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(54) **INCLINATION MEASUREMENT APPARATUS**

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(52) **U.S. Cl.** **33/391; 33/397; 33/401; 33/366.13; 33/366.25; 33/1 N; 33/1 PT**

(58) **Field of Search** **33/365, 366.11, 33/366.24, 366.25, 366.26, 391, 397, 401, 534, 536, 366.13, 1 N, 1 PT**

(56) **References Cited**

U.S. PATENT DOCUMENTS

- 3,829,981 A 8/1974 Vlasblom
- 3,849,897 A 11/1974 Markakis et al.
- 3,876,309 A * 4/1975 Zicaro et al. 33/366
- RE28,694 E 1/1976 Markakis et al.
- 3,956,831 A * 5/1976 Sibley 33/352
- 4,196,524 A 4/1980 Bechtel
- 4,528,760 A 7/1985 Plummer
- 4,584,778 A * 4/1986 Komasaku et al. 33/366
- 4,680,867 A 7/1987 Hufman et al.

- 4,694,584 A * 9/1987 Mills 33/366
- 4,866,850 A 9/1989 Kelly et al.
- 4,942,668 A * 7/1990 Franklin 33/366
- 4,943,158 A 7/1990 Pertl et al.
- 4,974,329 A 12/1990 Willa
- 5,184,336 A 2/1993 Wanger et al.
- 5,210,954 A 5/1993 Schafner
- 5,317,810 A 6/1994 Isono et al.
- 5,365,671 A 11/1994 Yaniger
- 5,406,713 A * 4/1995 Oman et al. 33/366
- 5,435,067 A * 7/1995 Uchida et al. 33/1 PT
- 5,575,073 A 11/1996 von Wedemayer
- 2002/0002777 A1 * 1/2002 Torr 33/1 PT
- 2002/0053144 A1 5/2002 Matsumoto et al.
- 2002/0073563 A1 6/2002 Toda et al.

FOREIGN PATENT DOCUMENTS

- FR 2640042 6/1990
- JP 62096813 5/1987
- JP 62129718 6/1987
- JP 63015112 1/1988
- JP 01136010 5/1989

* cited by examiner

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(57) **ABSTRACT**

Inclination measurement apparatus includes an indexable clinometer bearing turntable rotatable in a single plane between a pair of precisely reproducible diametrically opposite orientations with respect to the desired measurement axis for respectively issuing inclination measurements V_0 and V_{180} responsive to the inclination of a surface with respect to a desired measurement axis, and a reference clinometer for enabling uninterrupted accurate bias corrected inclination measurements of the inclination of the surface with respect to the desired measurement axis by virtue of its inclination measurements being employed for calculating bias corrected inclination measurements.

22 Claims, 5 Drawing Sheets

