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QUARTERLY PROGRESS REPORT #3

ON DEVELOPMENT OF

THE OIL-WATER MONITOR

by

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1. INTRODUCTION

The oil-water monitor is a device invented by Dr. Claude Swanson of Applied Physics Technology to respond to the petroleum-loss problem in crude oil transfers. It is a device which measures water content in crude oil and other petroleum products, in a flowing pipe such as a pipeline or tanker manifold. It is capable of accurately measuring the water contamination levels in crude oil shipments, in real time as the crude oil flows through the loading manifold into the tanker, or at the receiving point as the oil is off-loaded. It has application in the verification of oil volumes and concentration of contaminants at petroleum transfer points. The industry-estimated level of water loss at transfer points due to inadequate monitoring technology amounts to several billion dollars per year, so there is a definite perceived need within the petroleum community for this type of accurate water monitoring technology.

The device has been patented, and initial feasibility experiments have been conducted. The present research is directed toward developing and demonstrating a bench model prototype of the oil-water monitor, complete with the computer software and automated microwave equipment and electronics which will demonstrate the performance of the invention, for implementation in full-scale fielded systems.

II. TECHNICAL PROGRESS - THIRD REPORTING PERIOD

In the Third Reporting Period, development of the processing and control software required to operate the oil-water monitor continued, and is expected to be complete in May of 1990. Certain changes in the hardware configuration have been made in order to provide better GPIB control of the microwave signal generator, and comparisons were made between the theoretical predictions and actual microwave absroption measurements. The specific accomplishments achieved during this period of the project are listed below:

(1) PROGRESS ON THE OIL-WATER MONITOR HARDWARE.

During this reporting period, changes in the hardware configuration were made to provide better computer control of the microwave sweep generator and compatibility in signals processing. The hardware was changed to all Hewlett-Packard equipment, including an HP8350B Sweep Generator, with HP8359A RF Plug-In, an HP9757A Scalar Analyzer, an HP11667B microwave splitter to provide a referece signal for differential measurement of absorption, and two HP 11664E Detectors. The controlling computer, a Hauppauge 33MHz 386, with a DASH-16 A/D board and ASYST GPIB Programming Language, remained unchanged from the previous configuration. A schematic of the new experimental arrangement is shown in Figure 1.

Figure 2a and 2b show the complete system during tests, using two different receiving antenna configurations. Resonances within the antenna crude-oil cavity caused changes in impedance with frequency, and the testing of different receiving antennas was initiated to reduce this effect as much as possible. Additional correction for frequency dependent impedance changes will be made in software in the analysis program.

Shown in Figure 2a and 2b are, in the center of the photograph, the crude oil sample holder, with input microwave horn antenna on the bottom, and receiving microwave horn on the top. To the lower left in the figure is the HP8350 Sweep Generator and, and above it, the HP8757 Scalar Analyzer. Input power levels and sweep pattern are monitored on the Iwatsu SS-5702 Oscilloscope, while data is acquired and processed by the Hauppauge 386 Computer to the right in the photograph.

(2) SOFTWARE DEVELOPMENT

The software required to control and analyze the operation of the oil-water monitor is proceeding well, and expected to be completed within the next six to eight weeks. Some changes in the code were necessitated by the change in hardware, but the modification has been carried out successfully.

A control program, written in ASYST GPIB, is being developed to control the chirp timing and sweep characteristics of the microwave signal. Part of the effort under this task has required the Principal Investigator to become more familiar with GPIB, which he has not used previously, and in particular how it interfaces with the HP8757A Scalar Analyzer. It is estimated that the implementation in software of the control program is about 70% complete at the present time.

A data analysis program, written partly in FORTRAN and partly in ASYST, is under development to receive the absorption measurements, apply the inverse Laplace Transform technique developed and described in the oil-water patent, and compute in real time the average water content in the crude oil. It is estimated that this software effort is also about 60% complete at the present time.

III. CONCLUSIONS

At the present time, the hardware components of the oil-water monitor prototype are functioning together as expected. The software required to operate the system as an oil-water monitor is under development, proceeding well, and is about 65% complete at the present time. Completion of the software development is anticipated to be achieved in May of 1990, at which time the first comprehensive testing and evaluation of the complete system performance will begin.

The development program is on time and within budget. For further budgetary information, refer to Form 272, "Federal Cash Transactions Report", included in Appendix I of this report.

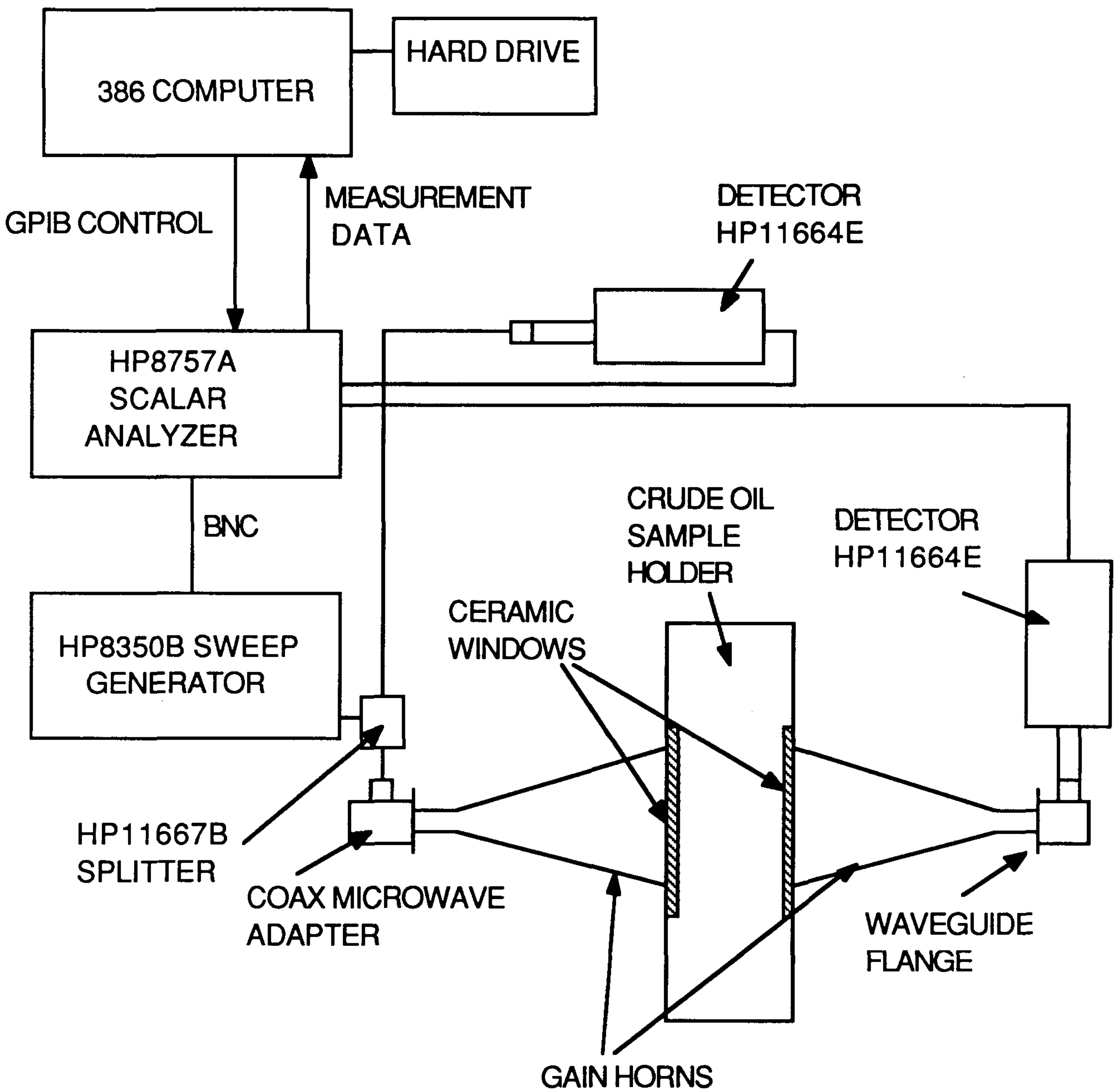
386 COMPUTER
HARD DRIVE
GPIB CONTROL
MEASUREMENT
DATA
DETECTOR
HP11664E
HP8757A
SCALAR
ANALYZER
BNC
CRUDE OIL
SAMPLE
HOLDER
DETECTOR
HP11664E
CERAMIC
WINDOWS
HP8350B SWEEP
GENERATOR
HP11667B
SPLITTER
COAX MICROWAVE
ADAPTER
WAVEGUIDE
FLANGE
GAIN HORNS

FIGURE 1

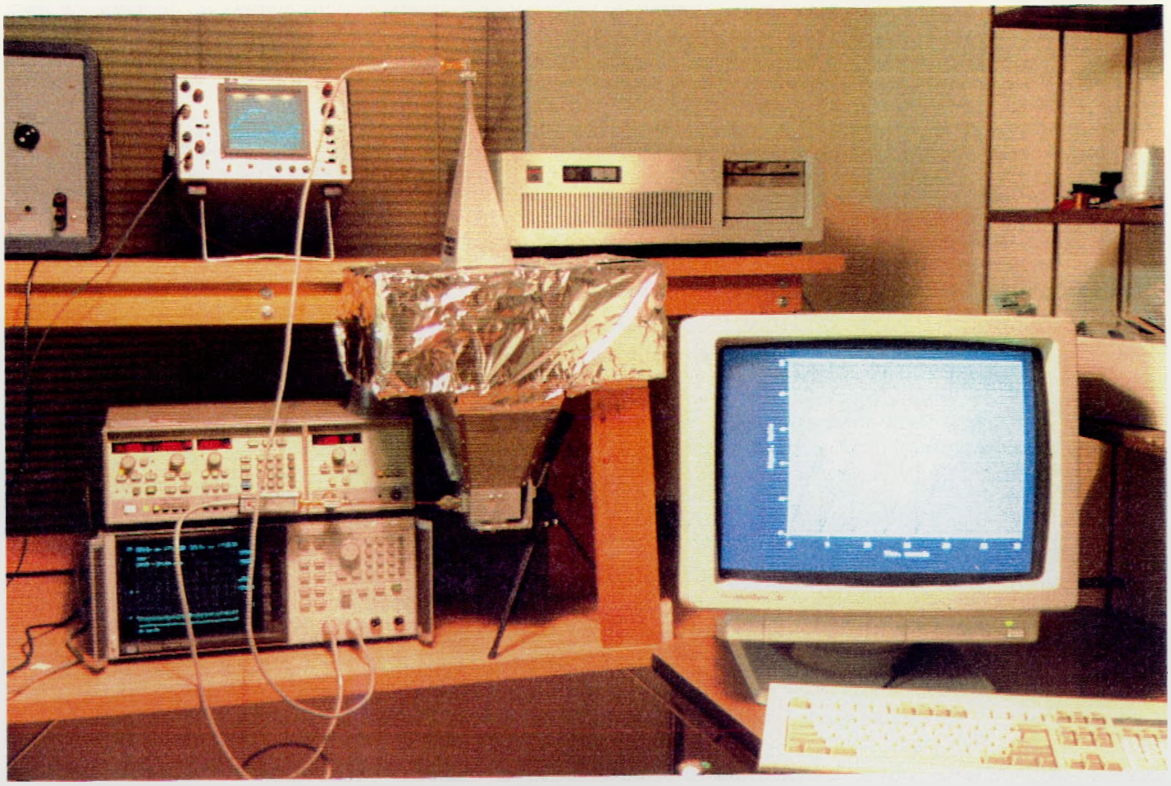

FIGURE 2A

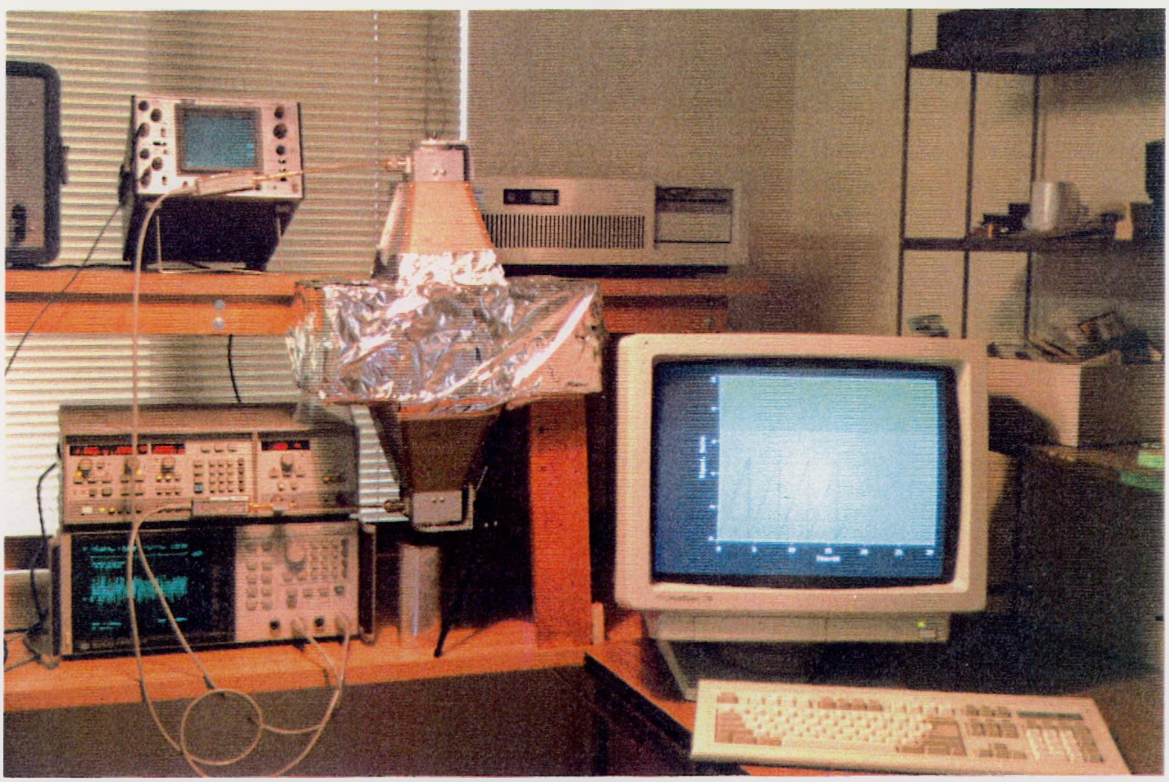

FIGURE 2B