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Wave & Tide Gauge

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A wave and tide gauge has been developed utilising a strain-gauge pressure transducer. The transducer with associated electronic circuitry gives an output voltage proportional to the water column above it. In laboratory experiments, the system has been calibrated and checked to an accuracy of ± 10 cm in a total water column of 40 m. The instrument has been field tested as a tide gauge in shallow waters where there is minimal wave activity and also as a wave recorder. In both cases appropriate filtering is applied to emphasise the measuring parameter. The unit may also be used as a wave recorder in deep waters with appropriate corrections. Possible improvements in the mechanical fabrication and the electronic circuitry are discussed.

Waves and tides are parameters important for oceanographic studies. Wave staffs of resistance and wire capacitance types are used to measure these parameters. These are, however, restricted to near shore regions, or if used in deeper waters, should be clamped to rigid offshore structures. The accelerometer type of sensor is used for the measurement of waves. However, being a delicate unit, a lot of care is to be taken to protect it. Mooring problems for this are also severe. Moreover, the accelerometer cannot give tidal measurements because it is insensitive to very low frequency variations as is the case for tidal changes.

In the present instrument, a strain gauge pressure sensor technique has been adopted for the measurement of waves and tides. In a hostile marine environment, sensors need to be chosen for their ruggedness, stability and repeatability. All these requirements are met by the strain-gauge sensor. moreover, this type of sensor is indigenously available.

Methods

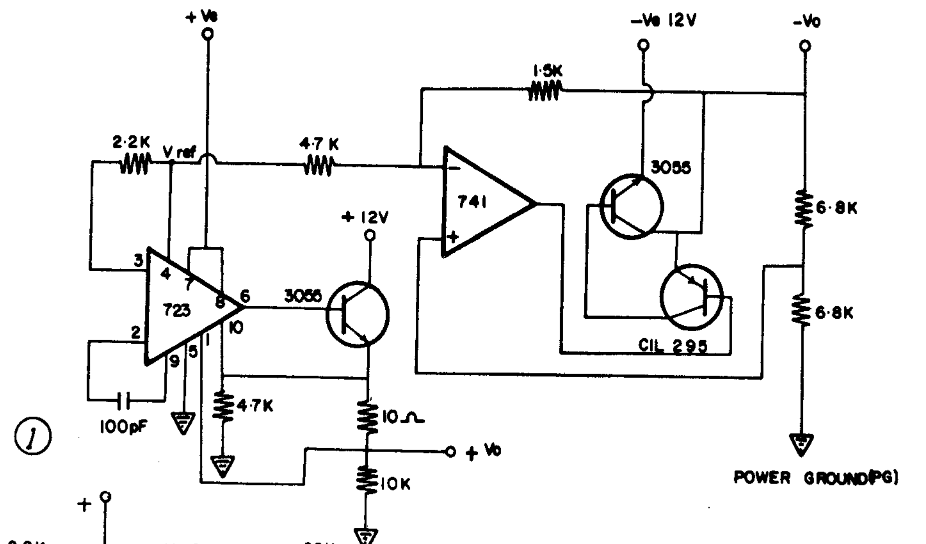
The instrument is designed to work on 12 v batteries. A 10 bar pressure sensor fabricated by Indian Space Research Organization, Bangalore is selected for the design. The transducer measures absolute pressure. The sensor bridge is excited by a stable DC of ± 7.5 v which is derived from the IC 723 (Fig. 1). The quoted sensor output is given as 32.3 mv at 10 bar pressure, when excited by a 15 v power supply.

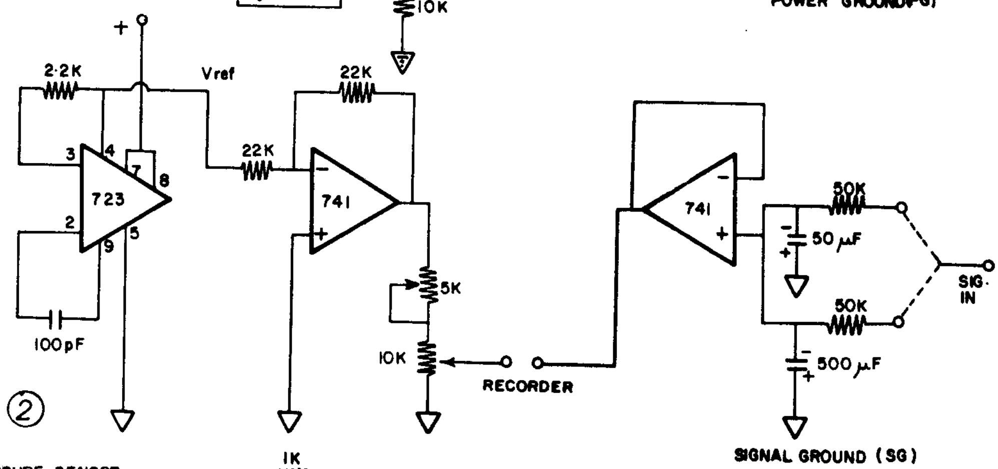
The output of the sensor bridge is amplified using a balanced high input impedance data amplifier having a gain of 11. The output of the data amplifier is chopped at a frequency of about 400 Hz, using a complementary symmetry metal oxide semiconductor (CMOS) switch (Fig. 2). It is further amplified and filtered to get a DC output with a total effective gain of 155. The DC output is taken via a cable into the deck unit and fed to RC filters of 2.5 and 25 sec time constants. The 2.5 sec filter is used for wave and 25 sec filter for tidal measurements. These filters can be manually selected on the deck unit. The filter output is given to a voltage follower (Fig. 3). In order to minimise the effect of cable resistance variations, the signal voltage is measured with respect to a separate signal ground. A continuously adjustable stable voltage reference is derived from IC 723 and is available at the deck unit. This reference is derived with respect to a signal ground. A 10 turn potentiometer of 10 kΩ is used to vary the reference voltage, which allows the transducer signal to be offset and recorded on an expanded recorder scale. The negative DC pressure output is compared with this reference signal and fed on to the floating points of the battery operated recorder. Depending on the depth to which the instrument is anchored, this reference voltage can be adjusted to read conveniently on the recorder.

Five core neoprene cable is used to excite the underwater unit, 3 wires for the positive, negative and power ground line, 1 for the signal and 1 for signal ground.

Mechanical design—The underwater electronics and the pressure sensor are placed and secured on a circular brass plate which fits into a brass cylinder (Fig. 4). The '0' rings are used for sealing the underwater unit. The unit is mounted on a steel base. All steel components are nickel plated, and the brass portion of the unit is coated with paint. The unit can be lowered by nylon rope along with the 5 core neoprene cable. Cylindrical weights are fitted on the lower steel plate to make the unit sit firmly on its base even at high water flows.

The installation of the unit can be done in 2 ways. With an anchored boat the unit is lowered into the water to rest on the bottom surface. In this position





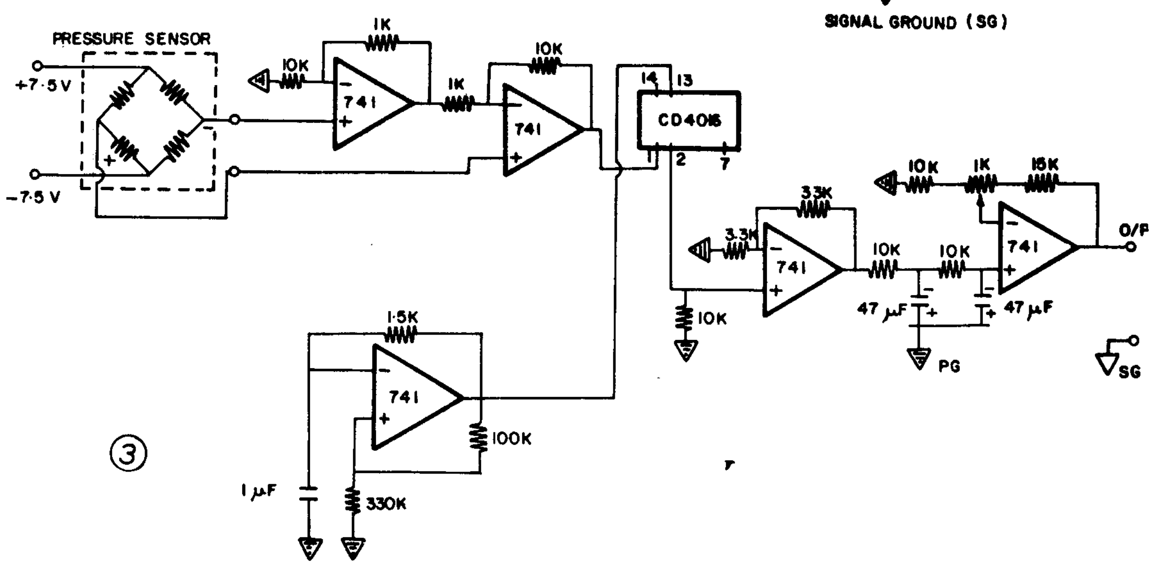


Fig. 1—±7.5 v Power supply. Fig. 2—Deck unit of the wave and tide gauge. Fig. 3—Underwater unit of the wave and tide gauge

both waves and tidal observations can be made. In the other, the unit is placed offshore to a distance governed by the cable length and the recording unit is kept on shore. Small cylindrical lead weights are mounted all along the length of the cable to weight it down on the sea floor. A marker float is suspended from the unit. In this case also wave and tide measurements can be made.

Calibration—The calibration was done using a dead weight pressure gauge tester. The sensor was coupled to the pressure arm of the unit, and the gain of the electronic circuitry was adjusted so that at 10 kg/cm^2

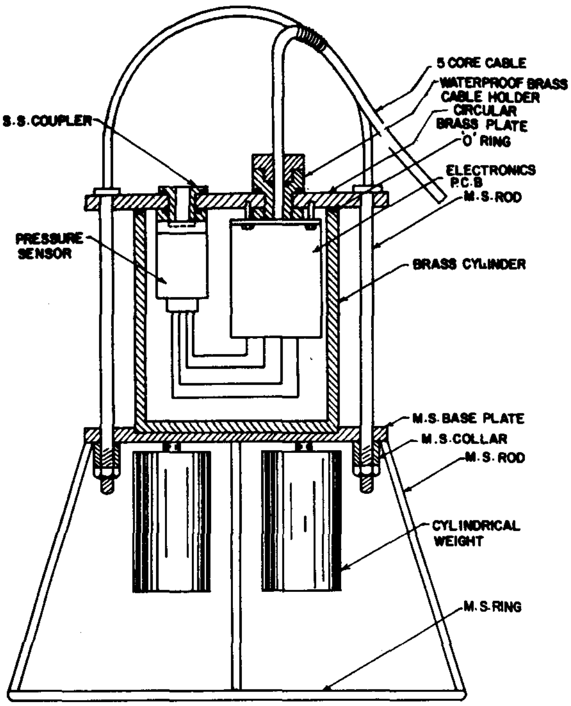


Fig. 4—Mechanical design of the underwater unit

pressure the circuit output reads 5 v DC. This corresponded roughly to 100 m of hydrostatic pressure.

Operation and field test—The unit was tested from an anchored boat in 40 m of water column. As a tide gauge it was tested for 8 hr in the esturine regions where waves were practically absent and hence the output was compared with a wave staff. The results were well within an accuracy of 10 cm. A continuous test for 24 hr as a tide gauge was carried out at Versova Beach, Bombay. The gauge was positioned at about 30 cm below the water surface at low tide position. The results are shown in Fig. 5.

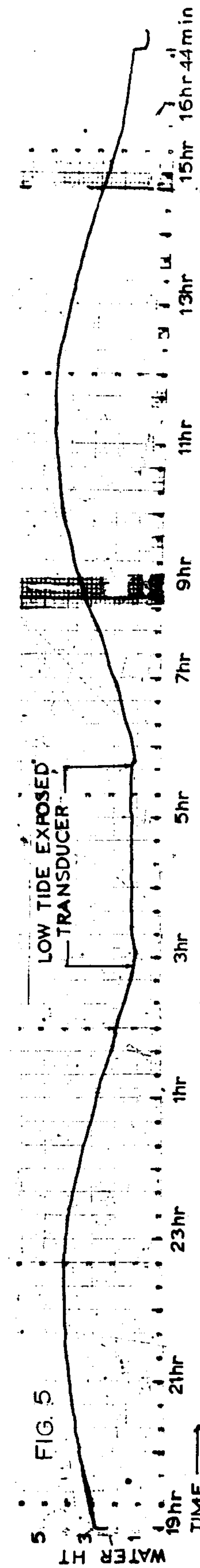
As a wave recorder the unit was tested at 25 m depth of water from an anchored boat. The wave record is shown in Fig. 6.

Results and Discussion

As a tide gauge, the unit performs quite satisfactorily with an accuracy of < 10 cm up to water depths of 40 m.

For wave recording, according to the theory of periodic waves[1], there is an attenuation of wave record which depends on the bottom depth and the period of the waves. When the unit is placed at the bottom, the attenuation will be considerable for shortwaves so that small waves will be practically filtered out. Hence the laboratory calibration holds good for its use in shallow water areas. For greater depths, it is necessary to provide corrections.

The Wave and Tide gauge can be further modified in both its electronic and mechanical design. The sensor



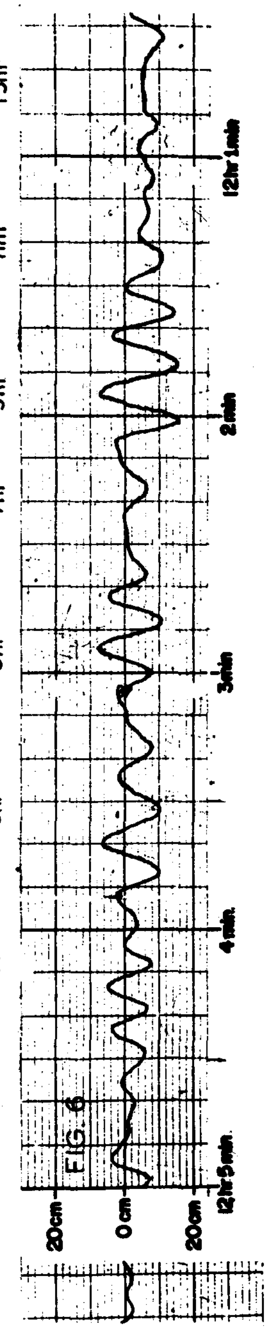


Fig. 5—Tidal record (20-6-79 to 21-6-79). Fig. 6—Wave record (9-4-79; sensor unit at 28 m depth).

bridge can be exicted in a DC constant current mode and the bridge output can be chopped and amplified to get the desired signal level. In this system the advantages will be: (1) The underwater unit will consist of only a pressure sensor housing and all the electronics will be on the deck unit. This makes for an easy approach to the electronics of the instrument and for its trouble shooting. (2) Only 4 core cable is necessary, i.e. 2 for current excitation and 2 for the bridge output connected to high input impedance data amplifiers. (3) Since the underwater unit will consist of only a pressure sensor housing, it will be small in dimension and the senor weights required to hold it down to the sea bottom will also be small. (4) It will be easy to operate the instrument in a floating mode near the mean sea surface level using a sub-surface bouy and a proper mooring system.

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