect the spark with the Model 251 then there are three possible explanations:

i. The sensor of the Model 251 does not have line of sight to the source. For example, a spark <u>inside</u> a lightning arrester or transformer or a spark on top of an insulator may not be “seen” by the Model 251 ultrasonic sensor. If this is the case it is necessary to use RF techniques. The use of the Radar Engineers Model 247 Hotstick Line Sniffer is a good choice since it

combines RF and Ultrasonic detectors and it can be used from a bucket to position the sensor above the insulator.

ii. The source is too weak to be detected from the ground. Try the Model 251 from a bucket. (Maintain safe working distances.)

iii. The RF equipment locate identified the wrong pole. Scan the adjacent poles.

d. Triangulate: Once you have detected a source you must confirm the exact piece of hardware that is sparking. Often there will be more than one device in your line of sight. If you move 45-90° and take another reading it will become clear which is the actual source.

e. Reflections: Ultrasonic signals from a strong spark source may reflect off nearby hardware. In some cases the ultrasonic signal may even reflect off the ground. If the Model 251 detects reflections, reduce the gain.

f. Use of the Model 251 from a bucket:

i. Safety: Maintain safe working distances. The Model 251 is not insulated.

ii. Instrument Integrity: Stay at least 10 to 15 feet from distribution level voltage conductors. At distances closer than about 10 feet the electro-magnetic field could interfere with the operation of the Model 251. At higher line voltages increased distance may be necessary.

iii. Transformers: When used from a bucket the core vibration from a transformer may be strong enough that the transformer will appear to be a sparking source to the Model 251.

C. Corona Check:

The Corona Check switch is available to help you determine whether the detector and source LED

are reacting to corona (which occurs naturally on EHV lines) or a spark. Corona is not ordinarily the cause of customer RFI/TVI complaints because it produces a relatively weak RF signal and is usually not present below 115 KV. See Page 11.

With the exception of an undressed tie wire on a distribution pin insulator, corona is ordinarily only seen at transmission level voltages. The Corona Check feature should NOT usually be used on distribution level structures. The usual position for the Corona Check switch is off.

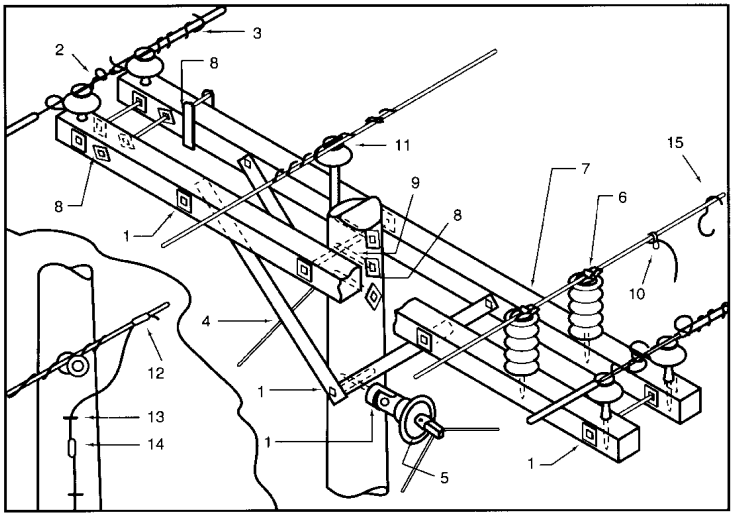
When it is “ON” the Corona Check switch will degrade meter performance for ordinary sparks. In addition, the Corona Check has some limitations and should only be used by the experienced operator. For example, in the presence of several tightly spaced EHV phases it may not react as expected. And it can react to a very small subset of actual sparks as though they are corona. A skilled operator using his knowledge of powerline sparking will nevertheless find the corona check a useful tool.

V. SPARKING & CORONA

A. SPARKING:

On distribution power lines the source is often a spark at a loose or corroded connection between two pieces of metallic hardware. Metal (or any conductor) in an electric or AC magnetic field will become electrically charged. When two pieces of metal are not making good contact they can become charged up to different voltage levels. If this difference becomes large enough a spark will jump from one piece of metal to the other. It is not necessary to have high voltage between the two pieces of metal. If the gap is small a spark may be created with less than 100 volts.

1. Examples of Powerline Noise Sources:



1. Loose Hardware.
2. Loose Tie-Wire on Conductor.
3. Loose Tie-Wire on Insulated Conductor.
4. Guy Wire Touching Cross-Arm Brace.
5. Corroded and/or Loose Pin in Bell Insulator.

6. Conductor Loose in Post Insulator Clamp.
7. Clamp Loose in Pivot Screws, Post Insulator.
8. Insufficient Clearance on Wood Surface Between Hardware Parts.
9. Insufficient Clearance, Internal Hardware.
10. Corroded or Loose Hot-Line Clamp.
11. Loose Tie-Wrap on Porcelain.
12. Loose Connection to Neutral Conductor.
13. Ground Wire Loose in Staple.
14. Loose or Corroded Ground Wire Splice.
15. Foreign Object (Trash) on Conductor.

2. Factors Affecting Spark Gap Noise

a. Rain Humidity: Rain can complicate RFI locating because moisture normally shorts out the small gaps and suppresses sparking. After rain starts, it may take an hour or more for the sparking gap to be shorted out. Thus, interference can continue for limited periods during foul weather. Conversely, after a rain or heavy dew, sparking will not ordinarily reappear until the moisture has evaporated.

b. Wind: Wind can also affect sparking. Wind pressure on cross arms and conductors can change the size of a spark gap and thereby cause sparking to stop or start.

c. Salt: Salt and other contaminants in coastal and industrial areas can adhere to insulator surfaces. When wet these contaminants create a path for current to flow. Micro gaps in the current path act like spark gaps and create RFI.

B. CORONA SOURCES:

Corona is considered a point discharge. The discharge off the end of a sharp object at very high voltage is an example of corona. Sparking is caused

by a complete discharge across a gap, which is usually very small. The difference between corona (point discharge) and sparking (gap discharge) is significant. Corona is not as intense and usually does not radiate as far as a spark.

Corona may be classified as being either the foul-weather type or fair-weather type. In foul-weather on extra high voltage transmission lines (above 230 KV) water droplets on a conductor are distorted into pointed shapes and corona will emanate from these points. Thousands of corona plumes may be present on a transmission span, and may cause radio and television interference to nearby residences. When foul-weather corona interference is present, it will be obvious all along the EHV conductor and will not be a locating problem.

Fair-weather corona often occurs where a pointed object protrudes into the air and is energized at high transmission line voltages. This type of fair-weather corona is sometimes called point corona and is usually caused by frayed conductors, sharp corners on hardware, sharp mold nibs on vibrator dampers and foreign objects on the conductor.

Fair-weather corona may cause radio interference. However, it has not been known to cause television interference because radiation from a point corona source is very weak at the high frequencies of television broadcasting.

C. Noise Spectrum of Spark Sources:

A single spark generates radio noise from 1 KHz to 1 GHz and also generates acoustic energy. The Model 251 parabolic pinpointer senses acoustic energy in the ultrasonic range. Ultrasonic spark noise has a couple of characteristics that are helpful in locating sparking with the Model 251.

1. The ultrasonic noise generated by a spark is usually weak and usually detectable only from the base of

the pole or from a bucket

2. The ultrasonic noise generated by a spark will not pass through a pole or cross arm. The wood absorbs the ultrasonic signal. (This is why line of sight to the ultrasonic sensor is required.)
3. Ultrasonic noise will not transmit down a conductor or couple on to conductors. Therefore, when you detect ultrasonic noise you can be reasonably sure you are pointing at the source itself and not a radiated signal. These characteristics of the ultrasonic component of a noise source contrast sharply with the radio and T.V. frequency component of a noise source:
   a. The RFI signals generated by a spark can be detected at much greater distances by radio receivers. RFI will routinely radiate a number of spans away from the source. It is not uncommon to detect AM radio band interference a mile away from the source at 1 MHz.
   b. RFI will pass through solids such as glass windows and wood poles. Direct line of sight is not required for RFI locating at higher frequencies.

      For these two reasons using an RF receiver (such as Radar Engineers Inc Models 243 and M330) to pre-locate the pole is a good idea. On the other hand use of the Model 251 with its ultrasonic sensor is preferable for pinpointing since it will not be fooled by coupled signals. As noted, ultrasonic noise will not couple onto powerline conductors or hardware. However, it can reflect or bounce off of nearby objects such as a cross arm. Evaluating a spark from a couple of directions helps confirm the true source.

VI. WARRANTY AND NOTICE TO PURCHASER

The Model 251 is warranted against all defects in material and workmanship for a period of one year following shipment. Our liability is specifically limited to replacing or repairing, at our option, defective equipment. THIS WARRANTY IS MADE IN LIEU OF ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Neither seller nor manufacturer shall be liable for any injury, loss or damage, direct or consequential, arising out of the use of this product.

All statements, technical information and recommendations contained herein are based on information believed to be reliable, but the accuracy or completeness thereof is not guaranteed. Before using, the user shall determine the suitability of the product for his intended use, and user assumes all risks and liability whatsoever in connection therewith. All statements or recommendations not contained herein shall have no force or effect unless in an agreement signed by officers of seller and manufacturer.

VII. REPAIRS AND CUSTOMER SERVICE

Radar Engineers Inc. maintains a complete instrument repair service. Should this instrument ever require repairs, do not attempt to repair it yourself. Return it to the following address:

Radar Engineers Inc

9535 NE Colfax St.

Portland, OR 97220

When returning the instrument for repairs, it should be shipped in a protective container Pre-paid and Insured. A note should be included describing the defect and the name and phone number of the person to contact in case additional information is needed.

If you have questions regarding the operation of this instrument, call Radar Engineers Inc at: (503) 256-3417.

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