position which separates the contacts between the remote monitoring unit and the AC power source and the measurement circuit a sufficient distance to prevent any electrical arc therebetween. The normally off position of the switch and the distance between the contacts on the switch prevent failure of the remote monitoring unit from electrical surges, thereby ensuring the successful operation and substantially increasing the lifetime of the remote monitoring units.

[0027] A method of measuring instant "off", rectifier influence, and "on" potential for first and second rectifiers in cathodic protection circuits includes: (a) measuring pipe-to-soil potential while the first and second rectifiers are off and recording the instant "off" potential; (b) measuring pipe-to-soil potential while the second rectifier is on and the first rectifier is off and recording the influence of the first rectifier; (c) measuring pipeline current influence while the first rectifier is on and the second rectifier is off and recording the influence of the second rectifier; and (d) measuring pipeline current influence while the first and second rectifiers are on and recording the "on" potential. Interrupters may be used to program the sequence of turning the rectifiers on and off.

[0028] Other objects and advantages of the invention will appear from the following description.

BRIEF DESCRIPTION OF THE FIGURES

[0029] A better understanding of the present invention can be obtained when the following detailed description of the preferred embodiment is considered in conjunction with the following drawings:

[0030] **FIG. 1** is a schematic of a cathodic protection circuit;

[0031] **FIG. 2** is a schematic of a cathodic protection system;

[0032] **FIG. 3** is a schematic of a pipe-to-soil measurement unit;

[0033] **FIG. 4** is a schematic of a pipeline current measurement unit;

[0034] **FIG. 5** is a remote monitoring unit incorporating a pipe-to-soil measurement unit and a pipeline current measurement unit;

[0035] **FIG. 6** is a calibration chart showing the influence on pipe-to soil potential value of four rectifiers along 100 miles of pipeline;

[0036] **FIG. 7** is a schematic of a remote monitoring unit configuration;

[0037] **FIG. 8** is a schematic of a disconnect device for use in a preferred embodiment of the present invention;

[0038] **FIG. 9A** is a schematic of a cathodic protection system with interrupters at the rectifiers;

[0039] **FIG. 9B** is a chart of the on and off cycles of the interrupters of **FIG. 9A** when the interrupters are synchronized;

[0040] **FIG. 9C** is a chart of the on and off cycles of the interrupters of **FIG. 9A** when the interrupter time cycles are staggered;

[0041] **FIG. 9D** is a chart combining the time cycles shown in **FIG. 9**B and **FIG. 9C**;

[0042] **FIG. 10** is a schematic of a preferred embodiment of the present invention for measuring the pipe-to-soil potential of a casing that surrounds the pipeline;

[0043] **FIG. 11** is a schematic of a preferred embodiment of the present invention for monitoring a bond between two pipelines; and

[0044] **FIG. 12** is a schematic of a preferred embodiment of the present invention for monitoring pigs passing through the pipeline;

[0045] While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof are shown by way of example in the drawings and will herein be described in detail. It should be understood, however, that the drawings and detailed description thereto are not intended to limit the invention to the particular form disclosed, but on the contrary, the intention is to cover all modifications, equivalents and alternatives falling within the spirit and scope of the present invention as defined by the appended claims.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0046] In the description which follows, like parts are marked throughout the specification and drawings with the same reference numerals, respectively. The drawing figures are not necessarily to scale. Certain features of the invention may be shown exaggerated in scale or in somewhat schematic form and some details of conventional elements may not be shown in the interest of clarity and conciseness.

[0047] The present invention relates to methods and apparatus for remotely monitoring cathodic protection. The method and apparatus is described for use in monitoring cathodic protection on a pipeline but it should be understood that the method and apparatus of the present invention is susceptible to embodiments of different forms and may be used for monitoring cathodic protection of any metal structure. There are shown in the drawings, and herein will be described in detail, specific embodiments of the present invention with the understanding that the present disclosure is to be considered an exemplification of the principles of the invention, and is not intended to limit the invention to that illustrated and described herein. For example, it will be understood that a remote monitoring unit measures pipe-to-soil potential, but may optionally measure other parameters such as current, etc. It is to be fully recognized that the different teachings of the embodiments discussed below may be employed separately or in any suitable combination to produce desired results. Additionally, certain terms may be used throughout the specification interchangeably. For example, the terms "pipe-to-soil potential" and "electrical potential" are synonymous.

[0048] Referring initially to **FIG. 1**, there is shown a pipeline **10** made up of pipes **12** for transporting fluids or gasses such as water or hydrocarbons, e.g., oil or gas. The pipeline is typically buried in the ground and has an organic coating **14** therearound to protect the pipeline **10** against corrosion. Typical organic type coatings include an asphalt or carbon based coating, fusion bonded epoxies, plastic wrap or the like.