Magnetomechanical markers can also be used to mark underground assets. U.S. Patent Publ. No. 2012/0068823 describes use of magnetomechanical markers in a variety of configurations to mark underground assets.

Other types of markers can also be used to mark obscured assets, as known in the art.

Each of the types of markers responds to a locating device, or locator, which generates an electromagnetic field burst that couples to the marker which in turn generates its own magnetic field as it dissipates the stored energy. Such a locating device typically includes antennas configured as transmitters, receivers, or transceivers to transmit and receive signals to and from the marker, and a user interface as discussed in further detail below. An improved locator for locating obscured markers would be welcomed.

Summary

The present disclosure is directed generally to a multi-axis portable locator for locating obscured markers. A multi-axis locator includes more than one antenna disposed on more than one axis. A multi-axis locator consistent with the present disclosure can provide additional benefits, such as allowing detection of a marker signal over a greater physical range. A multi-axis locator also allows use of markers with a variety of orientations relative to the marker to still receive a substantial signal. This can decrease marker installation time, effort and expense for obscured markers. For example, if a marker is being placed in the ground at the time a pipe is being buried, it can be dropped or placed in the ground without regard to its particular orientation. Some obscured markers are designed with multiple antennas at various orientations to allow installation without regard to landing or placement orientation of the marker. A multi-axis antenna locator consistent with the present application provides the additional advantage of detecting markers without regard to orientation of the marker, without the marker requiring a multi-axis antenna.

The present ~~disclosure includes~~invention provides, in one ~~embodiment~~aspect, a multi-axis portable locator for locating an obscured stationary, single-axis dipole marker. The locator includes a portable locator housing, a first antenna oriented along a first axis and disposed within the housing, a second antenna oriented along a second axis and disposed orthogonally to the antenna within the housing, wherein the first antenna transmits a signal along the first axis and the second antenna transmits a signal along the second axis oriented orthogonally to the first axis; and a processor. The processor is configured to interact with each of the first and second antennas, such that at least one of the first and second antennas is configured to transmit and receive signals and the multi-axis locator is configured to transmit and receive signals in both the first and second axes.

The present ~~disclosure~~ invention further ~~includes~~ provides, in another aspect, a method of locating obscured stationary single-axis dipole markers underground. The method includes providing a multi-axis portable locator, wherein the multi-axis locator comprises a first antenna and a second antenna, and wherein the first and second antennas are orthogonal to each other. The method further includes transmitting ~~a signal from one of the first or second antennas~~signals from both the first and second antennas, wherein the first antenna transmits a signal along a first axis and the second antenna transmits a signal along a second axis oriented orthogonally to the first axis; and receiving a signal from ~~a~~ an obscured, stationary single-axis dipole marker by at least one of the first and second antennas. ~~It~~ The method then includes processing the received signals to create a cumulative received signal.

What is claimed is:

1. A portable multi-axis locator for locating an obscured stationary, single-axis dipole marker, the locator comprising:

a portable locator housing;

a first antenna oriented along a first axis and disposed within the housing;

a second antenna oriented along a second axis and disposed orthogonally to the first antenna within the housing, wherein the first antenna transmits a signal along the first axis and the second antenna transmits a signal along the second axis oriented orthogonally to the first axis; and

a processor, wherein the processor is configured to interact with each of the first and second antennas, such that at least one of the first and second antennas is configured to transmit and receive signals and the multi-axis locator is configured to transmit and receive signals in both the first and second axes.

2. The locator of claim 1, further comprising a third antenna, wherein the third antenna is orthogonal to the first antenna and the second antenna.

3. The locator of claim 1, wherein the locator is handheld.

4. The locator of claim 2, wherein the first antenna comprises a coil disposed around a ferrite rod.

5. The locator of claim 4, wherein the second antenna comprises an air coil disposed on a printed circuit board (PCB) or a wire coil.

6. The locator of claim 5, wherein the third antenna comprises a coil disposed around a ferrite rod.

7. The locator of claim 6, wherein the first antenna is disposed on a first side of the PCB and wherein the third antenna is disposed on a second side of the PCB, wherein the first side is opposite the second side.

8. The locator of claim 1, wherein the multi-axis locator is configured to locate obscured radio frequency identification (RFID) markers.

9. A method of locating obscured stationary single-axis dipole markers underground, the method comprising:

(a) providing a portable multi-axis locator, wherein the multi-axis locator comprises a first antenna and a second antenna, and wherein the first and second antennas are orthogonal to each other;

(b) transmitting ~~a signal from one of the first or second antennas~~ signals from both the first and second antennas, wherein the first antenna transmits a signal along a first axis and the second antenna transmits a signal along a second axis oriented orthogonally to the first axis;

(c) receiving a signal from ~~a~~ an obscured, stationary single-axis dipole marker by at least one of the first and second antennas;

(d) processing the received signals to create a cumulative received signal.

10. The method of claim 9, wherein the portable multi-axis locator further comprises a third antenna, wherein the third antenna is orthogonal to the first antenna and the second antenna.

11. The method of claim 9, wherein the multi-axis locator is handheld.

12. The method of claim 9, wherein the received cumulative signal is the root mean square (RMS) of the received signals.

13. The method of claim 9, further comprising providing an indication to a user of a direction of the marker.

14. The method of claim 9, further comprising providing an auditory or a visual indication to a user of the proximity of the marker.

~~15. A portable locator for locating an obscured marker comprising:~~

~~a portable locator housing;~~

~~a first set of antennas disposed within the housing, the first set of antennas comprising at least two antennas disposed orthogonally with respect to each other;~~

~~a second set of antennas disposed within the housing, the second set of antennas comprising at least two antennas disposed orthogonally with respect to each other;~~

~~a processor, wherein the processor is configured to interact with each of the first and second sets of antennas, such that at least one of the first and second sets of antennas is configured to transmit and receive signals.~~

~~16. The locator of claim 15, wherein the processor is configured to process signals received by each of the first and second set of antennas from a marker to create a cumulative received.~~

~~17. The locator of claim 15, wherein the processor is configured to process signals from each of the first and second set of antennas to estimate a depth of a marker.~~

~~18. The locator of claim 15, wherein the locator is configured to locate a RFID marker.~~

~~19. The locator of claim 15, wherein the locator is handheld.~~

~~20. The locator of claim 15, wherein the first and second set of antennas are physically separated.~~