A New Method of Corrosion Surveying Inservice Pipelines

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A new means of performing corrosion surveys of inservice pipelines has been developed. An instrumented pig is propelled by the throughput normally transmitted through the pipeline at a velocity of 2 to 5 mph. A recording is made of both ID and OD corrosion pitting as the pig travels through the line. Analysis of a continuous log made from the recording reveals the location and approximate degree of pitting along the lower quadrant of the pipe. The ability to determine the extent of damage to an inservice pipeline caused by corrosion, gives the pipeline operator a new tool for reducing maintenance cost by determining the condition of a line.

Corrosion surveys of inservice pipelines have become more important to the pipeline industry since pipelines now transport the majority of the energy fuels used in the United States today. The rising costs of construction and repairs require that all work done on a pipeline be planned as far in advance as possible to insure a minimum loss of throughput. This has necessitated that corrosion surveys determine the condition of a line before corrective maintenance and repairs are started. The corrosion engineer is successful in pointing out general locations where the corrosion may be expected; but he cannot forecast the exact location or joint where it has occurred nor can he forecast the depth of the pits. This survey gives the corrosion engineer a log or record made from the recording which shows the approximate location relative to known points on the line and the severity of the corrosion pits.

This survey instrument, as shown in Fig. 1, is very similar to a conventional cleaning pig in many respects. It is equipped with scraper cups for support and centering. The front section supports the transducers for pit detection and the rear section contains the power supply, exciter, electronics and recording means for self-contained operation while in the line. The instrument equipped as shown is eight ft long but has universal joints such that it will pass through full opening bends with a radius of 80 in. or eight pipe diameters for 10-in. lines. Other instruments will pass through shorter bends in other size pipe. Some existing trap facilities must be extended for a pig of this length. A trap can be extended very easily by taking a piece of pipe the same size as the trap barrel and attaching a closure, the same as the trap closure, to one end and a blanking flange to the other end. This can then be substituted for the regular closure to extend the trap. The pig is constructed in a manner such that it will pass through old style gate valves and full opening unbarred laterals or side openings. The pig will operate over a range of speed from 1-1/2 to 5 mph. For best results, the speed should be maintained relatively constant at approximately three mph. At this speed, a 150-mi line can be surveyed without trapping.

The transducer is fairly heavy and serves to keep the pig from rotating as it travels through the line. It covers approximately the bottom quadrant or 90° of the pipe. This area is where the majority of the corrosion pitting occurs in a pipeline and is more evident in older uncoated pipelines where as much as 90 per cent of the outside corrosion and an even higher percentage of inside corrosion is found. Therefore, this tool was constructed to cover this area where the majority of the corrosion pitting is found. The tool detects both inside and outside pitting but does not distinguish between them.

This equipment has operated in lines from 6-in. through 20-in. in diameter. As shown in Fig. 1, it is equipped for operation in a 10-in. line.

A corrosion-pitting survey of a pipeline using this system is performed by first determining the problems which may be encountered. The traps are checked to see that they are long enough and if extensions are needed, they must be added to a line. If there are any mitered bends or bends too short for the particular tool

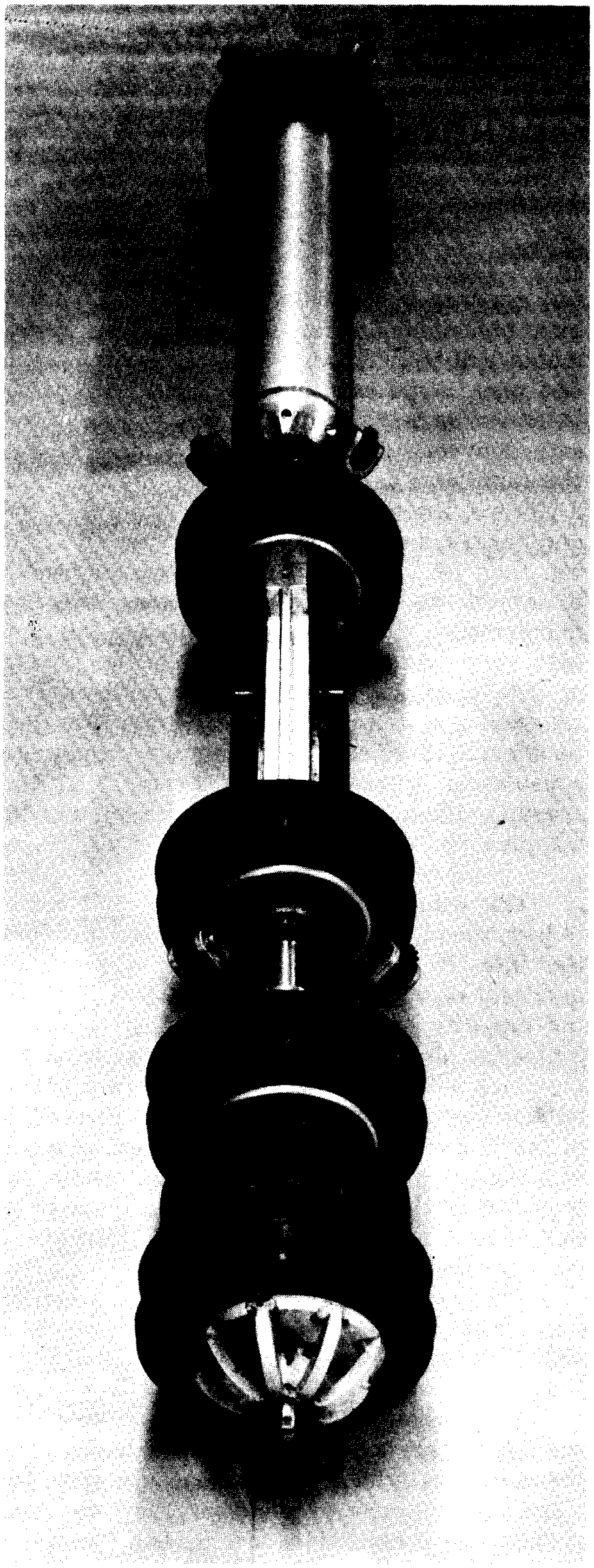

FIGURE 1

being run, they must be replaced before the dummy tool can be run. After it is determined that there are no apparent restrictions, the equipment necessary to perform the corrosion-pitting survey is moved to the job and set up in an office or motel nearby. This permits making a working copy of the survey on the job to insure that the best possible information has been obtained. A dummy gauging tool is first run in the line to determine if there are any internal obstructions such as mashes which may damage or destroy the instrumented tool. The dummy tool has the same dimensions and weight as the instrumented tool to assure us that it will travel in the same manner. After the dummy tool has successfully passed through the line, magnetic markers are then placed on top of the pipe at intervals of two miles or less. These markers are detected and recorded by the instrumented tool when it passes the points where they are located. The indications on the log from these markers serve as tie-points between the surface of the ground and the log. This permits easy location of the corrosion pitting by scaling the distance on the log from a marker and then measuring the distance on the surface of the ground. After the markers have been installed, the pipeline is then ready for running the instrumented pig.

The instrumented pig is run in the line the same as a conventional cleaning pig. It is launched and trapped using the same procedures. It travels through the line with the throughput and at the same speed. It is desirable for the throughput to be relatively constant while the survey instrument is in the line but some variation in the speed of travel will not affect the results. The constant speed permits more accurate scaling of the log when determining how far the corrosion pitting is from a marker or other known points on the line. Once the survey instrument reaches the end of the section of line being surveyed, it is removed from the trap and a working copy of the recorded information is made. This working copy is for field use only and is used to compare with the alignment map. Markers are located to assure that tie-points with the surface of the ground are established. Areas of severe corrosion are studied to see that they can be located relative to known points on the line. If there are areas of corrosion which cannot be easily located, markers are then placed in the approximate area of the corrosion which will be detected on the second instrument run.

This second instrument run is for correlation with the first run to more accurately locate the areas of severe corrosion and to prevent mistaking an indication from foreign objects in the line for a pit indication. Nuts, bolts, wires from brushes and other foreign materials are sometimes present in pipelines, and these can cause a signal to be recorded. After the second instrument run is made, it is compared with the first run. If the two instrument runs correlate, the survey has been completed at the job site. If they do not correlate, a third instrument run is made to assure that the best survey possible has been made.

The survey records are then taken to Houston where they are made permanent and each length of pipe is classified according to the severity of corrosion pitting detected. These permanent records are then returned to the customer with an explanation of the log and comments on the general condition of the line. This completes the survey.

Figure 2 is a short section of a typical log. It consists of five channels of information. The top channel is a marker channel and field-weld detector. The bottom four channels are the pit detector channels. The large indications that occur at regular intervals are the field welds usually occurring every twenty to forty ft of line. The line was constructed from single random lengths, and the distance between these indications represents approximately 20 ft of line. Since pits will not normally cover an area as large as the circumferential area inspected, pit indications will occur on only one or two channels but not on all four as field welds do. Three pits have been marked to show three typical pit classifications.

The light pit is one that penetrates less than 30 per cent of the nominal wall thickness. Moderate pits are those that have penetrated greater than 30 per cent but less than 50 per cent of the wall. Severe pits are those which

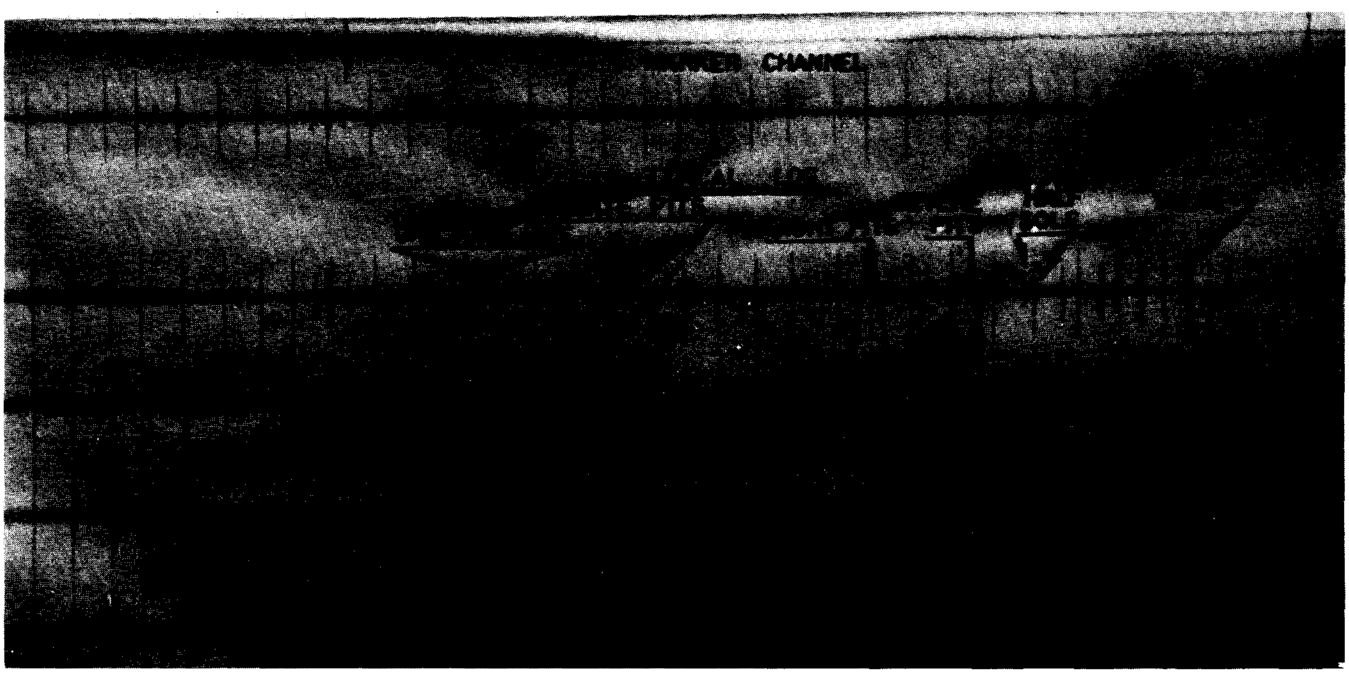

FIGURE 2

have exceeded 50 per cent of the wall. These classifications may be modified according to the individual requirements of the line being surveyed.

Note that there is a piece of half sole extending from approximately six ft on one side of a girth weld to two ft on the other side of the weld. The indications from the weld at each end of the half sole appear on all four channels but are not as large as a girth weld indication. The pits covered by the half sole are clearly indicated as severe pits. There is also a series of short sections of pipe. These short lengths are the tie-in and bends where the pipe comes out of the ground to the valve. The indication from the valve is very clear and distinguishable from the other indications. This serves as a tie-point to correlate the log to the alignment map. Such things as valves, stopples, new pipe, etc., make correlation much easier.

Fig. 3 is a record of three pits. The largest pit is 0.212 in. deep. The other two pits are 0.110 in. and 0.105 in. deep. These pits would be classified as severe for the 0.212 in. deep pit and moderate for the other two pits since they are in pipe with a wall thickness of 0.270 in. Note that the pit indications appear on only one or two pit channels and not on all four channels as girth welds do.

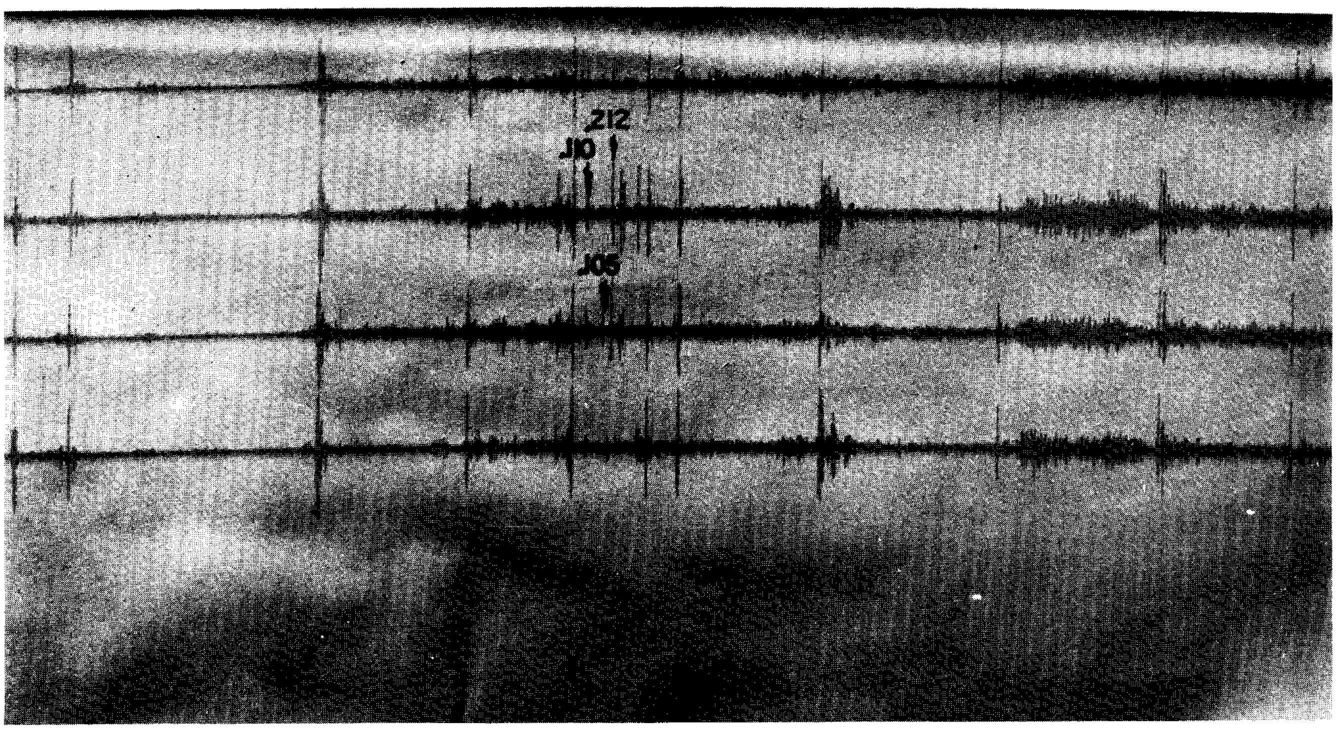

FIGURE 3

Figure 4 is the pipe with the pits shown on the record in Fig. 3. These are fairly large isolated pits which occurred in the bottom quadrant of the pipe. These pits are typical of corrosion pitting found with this tool.

A Linalog survey of corrosion pitting can be used in many ways to reduce the maintenance cost of a pipeline. A list of a few of the ways it can be used follows:

(1) Determining where repairs and replacement of pipe may be necessary so that maintenance can be done before leaks develop.

(2) Evaluating and locating corrosion pitting to determine to what extent corrosion has attacked the line.

(3) Evaluating the use of cathodic protection and inhibiters to see if they are doing the job. Many times, localized areas need additional protection.

(4) Planning general reconditioning of a line so that pipe can be purchased in advance and all arrangements made before work starts.

(5) Determining the condition of the pipe in critical areas such as river crossings heavily populated areas, road crossings, etc.

(6) Determining the condition of a line when it is to be bought or sold.

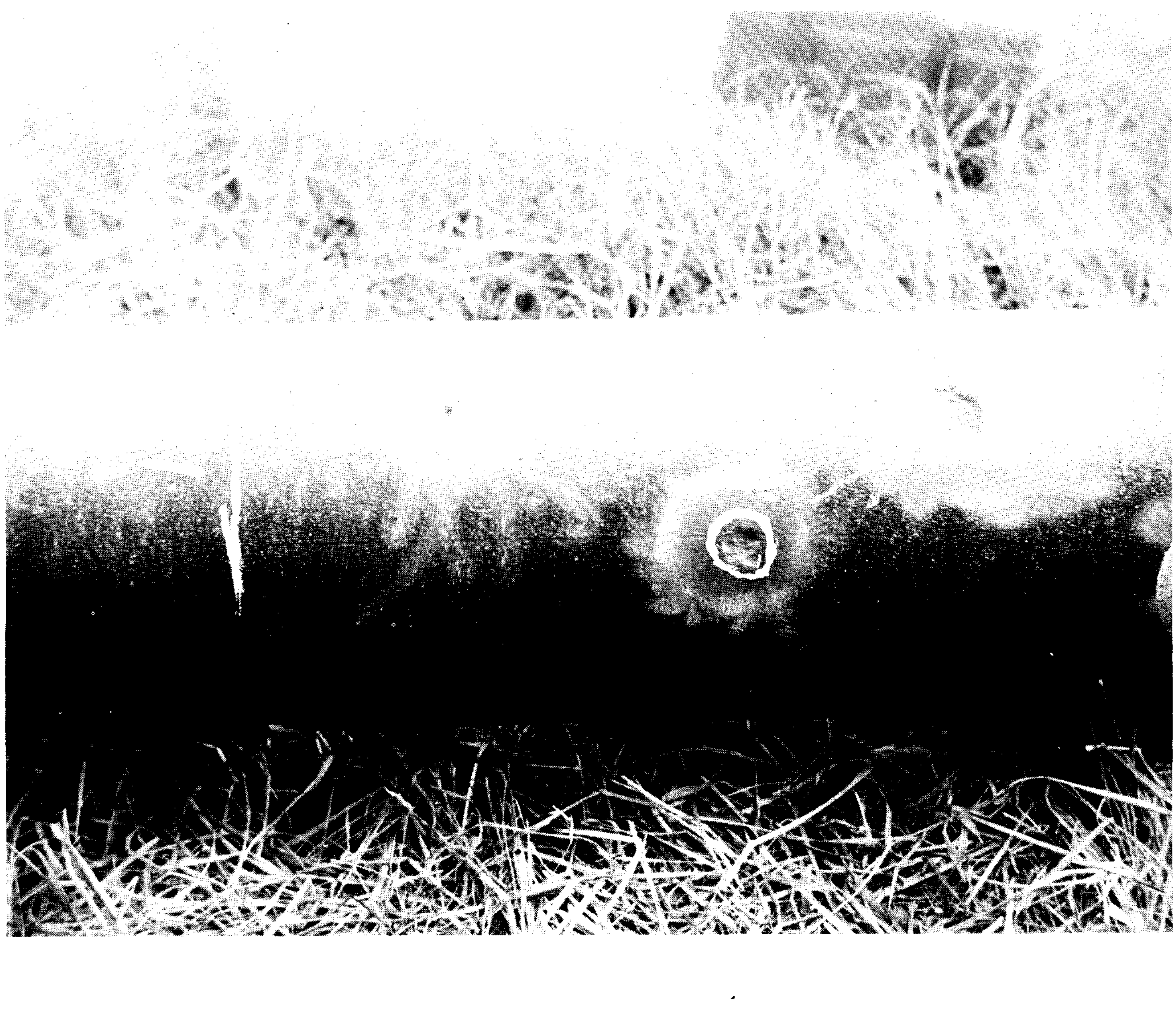

FIGURE 4

Many times when a line is being reconditioned, much of the pipe is in very good condition and does not need attention. As an example of the savings which can be realized by using this type survey, an 80-mi section of line was surveyed which was located in an area of light population density. The savings in replacement of pipe was as follows:

Scheduled Replacement		Replacement After Survey		Survey	
Miles	Cost	Miles	Cost	Miles	Cost
11	$196,000	4.5	$81,000	80	$26,000

Savings — $89,000

These figures do not include the savings which might result from not having unscheduled interruption of the throughput. In areas where replacement cost is much higher, the savings will be even greater. This is but one of the ways this equipment can be used to assist the pipeline operator.

This survey reveals the condition of a line while in-place. Past methods of determining how much corrosion had occurred on a line required that it be dug up or replaced but this is a very expensive method and does not determine the condition of the entire line. This type survey determines the condition of the entire line and is far more economical than visual examination.

This survey equipment has been field operational for over two years. It has operated in natural gas, crude, butane, propane, base gasoline and Diesel fuel. Several thousand miles of pipelines have been surveyed and the results have been excellent.