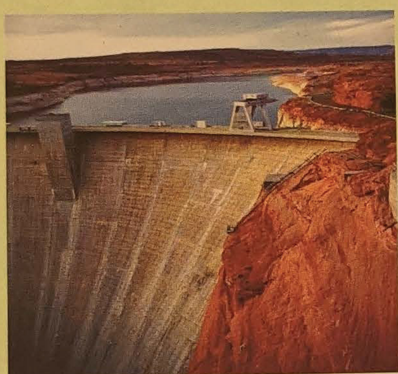
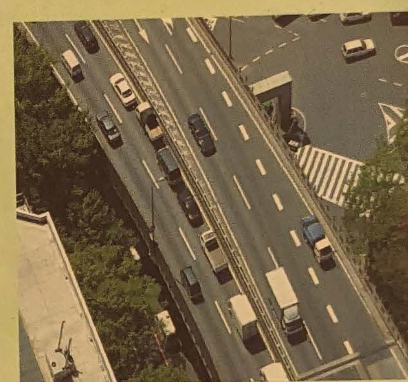
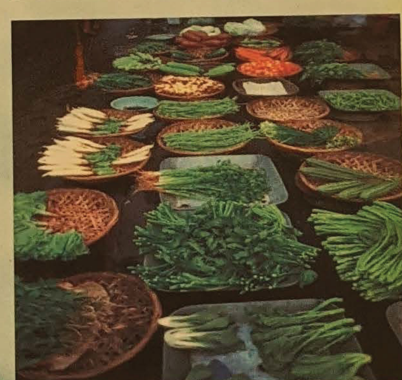
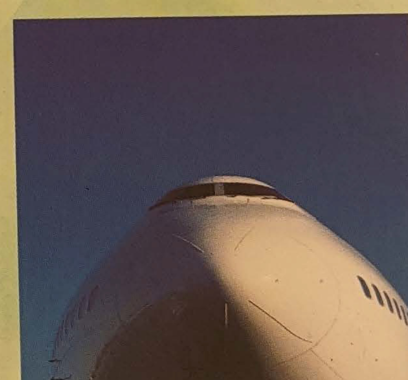
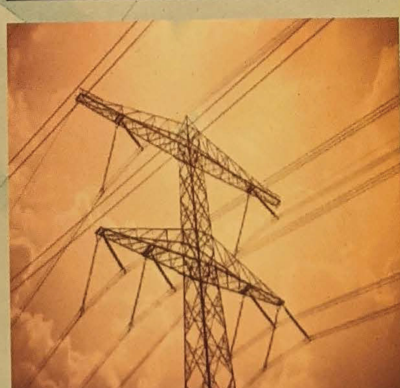
Current Trends in Engineering Practice





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MANAGEMENT

dual tine concept. Further, Sunstrand design had metallic as well as fused quartz flexure cum proof mass depending on performance. Sunstrand brought out resonant beam accelerometer, typed as RBA 500 during 1991 for a larger application market and at a considerable low cost. RBA 500 has a bias error of<1mg, scale factor error of<360 ppm, power input 0f 0.1 watt, weighs 9 gm, operates between C–55°C to +80°C with a range of 70g and all at a cost of only Rs.0.4 lakh. A more accurate version called Superflex accelerometer which uses quartz flexure cum proof mass has a performance one order better. Singer Kearfott reported the qualification of one VBA with a range of 500g for strategic application. It has a bias error of 20 micro g and a scale factor error of 10 ppm, weighs 70gm.

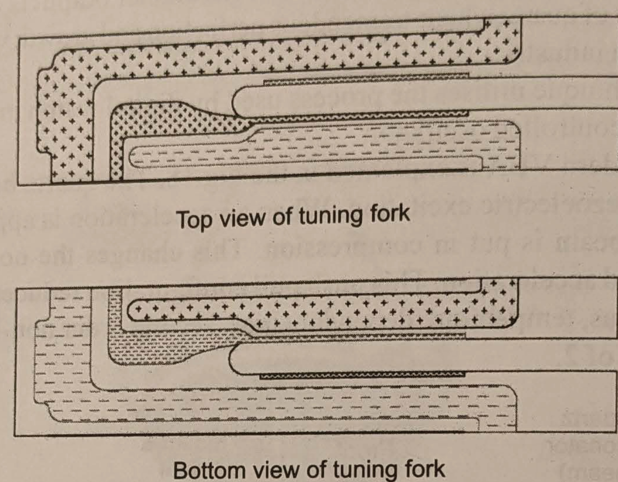
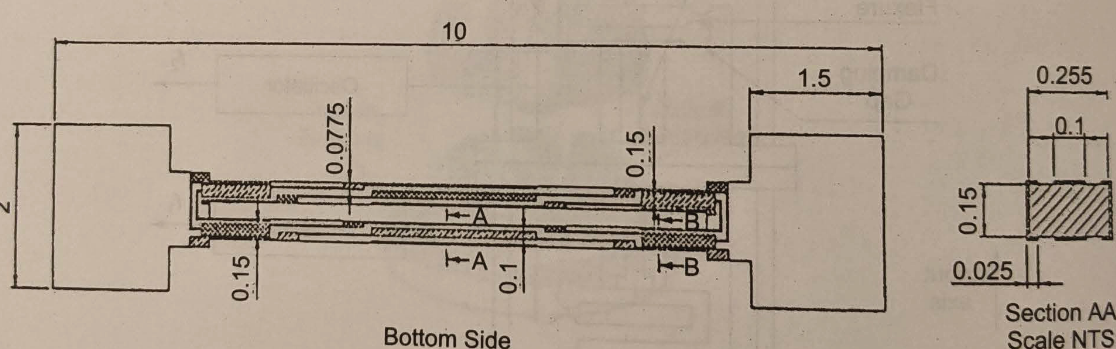


FIG. 19 TUNING FORK USED IN DIGITAL WATCH INDUSTRY WITH ELECTRODE PATTERN

Fig.20 shows electrode pattern of a dual tine resonator under development in ISRO.



ELECTROE PATTERN

FIG. 20 TWO TINE QUARTZ BEAM WITH ELECTRODE PATTERN (UNDER DEVELOPMENT IN ISRO)

Quartz is not the only material for resonator, subsequent development at Sunstrand during 1995 used silicon beam with capacitive excitation and fabricated using silicon micro fabrication technique. This accelerometer reached performance required for 1 Nmph INS.

6. MICROMACHINED INERTIAL SENSORS

Micromachined inertial sensors use process technology such as 'Bulk micromachining' and 'Surface micromachining' developed by integrated circuit manufacturing industry and uses materials like mono crystalline silicon, poly silicon and quartz to produce small sensors. Here, the motivating factors were substantial use of established facility and materials both of which witnessed tremendous growth during the last 30 years on account of electronic revolution. Force balance accelerometers, vibrating beam accelerometer and vibrating gyros of suitable shapes, are all amenable to micromachining.

Evolution

The first development of an open loop silicon accelerometer was reported in 1979 by Roylance and Angell. A partial application of this technology in gyro was reported by Systron Donner, USA during late eighties by bringing out Quartz Tuning fork gyro. During early part of ninety, Sunstrand, USA brought out quartz VBA in which the quartz beam alone was micromachined. During 1995, Allied Signal, USA reported all silicon VBA with navigation class performance. Draper lab, USA initiated [8] research on micromechanical sensors during 1985 and still continuing. It has reached 10°/hr class in gyro and 100 ug in accelerometer by now. Using these gyros and accelerometer, a very small (micro) IMU was realised which was integrated with a processor and GPS to guide a projectile fired from an artillery. Entire system was housed in 5 cm x 5 cm x 5 cm package. This IMU is shown in Fig.21. By 2005, an order improvement in performance is targetted with size reduced to 5 cm x 2 cm x 2 cm and price targetted for US $500.

Micromachined gyros and accelerometers development is actively funded for a vast range of application which could not be earlier thought off due to combined factors consisting of weight, size, cost and power. Diverse application such as Automotive, guided drilling, artillery shell guidance, personal navigator on soldier, spacecraft and unmanned micro air vehicle besides penetrating all the existing areas excepting where standalone high accuracy is required. In the medical field, these small gyros and accelerometers are planned to asist a person who has lost his balance due to some defect in the inside of the ear so that he can walk without falling. Due to such multifarious applications, research on MEMS technology is growing all over the industrialised world.

6.1 Multisensors

Considerable development effort is also going in the development of multisensors which combine rate and acceleration information in one sensor. SCIRAS is one such sensor reported in [7].

7. CONCLUSION

Advances in inertial sensors and systems during the the last 50 years reveal fascinating pictures. Initially, it was highly electromechanical requiring high specific investment in materials, fabrication, assembly and integration. The specific investment scenario somewhat continued even when later generation sensors like RLG or vibrating sensors like HRG were developed and qualified. However, the advance of IFOG and its consequent development saw emergence of technology cosharing with fiber optic communication. A similar observation was noticed in vibrating beam accelerometer where it co-shared with frequency standard and digital watch industry. Reduction of cost and viewing for a larger application market were the main driving forces behind the transition. Finally, the technology further took a turn with a view for substantial reduction in cost and weight in developing micromachining fabrication route to enable batch production. Also, it is seen that each technology had its specific problems which took a long time to solve but ultimately achieved very high performance and reliability. The advent of GPS or GLONASS is reorienting the decision making process on high accuracy sensors. Overall it can be seen that the research goal on cost, size, power and weight reduction in association with the improvement in performance and reliability have been achieved in each of the new technologies. The micromachined sensors and systems are penetrating large application areas unthinkable in other technologies.

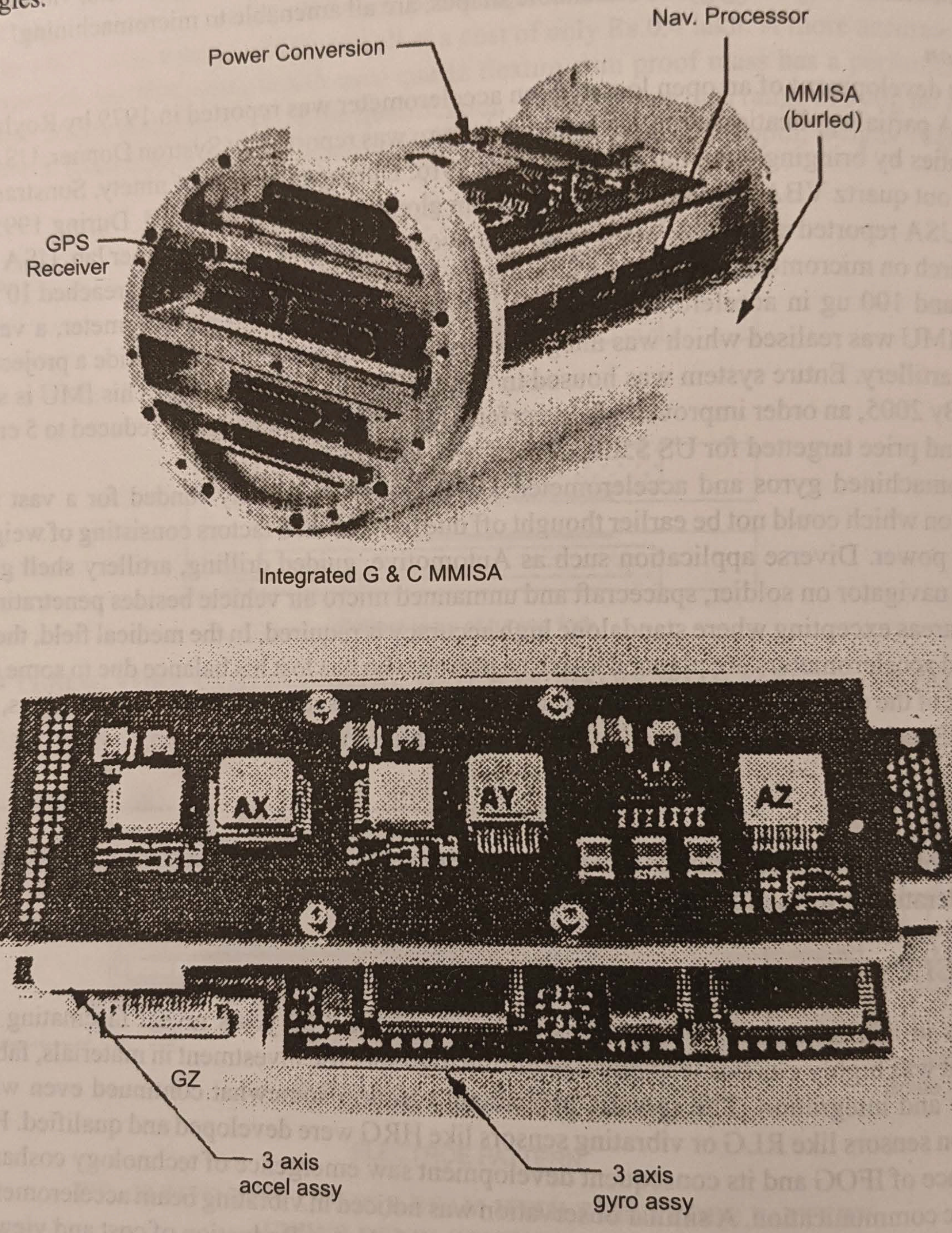


FIG. 21 MICRO-MINIATURE INS WITH MEMS TECHNOLOGY

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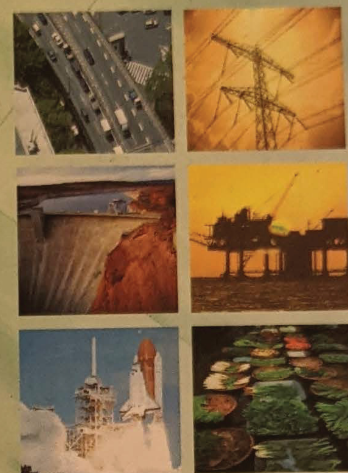

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Current Trends in Engineering Practices deals with recent engineering practices adopted in various projects in different engineering disciplines and specializations—Flyovers in Delhi, GIS applications, Geotechnical Investigations and structures, Construction of Earthmoving equipment, CAD CAM, Robotics, Automotive components, Rubber Technology, Fluid Catalytic Cracking, Syngas Production, High Voltage Measurement, Power System Methodologies, Optical Networks, Photovoltaic UPS, Inertial Systems, Access Technologies, Helicopter Technology, Launch Vehicle Design, Coal Mining, Iron and Steel making, New Product Development, Corporate Turnaround and Productivity of Vehicle Fleets.

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