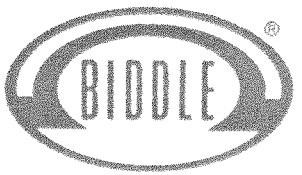

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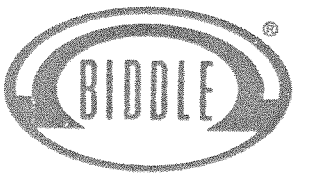
Instruction Manual
651103Jb

for use of the

Acoustic Impulse Detector

Catalog Number 651103
and Accessories



Biddle Instruments

BLUE BELL, PA. 19422

INSTRUCTION MANUAL
651103-Jb
Biddle Catalog No. 651103
Acoustic Impulse Detector
and Accessories

BIDDLE Instruments
Blue Bell, PA. 19422

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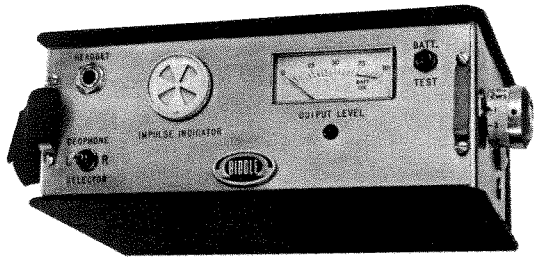
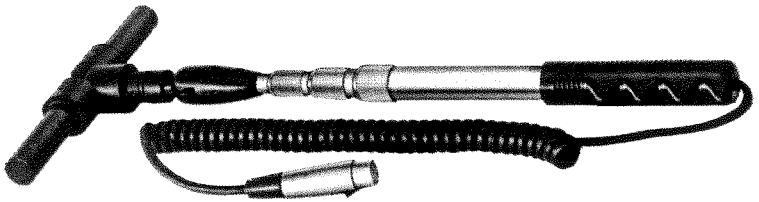


Amplifier unit of the Catalog No. 651103 Acoustic Detector



Catalog No. 651106 Surface Coil option.

Figure 1: The Catalog No. 651103 Acoustic Impulse Detector with Accessories and Available Options.

Section A
GENERAL DESCRIPTION

Introduction

The Catalog No. 651103 Acoustic Impulse Detector is a unique detection system designed to locate faults in direct buried electric cables by tracing the intensity of sound waves emitted from an arcing fault when it is impulsed. The Acoustic Impulse Detector can be used with impulse generators manufactured by BIDDLE Instruments or those of other manufacturers. The Acoustic set is designed for use in all weather and can easily be carried by the operator to any field location. A sturdy carrying case is provided for storing and transport.

In using the Acoustic Impulse Detector the operator first places a pickup element on the ground and listens for the characteristic "pop" or "thump" of escaping electrical energy in the earphones, moving along a line toward the location of the loudest sound. The set has a calibrated sound intensity meter which is used to make a final precise location of the point of maximum sound which will be directly over the fault. The meter often can be more sensitive than the ear in detecting a very weak acoustic signal. The meter and a solid state amplifier are contained in a lightweight compact housing which can be carried by an adjustable strap around the neck, leaving the hands free to operate the instrument.

Figure 2 shows a schematic representation of the system.

An important feature of the Acoustic Impulse Detector is the Impulse Indicator. This is an entirely separate system within the detector which detects the current pulse as it is applied to the faulted cable, giving a visual signal to the operator. When the operator is at a distance from the impulse generator and cannot see or hear it operating, the indicator verifies if the impulse generator is operating and tells the operator exactly when to listen for the thump and to watch the meter. This is very useful where there is high background noise. The Impulse Indicator, complete with its magnetic antenna, is included in the main amplifier housing. (See Figure 1.)

Section B
SAFETY PRECAUTIONS

SAFETY IS THE RESPONSIBILITY OF THE USER.

LA SEGURIDAD ES RESPONSABILIDAD DEL OPERADOR

This equipment itself is not a source of possible electrical hazard. However, it may be used in the presence of dangerous potentials such as energized cables or equipment. Also, a capacitive discharge type transmitter may generate hazardous potentials. Care must be exercised in the use of this equipment under these conditions.

Section C

RECEIVING INSTRUCTIONS

Check the equipment received against the packing list. Notify BIDDLE Instruments, Blue Bell, Pa., of any shortage.

Examine the equipment for damage received in transit. If any damage is found, file a claim with the carrier at once and notify BIDDLE Instruments or its nearest representative, giving a detailed description of the damage observed.

Your Biddle Acoustic Impulse Detector has been thoroughly tested and inspected to rigid specifications before shipping. It is ready for immediate use when operated as described in this manual.

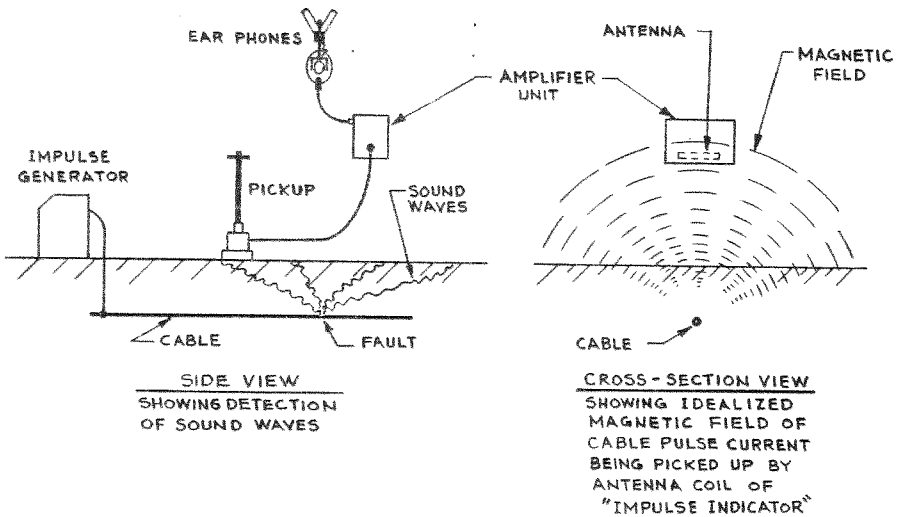


Figure 2: Use of the Acoustic Detector

Section D

DESCRIPTION

The Acoustic Impulse Detector Cat. No. 651103, is comprised of the following items:

Amplifier Unit with neck strap
Earphones with cable and jack
Two Pickups including cables and connectors
Two 2-piece handles for the pickups
Instruction Manual
Fitted Carrying Case

Optional

One Pickup Shield
One Surface Coil

Amplifier Unit: Measures 9" long x 3 1/4" wide x 6" high, and weighs 2 3/4 lbs. This unit contains electronics, battery, indicators, controls, and impulse antenna in an aluminum housing with black leather-grained plastic covering. A black adjustable neck strap measuring 55" long and 1" wide is permanently attached to the Amplifier Unit. Receptacles for two pickup plugs are located one at each side of the case.

The Earphones are of standard industrial quality wired especially for 150 ohm impedance. The weight is 1 lb.

The Pickups are made up of velocity sensitive elements enclosed in cast aluminum housings. Each unit is complete with a 10 ft. shielded neoprene jacketed cord terminated with a 3-pin connector. The pickups are sealed, and are waterproof and shock resistant. The complete pickup assembly weighs 1 1/2 lbs., while the pickup itself measures 2 1/4" high x 2 3/4" dia. with a bayonet-type, quick disconnect handle stud on the top. The handle measures 13 1/2" long, and weighs 1/2 lb.

The two pickups are identical and interchangeable except for color coding at each end of the cables: red for the right side; blue for the left.

Section D (Continued)

DESCRIPTION

The Carrying Case is made of black molded fiberglas, with black foam chambered inner cushion to protect each of the set components. The case is designed to be rain-proof when closed. The case dimensions are 8" x 12 7/8" x 17 5/6". The weight of the complete set and case is 15 lbs.

OPTIONAL ITEMS

Pickup Shield Cat. No. 651107, is an aluminum casting measuring 4 3/8" high x 5" dia. and weighing 1 1/2 lbs.

Surface Coil Cat. No. 651106 consists of an electromagnetic pickup coil in a T-swivel housing connected to a telescoping handle with hand grip, 6' of coiled cord and a connector. It measures 18" when retracted and 30" when extended.

Section E

CONTROLS AND INDICATORS

All controls and indicators are contained within the Amplifier Unit.

Gain: The edge-marked knob on the right side of the Amplifier Unit permits gain adjustment of the amplifier which converts the vibrations into a meter deflection and a headset signal. This control is calibrated from 1 to 10,000.

Pickup Selector: This two-position toggle switch connects either the left or right pickup to the detection system.

Batt. Test: This pushbutton switch permits battery testing at any time the unit is in operation.

Headset Jack: This jack is not a control of itself, however, the power "on-off" switch is a part of it; power is applied when the headset plug is inserted.

Output Level: The taut band meter gives a quantitative measurement of the intensity of the underground sound vibration. When the "Batt. Test" button is depressed, the meter serves as a battery condition indicator.

Impulse Indicator: The four-segment rotary indicator shows the propagation of a current pulse by changing from white to red for about 1/2 second.

Section F
OPERATION

General

Note: The operating ambient temperature limits are determined by temperature limits of the battery used. This is from 0^0F to 120^0F for the battery specified. Store the detector at a temperature of 70^0 to 75^0F for best battery life.

Before using the Acoustic Impulse Detector, it may be useful for the operator to become familiar with the equipment by making the Operational Test described in Section G, Maintenance.

Before starting the search for a fault, its general locality must be established by using other instruments such as a bridge, surface coil, radar test set, or other fault evidence. The impulse generator should then be connected and adjusted to cause an arc at the fault.

The size of the impulse generator necessary to create an arc at a fault depends upon the cable voltage rating, type of cable and installation, and the electrical resistance of the fault to be located. A broad line of cable "thumpers" designed to meet the requirements of practically any installation of primary and secondary distribution cable is available from BIDDLE Instruments. Descriptive information is available upon request.

After the impulse generator has been applied so as to create an arc, the voltage should be adjusted to the maximum level permissible in order to obtain the loudest possible thump from the fault. Generally, impulse voltages that do not exceed the corresponding values adopted for high voltage dc proof testing may be applied at intervals of a few seconds without harming good insulation. These proof-test values should be determined according to prevailing IPCEA standards, the cable manufacturer's recommendations, and local utility practices.

Test Procedure Using Acoustic Pickup

The detector should be removed from its transit case and assembled. The amplifier is designed to be comfortably slung from the neck by an adjustable strap. The earphones may be adjusted to fit comfortably on the head. Plug the earphones into the amplifier and check the battery condition by pressing the "Batt. Test" button. If the meter indication falls below the green zone, the battery should be replaced. Connect one pickup to start. The red coded pickup cable should be inserted in the

right side socket and the blue coded pickup in the left. The second pick-up may be connected and carried in the operator's pocket until it is needed, (after the thump is initially detected.)

Check the operation of the impulse detector. The indicator flag should switch to "red" for a moment each time there is a current pulse in the vicinity. Stand over the cable near the impulse generator and make sure this signal is observed.

Now proceed to trace for the fault along the surface route of the cable, first setting the controls as follows:

Gain: about 300 to 500
Pickup Selector: L or R, to select the pickup connected to the left or right receptacle.

Place the Pickup firmly in contact with the surface of the ground. Use the handle, or, without the handle, lower the Pickup by its cable and move it into place with the foot. The handle should be removed while observing the impulse in order to reduce wind and ambient noise. (Note: The Pickup must lie flat to within ±30 degrees of the horizontal to operate properly). The Pickup Shield may be used as needed to provide additional shielding from wind, traffic noise and raindrop interference. Place the Shield over the Pickup, not touching it. Also, it is helpful to stand on the cord about 2 ft. from the Pickup to reduce the wind noise carried along the cable.

If little or no sound is detected, increase the Gain located on right end of Amplifier Unit until the background noise registers 10% to 20% on the Output Level meter. Try to detect the sound of the impulse which will occur at the same time the red flag of the impulse detector flips into view. Listen for a "thump" in the earphones and watch for a kick of the meter. If neither signal is observed, proceed to spot the pickup every 25' along the cable run until sound is detected. After the signal is picked up, proceed along the cable run in the direction of increasing signal strength. As the fault is approached, reduce the gain to maintain about a 25% of full scale kick on the meter. When the intensity of the thump starts to decrease, the fault location has been passed. Re-trace the path until the point of maximum intensity is located. Under normal conditions the fault lies directly under this point.

Section F (Continued)
OPERATION

The use of two Pickups in the vicinity of the fault usually speeds fault location by allowing faster comparison of the intensity from two locations. Spot the two Pickups 10 to 12 feet apart along the cable run and observe their outputs alternately by changing the position of the Pickup Selector switch. Since the pickup responses are matched, equal meter indication at the same gain indicates very nearly equal distances from each pickup to the fault. Un-equal signals indicate the fault is closer to the Pickup giving the louder signal. Reduce the distance between the Pickups until no further change can be detected. Now the signal should be maximum from both Pickups. Under normal conditions, the fault is centered between the Pickups.

PRINCIPLES OF OPERATION

The block diagram shown in Figure 3 describes the functional relationship of the various system components.

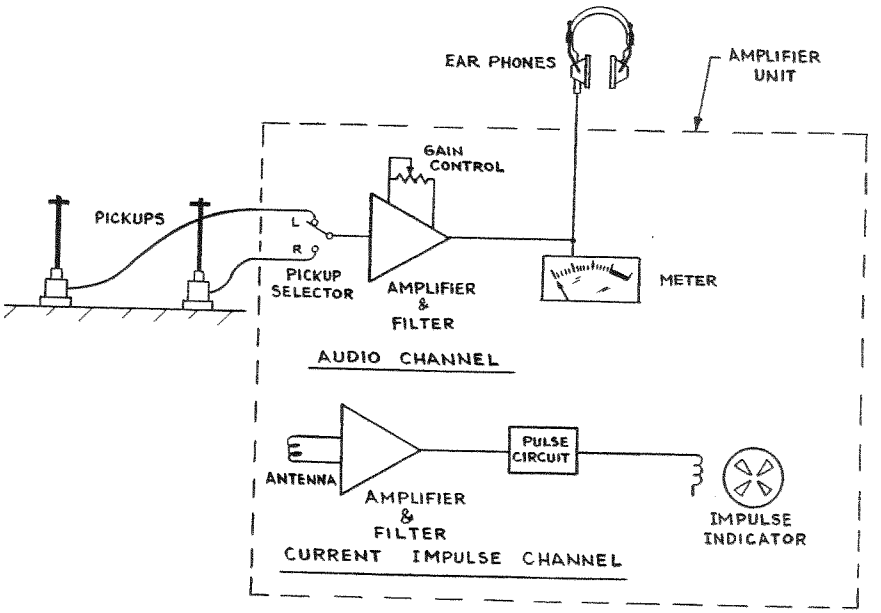


Figure 3: Block Diagram of Acoustic Impulse Detector System

In the audio channel, a voltage signal from the selected pickup is sensed by the amplifier; amplified, and passed to the output level meter and earphones. The gain control adjusts the output signal strength. The pickup itself is a vibration-sensitive transducer which responds to the thump generated by the discharge at the fault. The pickup is designed to emphasize the frequency range of the useful signal and to reject noise of higher and lower frequencies.

In the current impulse channel, a voltage is generated in an antenna coil by the magnetic field of the test current impulse. The antenna is located in the bottom of the Amplifier Unit. When the impulse signal is received, the amplifier output generates a pulse about 1/2 second long which causes the Impulse Indicator to show its red flag. The frequency band of this channel can respond to radio transmissions; however, it is not affected unless the set is within 100 yards of a high-power transmitting antenna. The Impulse Indicator tends to respond at a fairly wide range of distance from the cable being impulsed because of its sensitivity, and the fact that current flows through various ground return paths as well as through the cable.

When the "Batt. Test" button is pressed, the Ouptut Level meter is connected across the battery as a 10-volt voltmeter. The battery is under load during this test.

Test Procedures Using Surface Coil.

The Surface Coil, Cat. No. 651106, is used primarily to locate and trace the route of underground cable so that the acoustic pickup may later be spotted over the cable as accurately as possible. In addition, it can be used to estimate the depth of the cable. In some cases, the Surface Coil may also be used to find the approximate location of a fault as described later, but this is a secondary purpose.

The Surface Coil is an electromagnetic receiver that responds to any of four different kinds of signal current from an underground cable: the periodic high voltage impulse, the burning current in the proof test mode, the output, up to 1000 Hz from a tone generator such as the Biddle Cat. No. 656610-1, or the 60 Hz current in a loaded power line. It enables tracing of the cable route with the same HV impulse generator and acoustic detector used to locate a fault, thus eliminating the need of a separate tone generator and tracer. Whenever possible, the use of the proof test current is preferred over the impulse because it provides a continuous signal that is much faster to trace than the periodic impulse.

Section F (Continued)

OPERATION

The Surface Coil may be used on unfaulted and faulted cable. In either case, assuming the cable is deenergized and isolated from the power source, the impulse generator or the tone generator should be connected at one end between the conductor and ground, while at the opposite end the conductor should be directly connected to an earth ground. This creates an unbalanced condition by means of an earth return and thus avoids a concentric or parallel return on the cable shield that would only serve to cancel the forward signal on the conductor. In this way, the signal carries from end to end even where a fault exists in between.

To trace the route, the surface coil is extended and plugged into one of the pickup sockets on the Amplifier Unit, the L-R Pickup Selector is switched to that position and the swiveled pickup coil positioned according to the intended function as indicated in the table below. The earphones must also be plugged into the amplifier unit in order to turn it on.

Table I - Tracing Functions

Function	Position of pickup coil with respect to telescoping handle.	Position of pickup coil with respect to cable being traced.	Response of meter and earphones when unit is swept from side to side in the same plane perpendicular to the cable route.
Peak Tracing	Perpendicular.	Horizontal and perpendicular.	Peaks directly over cable with fading on either side.
Null Tracing	Parallel on either side.	Parallel.	Nulls directly over cable with a peak on either side.
Depth Estimating	45^{o} angle between peak and null.	45^{o} from horizontal and vertical	Returns to the same null as above when moved a distance that is equal to the depth.
All Functions	The instrument is carried in front of the operator at a comfortable angle to the surface from front to rear.		

The peaking signal is faster to trace and is normally used for coarse work, whereas the nulling signal is slower to trace and is normally used for fine tracing prior to excavation. Nulling is also used to determine a null reference prior to estimating the depth.

Tracing should be started where the underground route is known. At that point the gain is adjusted for either the intended peak or null directly over the cable so that the pointer does not go off scale in either direction. This adjustment should remain fixed for subsequent tracing. The Surface Coil is then swept from side to side as the operator advances toward the direction of the most pronounced signal, meanwhile keeping the handle parallel to the plane of the cable and avoiding the tendency to swing it in an arc from side to side so that the pickup coil maintains as constant a spacing over the surface as possible.

If the underground route is not known to start, the gain is adjusted to mid-scale and the Surface Coil is swept in a gridlike pattern until the desired signal is detected, at which point it may be necessary to readjust the gain to keep the pointer on-scale before the final peak or null is found directly over the cable.

To estimate the depth, a null directly over the cable is first adjusted by means of the gain control so that it rests above zero downscale with the pickup coil in the null or parallel position. A mark is then placed on the surface directly over the cable. Without changing the gain adjustment, the pickup coil is next swiveled to the 45^{0} angle and the entire instrument is restored to its original position and spacing with respect to the surface. Now, the null is lost, the pointer having moved upscale. The Surface Coil is then traversed perpendicular to the axis of the underground cable on the same side to which the pickup was swiveled, meanwhile keeping the handle parallel to the plane of the cable so that the coil maintains the same spacing over the surface, until the pointer returns to the original null. Make another mark on the surface at the spot where the pickup coil aims. The spacing between the two marks is the approximate depth of the cable below the surface. This is the distance X in the diagram in Figure 4.

Should the underground cable not maintain the original depth, as where the surface has been regraded, it may be necessary to readjust the gain, but this would not hinder the ability to trace the route.

Section F (Continued)
OPERATION

In some cases, the location of a ground fault may be indicated by loss or weakening of the signal beyond the point of fault away from the signal source. The lower the resistance of the fault, the more pronounced this effect will be. It may be more evident if the ground connection at the opposite end of the cable is cleared so that the signal goes to ground exclusively at the fault and travels no further.

Test Procedure Using the Pickup Shield.

As an optional item, the Catalog No. 651107 Pickup Shield may be helpful in detecting the sound of the underground thump under conditions of excessive background noise such as that produced by high wind, raindrops, constant street traffic, construction activity or other airborne sounds. It does not help, unfortunately, to shield the pickup from background noise that is transmitted underground.

When it is needed, the Pickup Shield is placed over the acoustic pickup so that the slot in the side surrounds the pickup cord and the pickup does not touch the shield in any way. The pickup handle can be used to lift the shield without stooping by inserting the upper cross-bar of the handle into the hole in the shield.

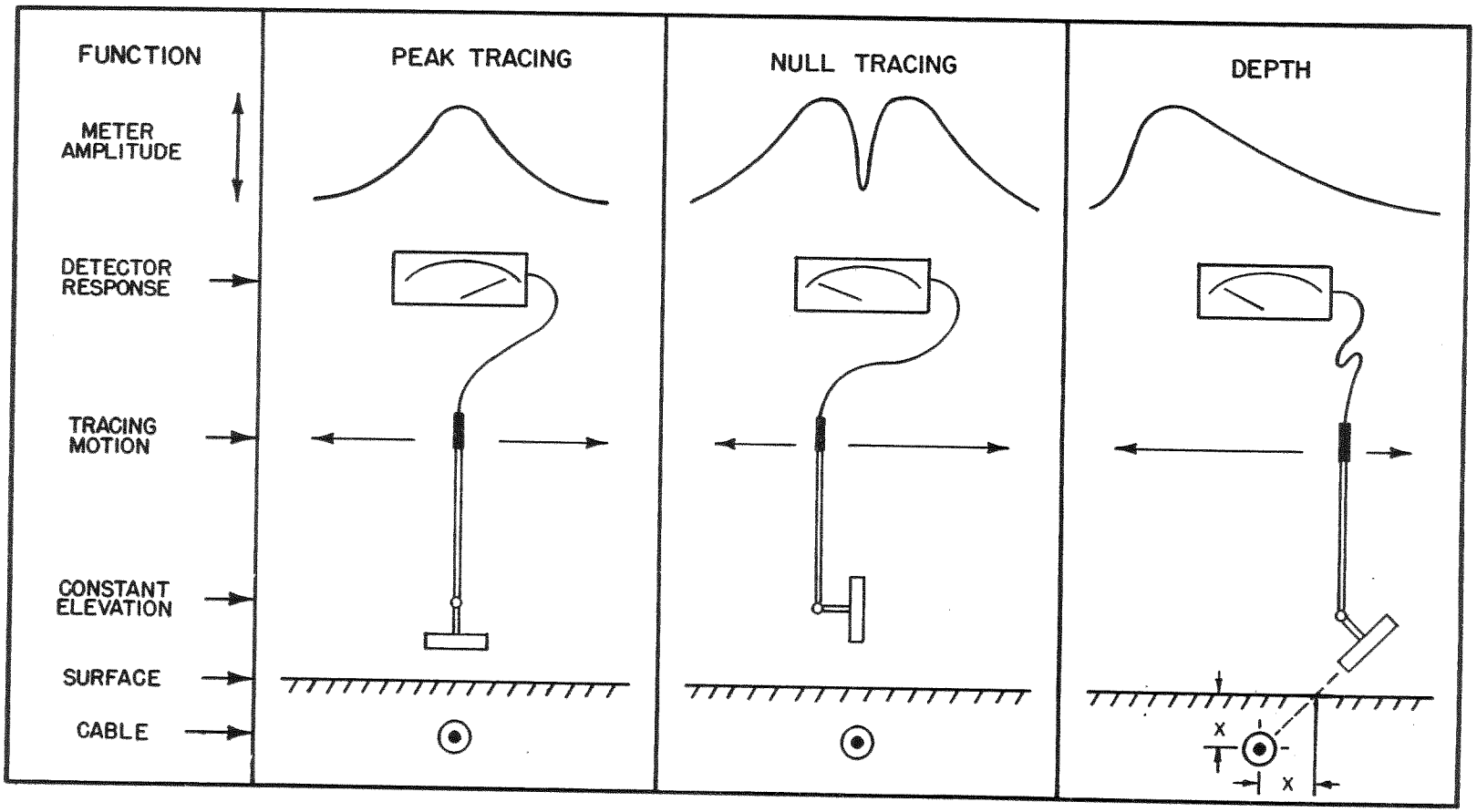


FIGURE 4: Functional Diagram for the Surface Coil.

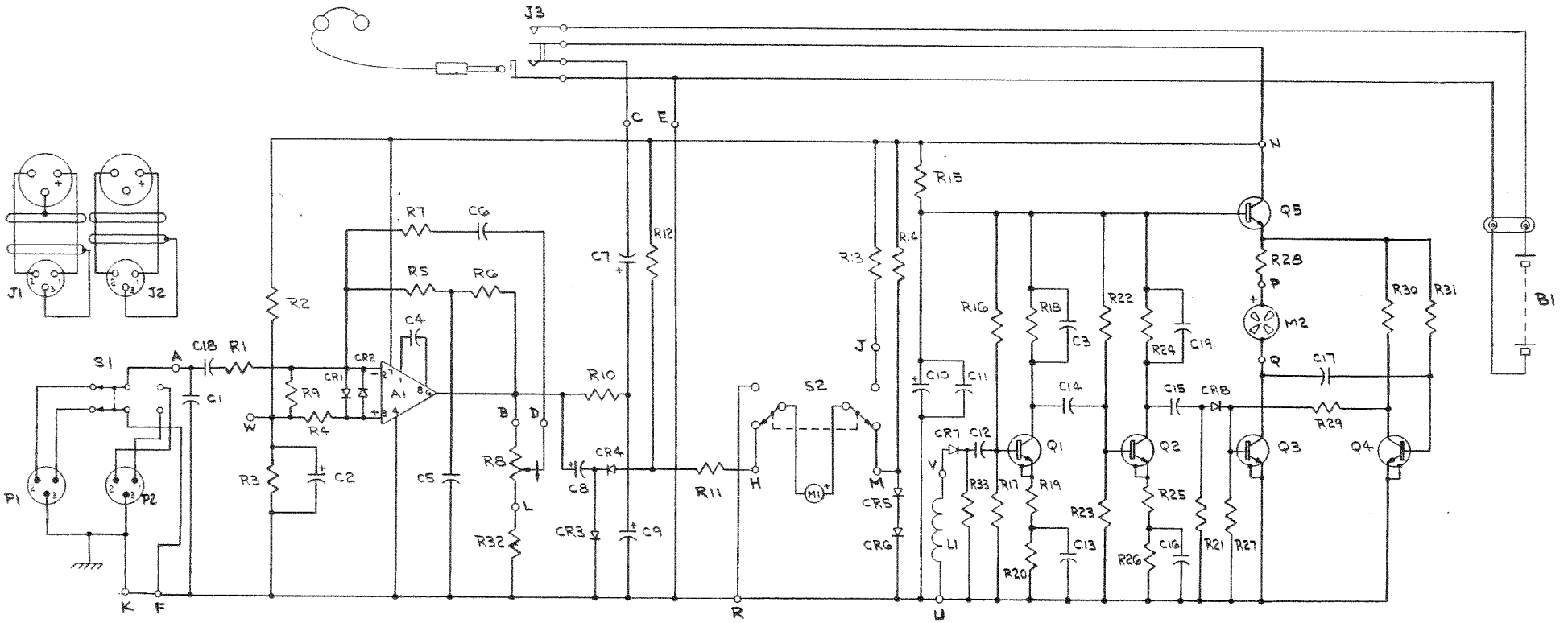


FIGURE 5: Schematic Diagram of Amplifier Unit.

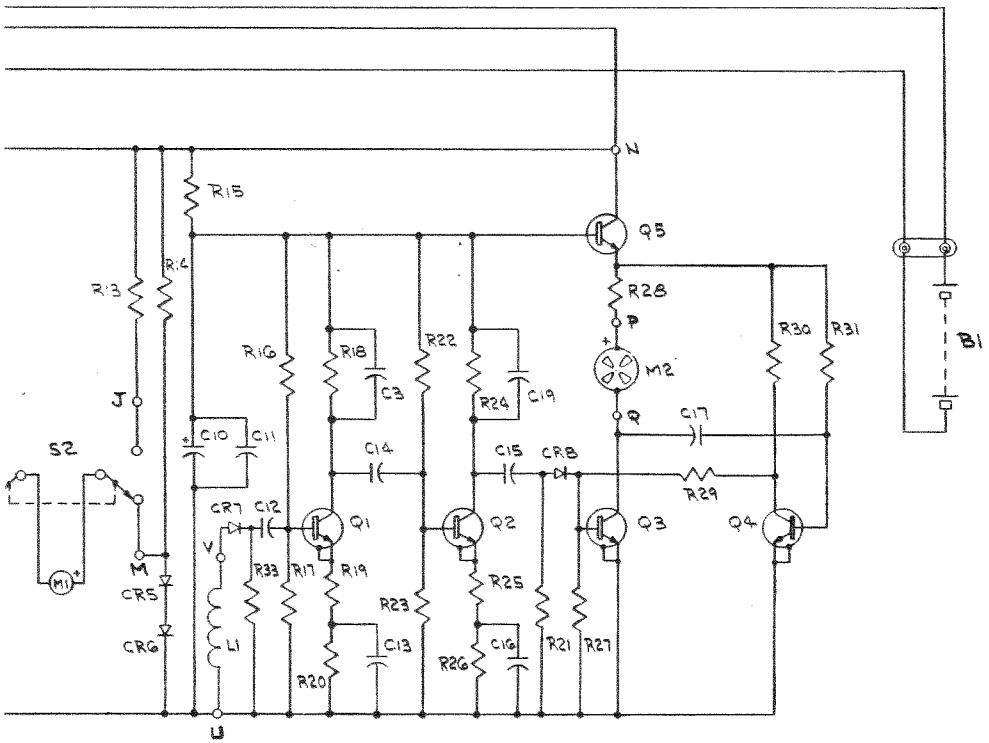


FIGURE 5: Schematic Diagram of Amplifier Unit.

Section G

MAINTENANCE

The only routine maintenance required is battery replacement.

Battery Replacement

The battery must be replaced after about 250 hours of use. A Burgess #2N6 battery or equivalent (NEDA 1602) is specified. If this battery is not available, a standard 9-volt transistor radio battery may be used with a reduced service life. A Burgess 2MN6 or equivalent (NEDA 1604D) is also recommended. If such a battery is used, use tape or other means to securely fasten it in place.

The battery replacement procedure is as follows:

1. Perform in a protected location where the unit can be handled on a bench or similar convenient working surface.

2. Remove eight (8) screws holding the black cover to the chassis assembly; carefully remove the cover and the two metal shield panels which are held by the same screws. The battery is located inside the chassis, at the bottom.

3. Lift the battery out of the clamp, turning it toward you to clear the wiring above.

4. Remove the plastic bag, disconnect, and discard the old battery.

5. Install the new battery by a reverse process, making sure it is enclosed in the plastic bag to protect the instrument from possible corrosion due to battery leakage. Make sure the battery is tightly held by the clamp before closing the case.

Operational Test

To check the overall operation of the Acoustic Impulse Detector, the following simple steps are recommended. They should be performed in an area relatively quiet and free of vibration. The sounds heard at the various settings will depend on the sensitivity of the operator's hearing.

1. Start with the Amplifier Unit on a level bench or table top, and one pickup on a sturdy, level vibration-free surface such as a carpeted floor or padded heavy table. Do not interconnect the separate parts.

The meter should read zero; if not, adjust using the screw below the meter.

2. With the headset on and the gain control set at 1, plug the headset into its jack. A single pop should be heard in the phones; afterward there should be no sound from the phones.

3. Turn the gain to maximum ("10 K" or "CWS"). A hiss should be heard starting at about 100, increasing in volume above 100. The meter should not deflect.

4. Return gain setting to 1 and set Pickup Selector to "R". Plug the pickup into the right side socket. Gently shake the pickup up and down; a rattle should be heard in the pickup and in the phones and the meter will kick several divisions. Now replace the pickup on a padded surface. Grasp the upper section between thumb and one finger and gently squeeze while slowly sliding both fingers up along the casting wall as tight as possible without actually moving the pickup. This rubbing motion should generate a noise in the phones but only a barely visible meter deflection. Repeat, but with gain at 10. Now a steady meter deflection of around 1 division should be seen with larger kicks if the fingers should stick and then slip. (The hands and the pickup should be clean to best duplicate these conditions.)

   Repeat, at a gain of 100. Meter should deflect at least 50% (10 divisions), and probably will go up 100.

5. Repeat Step 4 on the second pickup. Results should be the same with both pickups.

6. Repeat Step 4 with the pickup in the "L" channel. Both channels should respond equally to each test.

7. A very simple check of the Impulse Indicator is to insert and remove the Headset plug. This will usually trigger the flag, indicating normal function.

   A more positive test is to charge a 1-mfd capacitor to 10 volts, and discharge it through a wire within a foot or so of the detector unit (with Headset plugged in). The discharge should kick the Indicator.

Repairs

If the system does not perform as expected, the operational test of Section G should be performed. This will determine if there is actually a defect in the unit. If defective performance is noted, the set should be returned to the factory for repair according to the instructions in Section I.

However, if only one component of the system has failed, a replacement unit ordered from the factory, indicating the serial number of the system and the description and part number of the component from the Parts List (Section H). If a suitable repair shop is available, certain Amplifier Unit parts (See Parts List - Section H) can also be ordered separately.

NOTE: If repairs involving the printed circuit board are attempted, the warranty may be voided. There are no internal adjustments in any of the units.

Before attempting to make any repairs, please refer to the Warranty and Repairs Section I of this manual.

Section H
PARTS LIST

DESCRIPTION	JGB PART NO.
Fitted carrying case	12808
150-ohm headset	12833
Pickup and cable assembly, red code, W/O handle	12821-1
Pickup and cable assembly, blue code, W/O handle	12821-2
Plug connector for pickup cable	12824
Handle for pickup	12845
Pickup shield	12853
Amplifier Unit, complete with neck strap	12800
Neck strap	12809
Cover	12804
Battery (Burgess #2N6) with plastic bag	12854
Output level meter	12805
Impulse Indicator display device	12841
"Pickup Selector" switch	12119-1
Silicone rubber boot for "Pickup Selector" switch	12832-1
"Batt. Test" pushbutton switch	5431
Silicone rubber boot for "Batt. Test" switch	12832-2

Section I

WARRANTY AND REPAIRS

WARRANTY

All products supplied by BIDDLE Instruments are 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. Equipment returned to the factory for repair will be shipped Prepaid and Insured. The warranty does not include batteries, lamps or tubes, where the original manufacturer's warranty shall apply.
WE MAKE NO OTHER WARRANTY.

The warranty is void in the event of abuse or failure by the customer to perform specified maintenance as indicated in the manual.

REPAIRS

BIDDLE Instruments maintains a complete instrument repair service. Should this instrument ever require repairs, we recommend it be returned to the factory for repair by our instrument specialists. When returning instruments for repairs, either in or out of warranty, they should be shipped Prepaid and Insured, and marked for the attention of the Instrument Service Manager.