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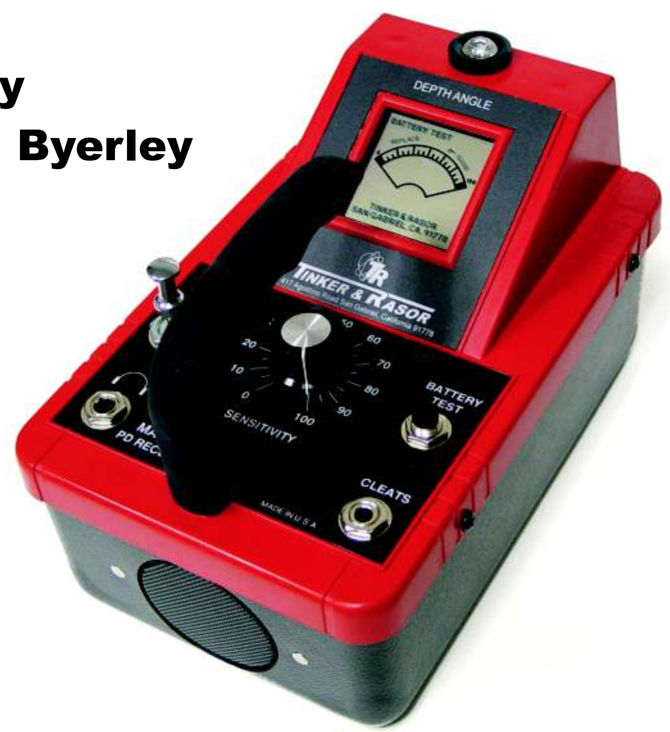

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NULL METHOD FOR LOCATING ELECTRICAL SHORTS AND OPEN COUPLINGS ON UNDERGROUND PIPELINES

This paper describes an improved method and apparatus used in locating electrical shorts and open couplings on underground pipelines.

Locating underground electrical contacts and open couplings on coated pipelines forms one of the major field problems in the installation and maintenance of a cathodic protection system. Locating and removing these contacts or open couplings is often very time consuming and expensive, particularly in urban areas where a considerable amount of the system lies under paving and in close proximity with other underground structures. Another hindrance is AC interference from overhead power lines or where the AC ground neutral is connected to the system.

The usual technique in locating major contacts or open couplings on coated pipeline systems is to apply an audio frequency signal between the coated pipeline and a good earth ground. A traverse over the pipeline away from the audio frequency generator is made by walking over the pipeline with an inductor in the form of a coil, a suitable audio receiver and earphones. Audio current flowing through the coated pipe will cause an electrical field around the pipe and by placing the inductance coil in a vertical position with reference to the pipeline, a strong signal is received. As departure is made away from the audio generator, the audio signal in the ear phones will diminish gradually depending on the condition of the coating and amount of audio energy that is being applied into the coated pipeline. These conditions also have a bearing on the distance from the audio frequency generator the operator can travel without advancing the generator. While traverse is made away from the audio generator and a rapid drop in audio is noted, an electrical contact is assumed to be at this point. This method means that a rather broad difference in audio signal level has to be observed. Further differences in audio signal can occur from interference of other pipelines in close proximity to the coated system. All of which can contribute to inaccuracies in locating the electrical contacts or open couplings.

An improvement in the method just described can be made with substantially the same equipment and which enables the operator to locate the actual point of contact with a greater degree of accuracy and a considerable saving of time. This method does, however, require that audio energy of from 5 to 10 watts be available to apply to the coated pipe system.

When alternating current of audio frequency is caused to flow in a conductor, such as a pipeline, an electrical field exists around this conductor in a plane at right angles to the conductor. (See Fig. 1.)

The intensity of the electrical field depends upon the amount of the audio current flowing in the pipe. This electrical field can be intercepted and measured by placing an inductance coil in the same plane as the coated pipe. As the coil is moved back and forth at right angles to the pipe, the field is cancelled directly over the pipe and a null effect will be noted as long as a large amount of audio current is flowing in the coated pipeline.

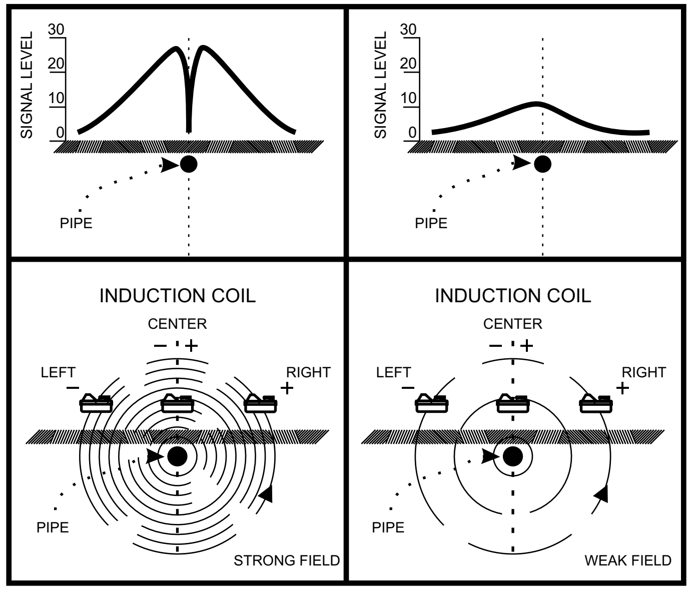

FIGURE 1

Using this null method, it is possible to follow the pipeline while a relatively large amount of audio current is flowing in it. The new method looks for the disturbance of the null rather than maximum signal strength and, therefore, give a sharper indication of the location of the electrical contact.

If the coated pipe is in contact with a foreign system that is grounded, the audio current will flow in the foreign system. The same null effect will then be present on the foreign system as on the coated pipe from audio oscillator to point of contact.

As illustrated in Fig. 2, when the null is disturbed at a given point, a square traverse is made around this point to determine in which direction the audio current is leaving the system. If, in the course of this square traverse, a point is reached

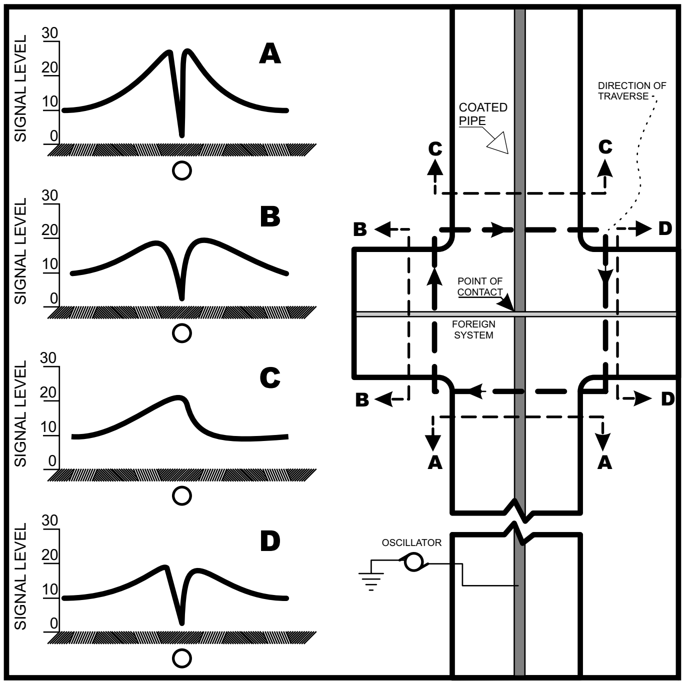

FIGURE 2

where a null occurs, it is assumed that audio current is flowing through a member below this point. If no null effect is noted in the course of the square traverse, it can then be assumed a foreign member is lying parallel above or below the coated pipe and making contact with the coated pipe. Note in Fig. 2 that no high current flows beyond the point of contact in the coated pipe.

In many gas distribution systems, insulating couplings are installed at each meter set. Many of these systems are sectionalized by means of insulators in the gas main. It is possible to check the function of the insulators at the meter set with use of the null method. By placing the audio oscillator across an insulated meter set, an excellent ground is assured since most gas systems on the dwelling side of the meter set are interconnected to a steel water system. A traverse is then made by crossing the service lines at right angles while remaining a few feet off the gas main. During this traverse the audio signal level will remain constant until a member conducting the audio current is crossed. At this point of crossing a null will occur. By following the current flow in this member using the null method, it is easily determined if audio current is flowing past the meter set. Current flow beyond meter set indicates the insulator is not functioning properly (See Fig. 3.).

This method is also extremely successful in determining the insulating qualities of buried insulators (See Fig. 4). It has been observed where potentials were measured on each side of an insulated coupling, several hundred millivolts

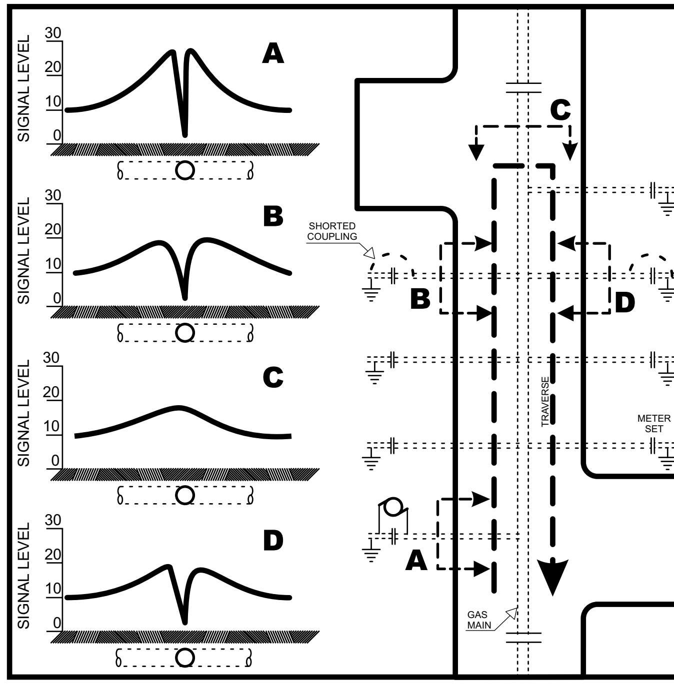

FIGURE 3

+/- difference was noted. However, when an audio current of 5 to 10 watts was applied to the coated system, it was noted that audio current was flowing through this insulated flange. With tests conducted, it can be understood that this

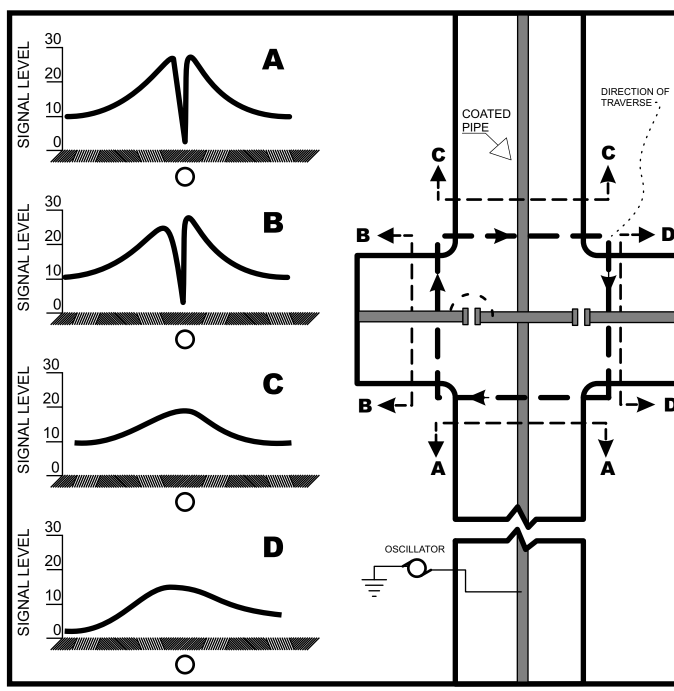

FIGURE 4

insulated coupling was considered a relatively high resistance open coupling. Potential measurement alone might indicate that this insulator was satisfactory. At a frequency of 750 cycles only a small amount of current flows through an insulator by capacitance, so that when a sharp null is obtained on the opposite side of the insulated flange, low resistance or a short is indicated.

If many electrical contacts or open couplings are present on a coated piping system, they may have to be corrected in sequence or the audio oscillator must be advanced to another location since the audio current will follow the path of least resistance back to the ground system of the audio oscillator.

It is recommended that all suspected points of electrical contact or open couplings be investigated thoroughly. This can be accomplished by advancing the audio oscillator beyond the point of null disturbance and tracing the audio current flow in the coated pipe back to the original point of null disturbance. If the null disturbance lies at the same point after traverse from both directions, it can be assumed that the fault lies beneath this point. If the point of null disturbance appears to be caused from contact with a foreign underground system (which is indicated by the square traverse around the point of disturbance, Fig. 2), the audio current can then be applied to the foreign system and traced back to the coated pipe. If audio current is flowing from the foreign system to the coated pipe, a null disturbance will be noted at the point of electrical contact. A thorough investigation can be made in a reasonable period of time and will substantiate each point to null disturbance.

It might be well to note that many electrical contacts and open couplings are located above ground. Usually the contacts are located where the coated pipe enters a building or is in contact with metal straps at bridge crossings which in turn are connected to reinforcing steel in the concrete. In either case, whether these faults lie above or below ground, the audio current flowing in the conductor can be followed.

In brief, the null method follows the flow of audio frequency current in a coated pipe, determines where it leaves and indicates where it contacts a foreign line. The point of discharge is determined by a sharp disturbance of the null itself rather than the signal level of the audio frequency.

This method is quite practical, particularly as competent corrosion field personnel can interpret their findings quickly and accurately.

When audio current of 5 to 10 watts is applied to a coated pipe, the distance between the coated pipe and the induction coil has little effect on the null method. This method has been used and proven to depths of thirty-five feet in surveys locating offshore fuel lines.

There are several primary features that are desirable to the apparatus used for locating electrical contacts or open couplings accurately with minimum time.

1. Audio generator capable of applying 5 to 10 watts of stable audio frequency.
2. Output voltage selector switch for proper impedance match to the pipe load.
3. Interrupter.
4. Receiver equipped with filters resonate to the frequency of the oscillator.

TYPICAL CONNECTION ACROSS INSULATED METER

TRUCK BATTERY USED TO POWER OSCILLATOR