UPGRADING MECHANICAL TOOLS⁺
SURVEY CLOCKS**MASTER**

B. H. Major

Sandia Laboratories
Albuquerque, New Mexico**DISCLAIMER**

This book was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

BACKGROUND

Development of the earth's high temperature geo-energy resources is dependent on sufficient well logging to obtain essential physical and chemical properties of the well. Methods for obtaining this information are limited at present by technical deficiencies in that the logging tools in current use were developed for the oil and gas industry. Such instruments rarely encounter temperatures above 150°C; whereas, gas wells frequently go to 180°C and some geothermal wells up to 350°C.

The "Amerada" type subsurface recording gauges have been the staple instruments of the oil and gas industry for several years. The same instruments are currently in use by the growing geothermal industry. However, at elevated temperatures, significant reductions in reliability and tool life have been reported.

A primary concern of the "Amerada" type instruments is its survey clock, which often fails in well logging at high temperature. Much test time and labor is lost as a result of a single failure of the clock mechanism. Currently, increased reliability is sought by either restricting the log to three hours, or by utilizing two gauges connected in tandem to ensure at least one successful log. However, because of the large number of "Amerada" type instruments currently in use by industry, it would be best to upgrade them for high temperature reliability. This should be accomplished with a minimum of redesign and rework.

CLOCK ANALYSIS

Several clocks were received for testing from the Kuster Company and from Geophysical Research Corporation (GRC). All of the tests and evaluations were performed at 300°C. Upon testing each clock, as received from the respective factories, it was noted that each one failed to operate the prescribed length of time. Two major problems were detected: either the friction through the gear train increased to the point of stopping the clock, or the escapement locked up. An investigation was made to determine

specific problem areas and methods for upgrading these clocks. This investigation resulted in the following recommendations:

Recommendations for Upgrading Survey Clocks:

- A. Oval the end of the pivot on the wheel side of the first miter wheel. See Figure 1.
- B. Insert a cap jewel (or cap plate) on the back side of hole jewel for the miter wheel. Set the cap jewel to a depth that will allow the ovaled pivot to carry the load instead of the pivot shoulder.
- C. Apply Electrofilm (LubriBond A* or equivalent) solid film lubrication to:
 1. All gear and wheel teeth of the gear train.
 2. Mainspring drive shaft and miter gear shaft, excluding the clutch spring area. (This application applies only to Kuster clocks.)
 3. The pallet faces and slot end of the pallet and fork assembly. See Figure 2.
 4. The escape wheel and pinion.
- D. Apply by dipping, in a mixture of one part Vydax AR** to twenty parts of Freon TF, mixing thoroughly before dipping, the following parts:
 1. All gear trains wheels and pinions.
 2. The mainspring drive shaft bearings (GRC clock only).

*Made by Electro Film, Inc., 7116 Laurel Canyon Blvd, North Hollywood, California. Contains Resin, Moly Disulfide and graphite.

**Made by E.I. DuPont Company, Wilmington, Delaware. Contains Fluorotellomer.

⁺Work supported by Division of Geothermal Energy, Department of Energy

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

3. All mainspring bearings and mainsprings. Do not remove mainsprings from their barrels but dip each spring as a unit.
 4. The pallet and fork assembly.
 5. The escape wheel and pinion.
- E. Assemble the clock excluding the balance assembly and pallet for assembly. Wind up the mainsprings and let the gear train spin down several times to seat the dry film at the contact points. Insert the balance and pallet for assemblies.
- F. Apply DuPont's Krytox 143 AD*** oil to all pivot and jewel interfaces, excluding the balance assembly. Wind up the mainsprings and allow clock to run through its total time cycle several times to seat everything in.

FIELD TESTING

Each of the clocks were field tested after modifications were completed. Testing was done in wells at East Mesa, CA, with Republic Geothermal, and at Cerro Prieto, Mexico, with CFE (Comision Federal de Electricidad); well temperatures were 170°C and 330°C respectively. The modified clocks gave good performance in all these field tests.

While testing the modified clocks in geothermal wells, another major design problem was encountered: upon disassembly of the instruments, it was observed that many of the seals had leaked, allowing fluid to enter. Although many of the clocks continued to operate under wet conditions, it is recognized that such leakages will greatly accelerate the deterioration of the clocks and other recording section components. Future work is planned to redesign the seal, allowing for dry operation of all internal parts.

***Made by E.I. DuPont Company,
Wilmington, Delaware.

Figure 1. Miter Gear and Wheel Assembly

Figure 2. Pallet Fork