PIPELINE IDENTIFICATION AND POSITIONING SYSTEM

RELATED APPLICATIONS

[0001] This application claims priority based upon provisional application Ser. No. 60/183,290 filed Feb. 17, 2000.

BACKGROUND OF THE INVENTION

[0002] Gas and petroleum products are transported on a worldwide basis by routinely passing through systems of pipelines constructed of different sizes and lengths. It is well known in the art that a substantial investment of time and money is associated with establishing and maintaining a pipeline system of such global extent. It is also well known in the art that the implicated plurality of pipelines is normally protected by certain features that are intended to prevent damage and corrosion. While most pipeline systems are designed to operate continuously for several years without interruption, a plethora of factors actually determine the life expectancy thereof.

[0003] As is well known in the art, Smart Pigs are electronic instruments designed to inspect pipelines internally while physically traveling with a fluid product within the pipelines, and without simultaneously interrupting fluid flow. That is, Smart Pigs are inspection devices that travel inside a pipeline and are pushed therealong by the fluid flowing therein. Having been used since the mid-1960's, Smart Pigs primarily detected wall-thinning attributable to corrosion and the like. As will be appreciated by those skilled in the art, various other pipeline defects including dents, gouges, cracks, and coating disbandment have eluded detection via Smart Pigs for several years. Due to pipelines being situated either on, in, or under a diversity of terrains and the like throughout the world, there is a strong demand for Smart Pigs that are capable of traveling within multi-diameter pipelines and concomitant bends therein, and of detecting the location of pipe-related problems.

[0004] Depending on the technology and degree of sophistication used by a Smart Pig, its sensors will record the distance traveled, location and clock position of features and defects, and the concomitant depth and magnitude thereof. As will be understood by those skilled in the art, inspection companies use several technologies to detect defects in a pipeline including Magnetic Flux Leakage (MFL), ultrasound, radiography, acoustic emission, etc.

[0005] MFL, of course, uses magnets to detect corrosion on thinning pipeline walls. Ultrasonic sensors are used to detect dents, gouges, cracks, and coating disbondment. The Global Positioning System (GPS) has been adapted to work with Smart Pigs to ascertain the exact location of any problem manifest within pipelines or, indeed, to map the pipeline, per se. It will be appreciated by those skilled in the art that some Smart Pigs are constructed with a collapsible design that readily accommodates entry into multi-diameter pipelines that include gate valves and the like.

[0006] An alternative to this MFL approach is the use of Smart Pigs incorporating ultrasonic technology to determine pipeline wall thickness as a means of monitoring the incidence of corrosion and the like. According to this methodology, a Smart Pig provides data prerequisite for analyzing the pipeline surface throughout its length for traces of corrosion. Besides not adversely affecting normal fluid flow operations throughout the pipeline, ultrasonic detection enables identification of the extent, location, depth, and position of any corrosion.

[0007] As is known by those skilled in the art, special Crawler Pigs have been recently introduced to self-propel themselves through a pipeline under conditions in which there is insufficient fluid flow therein. Another variety of pig monitors pipeline wall deformations using differential GPS surveying devices, whereby cracks, dents, buckles, and bending strain may be accurately measured. An interesting aspect of this GPS approach is that such factors as slope instability, subsidence, overburden, river crossings, free spanning, and temperature and pressure changes may be ascertained.

[0008] Smart pigs record pipeline attachments on a continuous graph or log. These locations are also marked with posts above-ground. A geographical correlation between the buried pipe logged by the pig and the above-ground benchmark is necessary. Defects are located by excavating the pipeline with measurements recorded by the pig between the defect and the nearest benchmark. Unfortunately, most pipelines do not have enough features to help correlate a buried section of pipe to a visible benchmark above-ground. Excavating a pipeline to locate a defect is a very expensive process.

[0009] Inspection companies have developed different methods of placing references at closer intervals to reduce the distance traveled from a pipeline benchmark to a defect. Pipeline markers are either placed directly on the pipe or emit electronic signals above-ground. For markers placed on the pipe, it is necessary to excavate the pipeline, forming a bell-hole. A worker then removes the protective coating and attaches the marker or magnet to the pipe. Markers that emit electronic signals are placed above-ground, directly above the pipeline, in the smart pig's path. Signals are processed and correlated to the pig's internal odometer to obtain above-ground distances to specific locations. Both these types of pipeline markers require that their location be identified before the markers are removed. Stakes or posts are currently used to identify the location.

[0010] Radial orientation of defects is achieved by viewing the circumference of the pipe as a clock face while looking towards the end of the pipeline. The depth of the defect is detected with smart sensors that detect changes in the thickness of the pipeline wall.

[0011] Many factors contribute to costly errors in pipeline inspection with smart pigs. Faulty correlation of distances jeopardizes the effectiveness of the inspection service and creates hazardous conditions for the public at large. A pipeline positioning system contemplated by the present invention would eliminate or reduce the plethora of problems that have plagued those skilled in the art for years. For instance, while smart pigs travel the buried pipeline, such pipelines do not necessarily follow the profile of the terrain above-ground. As another example, pipeline operators may monitor operational parameters, but cannot micro-manage and control product speed, pressure, and other parameters required by smart pigs throughout the inspection run. Electronic pipeline markers are inherently prone to suffer from interference by stray radio or electronic signals. Excavations are costly and have to be scheduled in advance.