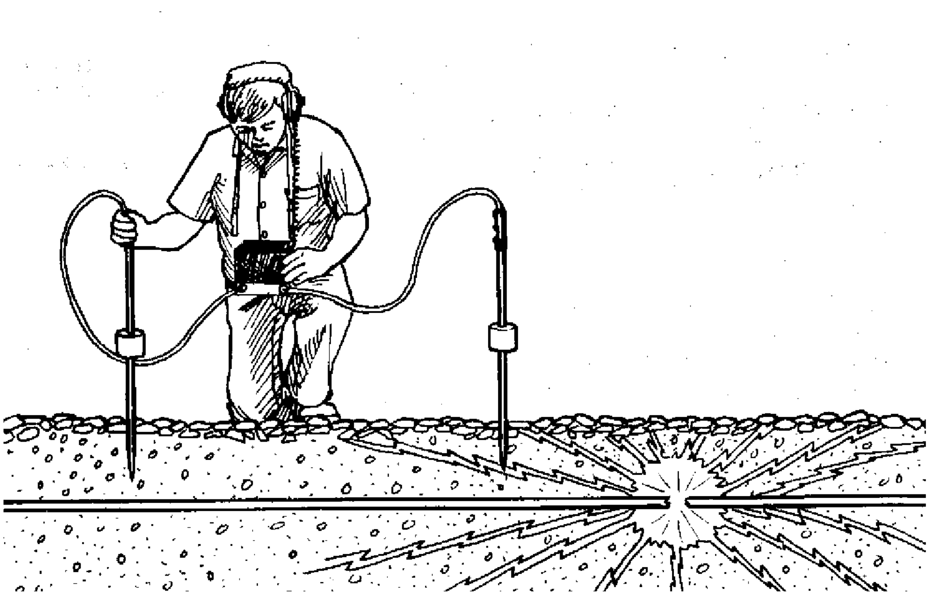
INSTRUCTION MANUAL

ON

D.A.D.
Directional Acoustic Detector



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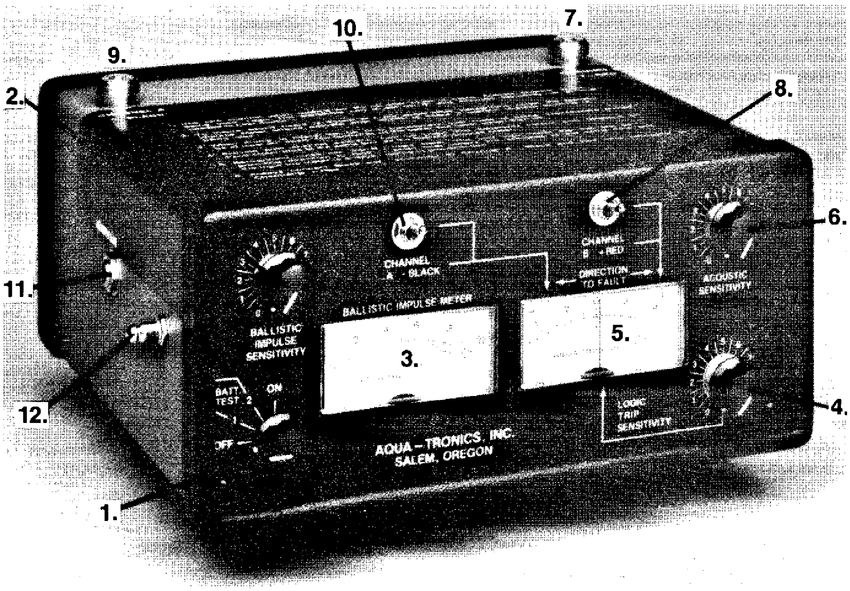
Directional Acoustical Detector

I. Instrument Controls and Connectors



1. **OFF - ON, and two-position batt. Test control.**

2. BALLISTIC IMPULSE SENSITIVITY control:
Controls instrument's detection of thumper pulse in cable, which is shown on Ballistic Impulse Meter.

3. BALLISTIC IMPULSE METER:
Shows thumper pulse in cable.

4. LOGIC TRIP SENSITIVITY control:
Controls directional detection circuits when using two microphones.

5. DIRECTION TO FAULT meter:
Shows the direction to the fault when using two microphones during fault-location.

6. ACOUSTIC SENSITIVITY control:
Controls amplification of audio signal to head phones.

7. (+) Red CHANNEL B input terminal:
For red connector from sensing microphone (either ground-contact or earth-probe type).

8. Red CHANNEL B activate toggle switch:
Center position: off.
Up position: locked on.
Down position: momentary on.

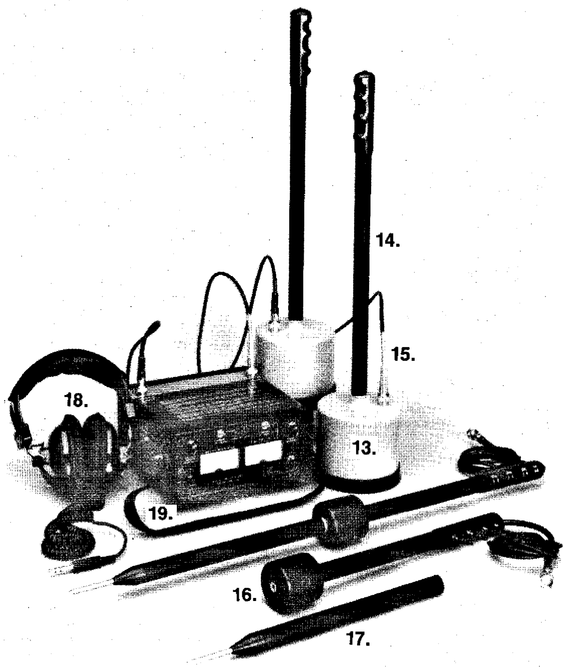
9. (-) Black CHANNEL A input terminal:
For black connector from sensing microphone (either ground-contact or earth-probe type)

10. Black CHANNEL A activate toggle switch:
Center position: off.
Up position: locked on.
Down Position: momentary on.

11. Headphone input terminal.

12. **Neck strap connector (one on each side).**

II. ACCESSORIES



13. Microphone: ground-contact type.

14. "Walking Handle" for ground-contact microphone (disconnects).

15. Microphone cable, for ground-contact microphone.

16. Microphone: earth-probe type.

17. Earth-probe rod, for earth-probe microphone.

18. Stereo headphone set.

19. Neck strap.

III .Batteries

A. Testing:

Rotate the OFF-ON control through the two "BATTERY TEST" positions and observe the "DIRECTION TO FAULT" meter. If the indicator needle points to the bottom line of the "Batt. OK" range or below it for either battery, replace both batteries. Both batteries should be operating at or near the same voltage.

B. Replacement:

The two batteries are located inside the back cover of the instrument. To replace batteries, remove the small plastic nut to open the battery compartment door.

C. Approved Batteries:

Two 9-volt Eveready #246 batteries, or the equivalent, are recommended to operate the instrument (NEDA #1602). If the recommended batteries are not available, two 9-volt Eveready #216 batteries, or the equivalent, can be used, However, these batteries will offer a shorter operating span than the recommended batteries.

IV. Sound

A. General Characteristics of Sound

a. Sound Waves

Sound is mechanical energy in the form of pressure waves. You can't see sound waves, but you can form a mental picture of how sound works by comparing it to what happens when a rock is dropped into a quiet lake. Sound waves leaving the sound's source would look like ripples on the lake's surface leaving the spot where the rock was dropped. As the ripples move away in all directions, they get smaller and gradually lose their energy. If any of the ripples strike a solid object in the lake, they reflect off the object and start traveling back in the direction they came from. Sound waves act very much like these ripples in the lake. They radiate out in all directions from the source of the sound; they grow weaker and lose more energy the farther they travel: and they bounce off objects and reflect back in the direction they came from.

Thumpers used to locate cable faults create sound waves which radiate out from the fault. When the high-voltage thumper pulse reaches the fault and arcs across a faulted primary to ground, it creates an "explosion" or rapid ionization of air. If this occurred in the open air, it would sound much like a large caliber riffle discharging. Since the explosion cause by the thumper pulse occurs underground, the exact type of sound it causes can be very different depending on the nature of the fault, the type of material surrounding the cable, the density of the soil, the amount of moisture in the soil, the voltage level used in the thumper pulse, and the other factors. An operator standing near the point on the fault might hear a soft “thump”, a very sharp “crack”, or some type of sound.

Most of the time, the sound of the thump is loud enough in the area of the fault that the operator can hear it without using any equipment to amplify the sound. Sometimes, the voltage are at the fault releases enough energy to actually move the soil at ground level. In these cases, the thump can be felt with the operator's foot or hand.

b. Sound Traveling In Different Materials

Sound travels at different speeds, and with greater ease or difficulty, in different materials. This can have an effect on the operator's efforts to accurately locate a fault. The operator should keep in mind some basic facts about how sound travels in different materials.

(1). Speed of Sound & Sound "Resistance."

Sound waves travel at different speeds in different materials. In open air, sound travels at about 1,100 feet per second (750 mph). In steel, sound travels at about 16,000 feet per second (11,000 mph). In general, sound travels faster in hard or dense materials. Sound waves also travel "easier" in dense or hard materials. For example, sound waves will travel farther in steel than they will in air before losing so much of their energy that they can no longer be heard. For the same reason, sound travels better in water than it does in air, which is why you can hear distant sounds better with your head under water than you can with your head above water. Also, like water running downhill or lightning darting through the sky, sound prefers to take the "path of least resistance." If sound has more than one material to use in moving away from a point, it will travel faster and with less loss in sound level (amplitude) through the material that is more dense. If you tap on the bottom of a boat sitting on a lake, someone on shore would hear the sound faster and louder with their head under water than they would standing on the shore.

(2). Sound Reflection.

Sound waves are reflected when they run into an object or surface that is more dense than the material they are traveling in. Like ripples on a lake's surface reflecting off a floating log, sound waves traveling through soil will reflect off building foundations, underground pipes, the bottom .surface of streets or sidewalks, and any other object that is more dense than the soil.

(3) Sound in Air.

Compared to many other materials, air is a very poor conductor of sound waves, or Sound energy. Water, metals, compact or moist soil all conduct sound better than air.

B. Factors Affecting Sound In Fault-Location Efforts

a. Soil Types:

Some types of soil can muffle the sound created by a thumper pulse arcing to ground. This muffling effect can be so severe that an operator standing near the fault may not be able to hear the thump. Dry, porous soil will muffle a thump to the greatest degree. Sand is good example of a soil type that will severely muffle a thump. Even though the sand grains are dense and would be good sound conductors if they were packed together very tightly, sand is filled with tiny air pockets that are poor sound conductors. If the sand is wet water fills the air pockets and improves the overall sound-conducting ability of the sand. Similarly, loose dirt or dry dirt is a relatively poor conductor of sound. Because of this, the soil around a fault may become a poorer sound conductor during a fault locate effort as the energy released by the thumper’s voltage are heats up the soil and dries out.

b. Temperature

While frozen soil is hard and may appear to be dense, there may actually be a lot of air pockets frozen into the soil, making it a poor sound conductor. Further, repeated freezing and thawing of soil tends to create more air pockets due to the soil's movement during the freezing and thawing process.

c. Asphalt & Concrete Surfaces

How well a thumper's sound can be heard above asphalt and concrete surfaces depends a great deal on whether there are air spaces between the soil and the bottom side of these surfaces. Dead air spaces can be created under these surfaces by soil settling or by soil-surface movement caused by freezing and thawing. Even if a thumper's sound travels well through the soil itself, the sound may be lost or greatly distorted if it runs into a dead air space underneath a road or sidewalk. Further, how well anyone area of a road or sidewalk surface conducts sound may change with temperature. A hard freeze may cause an asphalt surface to separate from the soil beneath it, but the asphalt may "relax" and make good contact with the soil on a hot day

d. Buried Ducts and Pipes

Because sound travels best along the path of least resistance, cables placed in ducts or cables buried near water pipes or other underground metals may create special difficulties in locating cable faults. In general, ducts will be better sound conductors than the surrounding soil, and the thump sound may travel down the duct and emerge at either end. If this happens, the operator will hear a thump which seems to come from a point that is nowhere near the actual fault. If a water pipe happens to cross the cable's path at a point near the fault, a similar thing can happen. The thump sound will travel faster and with less loss in sound level (amplitude) along the pipe than it will through the soil. If the water pipe picks up and transmits enough sound energy to a water meter or hydrant. it may seem to the operator that the thump sound is coming from a distant point.

e. Submarine Cables

Sound travels well in water with very little amplitude loss, so a thump can be heard at a great distance from the fault if a listening device is placed beneath the water's surface. Problems will be encountered, however, if the listening device is placed above the water's surface. A common property of water is its "surface tension," which creates a thin "skin" on the surface that behaves much like a weak elastic material when it is subjected to pressure. Since sound waves are pressure waves, weak sound waves will be unable to break through the water's surface tension and will be reflected from the surface back down into the water. If a listening device is placed above the water's surface, it will not be able to detect these reflected sound waves.

If an acoustic (sound) microphone is being used to locate a fault in a submarine cable, a metal boat should not be used. If a metal boat is used, sound waves coming from the fault will bounce off the metal hull and produce a loud "ping" that will be picked up by the microphone. This "ping" will confuse the acoustic microphone and will make it difficult to reliably locate the fault. Because wood or fiberglass materials are much less dense than metal, any sound waves that reflect off wood or fiberglass hulls are much weaker and will not cause strong "pinqs". Wood or fiberglass boats should be used when locating faults In submarine cable.

f. Surface Reflection

Like water, the top layer of soils has a tougher "skin" that can reflect sound waves back down into the earth. The surface layer of soil can become more dense than the soil beneath it due to rain compaction, sun baking, wind erosion, and the filling of soil voids by dust and other sediments. The harder or more dense the soil surface is, the more reflection of sound waves there will be.

To a sound wave, a change from soil to air, water to air, soil to concrete, soft soil to hard soil, and even hard soil to soft soil "looks" like a "surface." Any such "surface" will cause sound waves to be reflected and sound energy (amplitude) to be lost. This happens because each material has its own unique physical characteristics which determine how fast sound will travel through it, so each material has its own "speed of sound." When a sound wave runs into a material with a different speed of sound than the one through which it has been traveling, the sound wave acts like this is a "surface" and part of the wave is reflected, The more difference there is in the speed of sound between the new material and the old material, the more energy the sound wave is going to lose in getting through this "surface." Because the speed of sound in air is by far the slowest of any single material, sound waves lose more energy when they cross from another material into air.

V. Microphones

A. Ground- Contact Microphones

Ground-contact microphones pick up sound waves when they are placed in direct physical contact with the ground or some other solid material. They work well on hard surfaces such as concrete and asphalt because sound waves will make these materials resonate like the skin on a drum or a guitar string. Sound waves traveling through the earth strike the bottom side of these materials and are reflected. When the sound waves bounce off these surfaces they lose energy, and the energy lost is transmitted to the harder material and causes the concrete or asphalt to vibrate, or resonate. The ground-contact microphone detects this vibration and creates a corresponding sound in the headphones. The pickup element in the microphone acts like a phonograph needle on a record; any movement will produce a sound. As long as there is good contact (no air spaces) between the soil and the concrete or asphalt, ground-contact microphones allow good detection of the thump at a long distance from the cable fault. However, since any sound travels fast and without much energy loss through hard materials, it is easy for background noises from cars, machinery, people, dogs, birds and other sources to reach the microphone. Sound waves from these background noise sources can strike the concrete or asphalt at some distance away, and they will travel quickly to the microphone and may cover up the sound of the thump.

Ground-contact microphones do not work well on porous materials containing a lot of air spaces, such as soil, sawdust. bark dust and sand.

B. Earth-Probe Microphones

To solve the type of problems encountered with ground contact microphones on surfaces that are not solid, A-Tronics-Europe developed an earth-probe microphone for use in soils and other "soft" materials. By stabbing the earth probe microphone through the surface skin, or top layer of soil, sound waves from the thump can be detected before they have a chance to reflect from the soil's surface or disperse into the air (either above ground or in near-surface pockets in porous soil). Earth-probes also eliminate many background noise problems. Sound waves originating at the cable fault travel directly through the soil to the earth-probe microphone. But sound waves from above-ground noise sources have to travel through the air, which has the slowest speed of sound, and through the air-to-soil "surface" before they can reach the earth-probe microphone. Thus, many background noises lose their energy and are filtered out before reaching the microphone.

Because they pick up much less background noise, earth probe microphones should be used whenever possible. If a cable route lies under a sidewalk, for instance, using an earth-probe microphone in the soil to one side of the sidewalk will allow the operator to hear the thump more clearly. With less background noise entering the

microphone, a higher sensitivity setting can be used on the acoustic detector, which will allow the operator to hear the thump at a greater distance.
If field conditions allow the operator to use either an earth probe or ground-contact microphone. the earth-probe microphone will produce better results.

VI. Fault-location - Procedures & Operation

A. Pre-Location - Before You Begin

a. Trace the Cable Route
Before you can begin locating the exact position of the fault, you must locate the cable route and trace it.
While you are tracing the cable route, watch for any signs of construction or digging near the route, since these might be an indication of where the cable fault is located.

b. General Equipment Setup

Use the following steps in initially setting up the equipment for the fault-location process:
1. Connect the thumper to the cable and start It.
2. Check the batteries in the DAD by rotating the OFF-ON switch through both "BATTERY TEST" positions and observe "DIRECTION TO FAULT" meter for "BATTERY OK" position.
Note: If one battery needs to be replaced, replace both batteries, It is important to have both batteries operating at or near the same voltage.
3. Set the LOGIC TRIP SENSIVITY control to “0”.
This control (and meter) will not be used until you have located the general vicinity of the fault and have a need to use two microphones.
4. Use the procedures described in the following sections to set the BALLISTIC IMPULSE SENSITIVITY and ACOUSTIC SENSITIVITY controls for your fault-location search.

B. Finding the General Area of the fault

There are two methods you can use to quickly find the general area of the cable fault. You can use the BALLISTIC IMPULSE METER only, or you can use a single microphone connected to the DAD, In either of these methods, the BALLISTIC IMPULSE METER plays an important role.

a. Ballistic Impulse· How It Works
The BALLISTIC IMPULSE METER allows the operator to "see" the output pulse from the thumper as it travels down the cable's route, This meter gives you a "reference signal" so you know when each thumper pulse occurs or can see the rate at which the thumper IS pulsing the cable. The D.A.D.'s ballistic impulse circuitry detects the thumper's pulse without a microphone being connected to the instrument. This makes it possible to search for the general area of the fault without using a microphone, as explained below.

b. Setting the BALLISTIC IMPULSE SENSITIVITY
At full gain, the Ballistic Impulse Meter can pick-up the thumper pulse at considerable distance from the route of the cable. The lowest sensitivity setting that will provide a small meter reading should always be used. This will help you quickly find the general vicinity of where the fault is located.

To set the ballistic impulse sensitivity control move 10 to 20 feet away from the thumper and 5 to 10 feet off to one side of the cable path. Set the Ballistic Sensitivity for a small pulse when the thumper fires. About 1 1/2 to 3 on the meter dial. Walk the cable route keeping the same approximate distance from the cable path as used in setting the sensitivity control. THIS SAME METHOD OF PRE· LOCATION CAN BE MADE FROM INSIDE THE PICK UP AND DRIVING THE ROUTE OF THE CABLE. SET THE ELECTRONICS ON THE FRONT SEAT AND ADJUST FOR THE SAME 1 1/2 TO 3 ON THE METER WHEN THE THUMPER FIRES, (The above adjustment can be made 20 to 30 feet off to one side of the cable path providing this same distance can be maintained during the search for magnetic wave fall off.

c. Quick Search with BALLISTIC IMPULSE Only

With the right setting on the BALLISTIC IMPULSE METER, you may be able to quickly locate the general vicinity of the fault without using a microphone. As each thumper impulse travels down the cable, most of the thumper's energy is lost at the fault as the voltage breaks through to ground.

However, some of the thumper's energy will be forced past the fault to continue down the cable, With the BALLISTIC IMPULSE METER set at a high sensitivity, the meter will still detect the part of the thump that gets past the fault, so you will continue to see a meter reading even after you drive or walk past the fault. This is why you should try to use the lowest possible setting for the BALLISTIC IMPULSE SENSITIVITY control. With this control set at the lowest sensitivity that still shows a clear reading before you get to the fault, the meter will stop showing a reading within a very short distance after you have passed the. fault. In other words, If you set the control to give you just enough sensitivity to show a small meter reading as you start traveling the cable route, the meter will stop showing a reading soon after you pass the area of the fault. By doing this, you can quickly find the general area along the cable route where the fault is located.

d. Connecting and Using 1 Microphone

Once you have located the fault's general area by using ballistic impulse, or if you cannot detect the fault area using that method, connect one (1) microphone to the DAD instrument. Follow these procedures:

1.Connect one microphone to the DAD and activate that CHANNEL with the corresponding toggle switch.
The toggle switches can be locked on by pushing them into the up position, or they can be put into a "momentary on" mode by pushing them down.

2. Make sure the LOGIC TRIP SENSITIVITY control is set at "0", since this meter is only used when two microphones are being used.

3. Connect the headphone set to the instrument and put it on, making sure that the headphones are set to STEREO and that the cord entering one side of the headphones runs to your LEFT ear.

e. Setting the ACOUSTIC SENSITIVITY Control

In general, the lower you set the acoustic (sound) sensitivity, the more background noise you will filter out. The actual control setting which works best will depend on the operator's hearing and the conditions in which the operator is working.

To make the proper ACOUSTIC SENSITIVITY control setting, watch the BALLISTIC IMPULSE METER as you adjust the ACOUSTIC SENSITIVITY, You will be hearing the real thump (not background noises that might sound like the thump) at the same rate as the BALLISTIC IMPULSE METER is showing it. So, when you are hearing thumps at the same rate as you are seeing them on ,the BALLISTIC IMPULSE METER, you have found a setting for the ACOUSTIC SENSITIVITY CONTROL that will work.

If you can hear the thump when you connect the first microphone, you are ready to connect the second microphone and start locating the exact position of the fault.

If you cannot hear the thump after connecting the first microphone and trying to adjust the ACOUSTIC SENSITIVITY, walk the cable route until you find the area where you can hear the thump.

VII. Finding the Exact Area of The Fault

A. Connecting and Using 2 Microphones

When you can hear a clear thump that corresponds with the thumper pulse shown on the BALLISTIC IMPULSE METER, connect the second microphone to the other terminal and activate that CHANNEL, too. Make sure that headphones are set on STEREO and that the cord entering one side of the headphone set runs to, your LEFT ear, You are ready to start finding the exact location of the fault.

B. Positioning the Microphones on the Cable Route

Both microphones must be positioned on the cable route, and they should be positioned at least 30 inches apart. If the microphones are too close together, you may not be able to locate the exact position of the fault.

With the microphones set far enough apart, the sound from the thump reaches one microphone before it reaches the other. When the thump reaches the first microphone, electronic Circuits In the DAD shut off. the second microphone before the sound reaches it a fraction of a second later. This allows the Instrument to figure out and show the direction to the fault. If the microphones are too close together, the electronic circuits don't have

enough time to shut off the second microphone before the thump sound reaches it. And if this happens, you will get a confusing signal from the instrument.
In general, placing the microphones 30" apart will give the instrument enough time to work properly. On a hard surface, like cement, you may have to place the microphones more than 30" apart because the thump sound travels faster in hard materials. In dirt, you may be able to place the microphones less than 30" apart because the thump sound travels slower in materials filled with a lot of air spaces.

C. Setting the LOGIC TRIP SENSITIVITY

When you have placed both microphones over the cable route and the thumping sound in the headphones corresponds with the thumper impulse shown on the BALLISTIC IMPULSE METER, you can set the LOGIC TRIP SENSITIVITY. To make the proper setting on the LOGIC TRIP SENSITIVITY control, slowly increase the setting (from "0" toward "10") until the DIRECTION TO FAULT meter is tripping in only one direction. When this starts happening, check to make sure that you are ,getting a true logic trip signal. If you are getting a true signal, you Will be getting three (3) signals that are all happening at the same rate:

a). DIRECTION TO FAULT meter signal, showing one direction only,
b). Thump heard in the headphones, and,
c). BALLISTIC IMPULSE METER signal, showing the thump impulse traveling through the cable.

If the DIRECTION TO FAULT meter signal does not correspond with the other *two* signals, you are getting a false logic trip signal. Two things can cause a false logic trip signal: 1) too much background noise, or, 2) microphones too close together.
To eliminate a false logic trip signal, first reduce the ACOUSTIC SENSITIVITY control setting until the thump can just barely be heard In the headphones, This will cut out as much background noise as possible. Make sure the microphones are far enough apart. If false tripping still occurs, reduce the LOGIC TRIP SENSITIVITY control to the lowest possible setting that will still trigger a signal on the DIRECTION TO FAULT meter.

D. "Zeroing In" on the Fault

When the thump you hear in the headphones corresponds with the signals on both the DIRECTION TO FAULT meter and the BALLISTIC IMPULSE METER, you can start "zeroing in" on the fault.
Make certain that the DAD instrument is positioned correctly relative to the microphones, The microphone cables to the instrument should not be crossed. The DAD should be positioned so that the microphone to the right of the instrument is connected to the right-hand terminal, and the microphone to the left is connected to the left-hand terminal.

Notice, the direction in which the DIRECTION TO FAULT meter is tripping. The cable fault lies in that direction. Move both microphones approximately 3 feet along the cable route in this direction and set them down at least 30" apart. At this point, again, the DIRECTION TO FAULT meter will show the direction in which the fault lies. Keep repeating this processes, moving along the cable route until you reach a point where the DIRECTION TO FAULT meter reverses and points back in the opposite direction.

The first time the DIRECTION TO FAULT meter points back in the opposite direction, mark this spot on ground.
Next, still keeping the microphones 30" apart, move them back in the direction you just came from, but only move them about 1 foot along the cable route. If the DIRECTION TO FAULT meter still points m the same direction It did the last time, move the microphones another foot along the cable route. When the. DIRECTION TO FAULT meter reverses direction again.' make a mark on the ground half way between the two microphones. Then move the microphones 1 foot back In the direction you just came from.

By moving the microphones 1 foot at a time along the route, and by reversing the direction you move each time the DIRECTION TO FAULT meter reverses direction, you will reach an area where the DIRECTION TO FAULT meter reverses direction each time you move the microphones from one spot to the other. When you find these two positions, make your final marks on the ground, half way between the microphones, at each of these positions.
The fault in the cable should be approximately halfway between these two final marks. By readjusting all of the controls to the lowest possible settings that will maintain a good sound in the headphones and good meter responses, you may be able to zero in on the fault even tighter.

E. Verifying the fault’s Location

The final step you should take is to verify the location of the fault. To do this, set one microphone directly on top of the position of the fault. Set the other microphone 30" away and take a reading With this second microphone In each of four (4) positions:

a). 30”up the cable route,
b). 30” down the cable route,
c). 30” to one side of the cable, in line with the fault, and,
d). 30” to the other side of the cable.

This will give you readings on all four sides of the fault at 90 degree intervals. As you do this, remember to avoid crossing the microphone cables.

If the DIRECTION TO FAULT meter pulses toward the center microphone in each of the four test positions, the fault is under the center microphone. If the center microphone is directly over the fault, the DIRECTION TO FAULT meter will always trip toward the center microphone no matter where the second microphone is placed - as long as it is far enough away that the D.A.D.'s electronics have time to work before the thump reaches the second microphone.

Remember - the speed at which sound travels is faster or slower depending on the materials through which it is moving. As you verify the location of the fault, make sure the second microphone is far enough away from the center microphone to give the instrument's electronics time to work.

If the DIRECTION TO FAULT meter does not point toward the center microphone in one in anyone of the positions where you place the second microphone, then the center microphone is not really above the cable fault. This means that the center microphone is off to one side of the cable route. If this happens, the cable route must be retraced in the area of the fault, or the microphones must be relocated in the direction indicated by the "odd" DIRECTION TO FAULT meter reading and the steps used to verify the fault's location must be repeated.

VIII. Service and Warranty Information

A. Service

If you have trouble with the D.A.D. instrument or require assistance for any reason, contact the nearest A-Tronics-Europe sales outlet. You may also call or write directly to the A-Tronics-Europe, to explain your problem or the type of assistance you need.

B. Warranty

All A-Tronics-Europe products are warranted against defective materials and workmanship.

The Directional Acoustic Detector (D.A.D.) is covered by a one-year warranty.

A-Tronics-Europe will repair or replace all products which prove defective during the warranty period. All repairs will be performed at our manufacturing plant or at one of our field service centers, A-Tronics-Europe retains sole and exclusive right to determine where repairs are to be made and to determine if defects are covered by warranty or are the result of misuse and/or abuse of the instrument and thus, not subject to warranty repair or replacement.

All instruments shipped to the factory must be sent prepaid; no collect or C.O.D. shipments will be accepted.

ANY ATTEMPTS BY UNAUTHORIZED PERSONNEL TO REPAIR ANY A-TRONICS-EUROPE, INSTRUMENT WILL AUTOMATICALLY VOID THE WARRANTY COVERING THAT INSTRUMENT.