Development of a physical modelling system for 3-C x 3-D experiments

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INTRODUCTION

The development of the physical modelling system in the department of Geology and Geophysics at the University of Calgary began in the spring of 1983 (Cheadle, Lawton, and Bertram, 1985). This acoustical modelling system features a water- filled tank 2m deep, 3m wide, and 4m long. A system of beams and carriages are moved by stepping motors to position the source and receiver transducers over the model. Since the summer of 1989, the CREWES Project has expanded the physical modelling laboratory to include capabilities for elastic physical modelling. This paper describes the mechanical modifications of the elastic modelling system.

THE MODELLING SYSTEM

The elastic modelling system is an extension of the acoustical modelling facility. It uses the same data gathering system, which consists of a square wave pulse generator, a 60dB pre-amp, a Nicolet 2090 digital storage oscilloscope, and a Packard Bell 386/33 microcomputer (Figure 1). During an experiment, the traces are gathered and stored sequentially, using the pulse generator to transmit the source signal to the appropriate transducer and to trigger the data recorder. The data are stored on the hard drive of the 386/33 microcomputer. The data can then be sent over the Ethernet network to the Perkin Elmer 3240 or the Sun work stations.

The transducers used for the elastic modelling over solid models are manufactured by Panametrics. They are flat-faced cylindrical transducers with an active element of 1.26cm in diameter, for both compressional wave (V103) and shear wave (V153) pulse generation. The transducers are nominally rated at 1 MHz. They are coupled to the surface of the model with viscous coupling agents such as "Clear Couplant " or pharmaceutical cold wax. The compressional or P-wave transducer (V103) is vertically polarized, with the maximum sensitivity normal to the contact face. The shear wave or S-wave transducer (V153) is horizontally polarized, with maximum sensitivity parallel to a line across the contact face. To record the SV or radial component, the shear receiver transducer is used with the polarization in-line with to the spread direction, while for SH or the transverse component,the receiver transducer is rotated with the polarization perpendicular to the azimuth of the profile..

To record shot gathers across the surface of a solid model an aluminum frame was constructed from "U" channel (Mark I). It had two sliding carriages that held the transducers in Teflon blocks (Figure 2). The carriages moved independent of each other by means of 1/4" threaded shafts. The frame would be clamped to the model surface and the shot gathers would be recorded shot by shot with a foot switch that would trigger the Nicolet 2090 to record each trace individually.

In the spring of 1990, the aluminum frame was upgraded (Mark II). Made of 1/2" aluminum plate, the new frame was more robust. It had brass slide rails, Teflon transducer blocks and 1/2" threaded shafts (Figure 2). The end plates were fitted with ball bearings, so that the system could be automated in the future with stepping motors. The Mark II is a considerable improvement over the Mark I version, although both have the inaccuracy of a visual millimeter rule for the positioning of the transducers.

The present development of the elastic wave model system to include a 3-C x 3-D capability will greatly enhance its performance and accuracy. The automated elastic modelling system (Mark III) will be capable of faster, more accurate surveys because of the stepping motors used to position the source and receiver transducers.

The Mark III modeling system will use a hybrid of two Wang 32B X-Y plotter as a platform. A schematic diagram of the Mark III system is shown in Figure 2. A opening of 80cm x 120cm will be cut out of the center of the bed to allow placement of the model. One arm of the plotter will be adapted to hold the source transducer and move it in an X-Y coordinate over the model (Figure 3). The arm off a second Wang 32B plotter will be mounted on the opposite side of the plotter bed and hold the receiver transducer. The arms from the plotters are powered by two stepping motors, one for the "X" direction, the other for the "Y" direction.

The stepping motors will be driven by Cybernetics CY512 motor controller chips which in turn, cycle each of the motors the appropriate number of steps. The motors provide a fixed angular rotation per step, and can be operated at 200 steps or 400 half-steps per 360 degrees of revolution.

The Mark III version will incorporate an additional stepping motor mounted on each plotter arm that will lift the transducer after each shot and upon arrival at the next "X-Y" coordinate, will place it in contact with the surface of the model. This feature will save wear of the transducer face and ensure uniform coupling at each shot/receiver position. The motors that elevate the transducers will each be fitted with a cam to lift the transducer off the surface of the model. When the motor lowers the transducer down to the model surface, the transducer mount is uncoupled from the motor because of the cam action. In order to have the same coupling pressure at each station, a weight of approximately 4kg will be fitted to the top of each transducer mount.

When the automation of the elastic modelling system has been completed, large 3D x 3C experiments will be able to be done efficiently and accurately.

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REFERENCES

Cheadle,S.P., Bertram, M.B., Lawton, D.C., 1985, Development of a physical modelling system, University of Calgary : G.S.C. Paper 85-1A, 499-504.

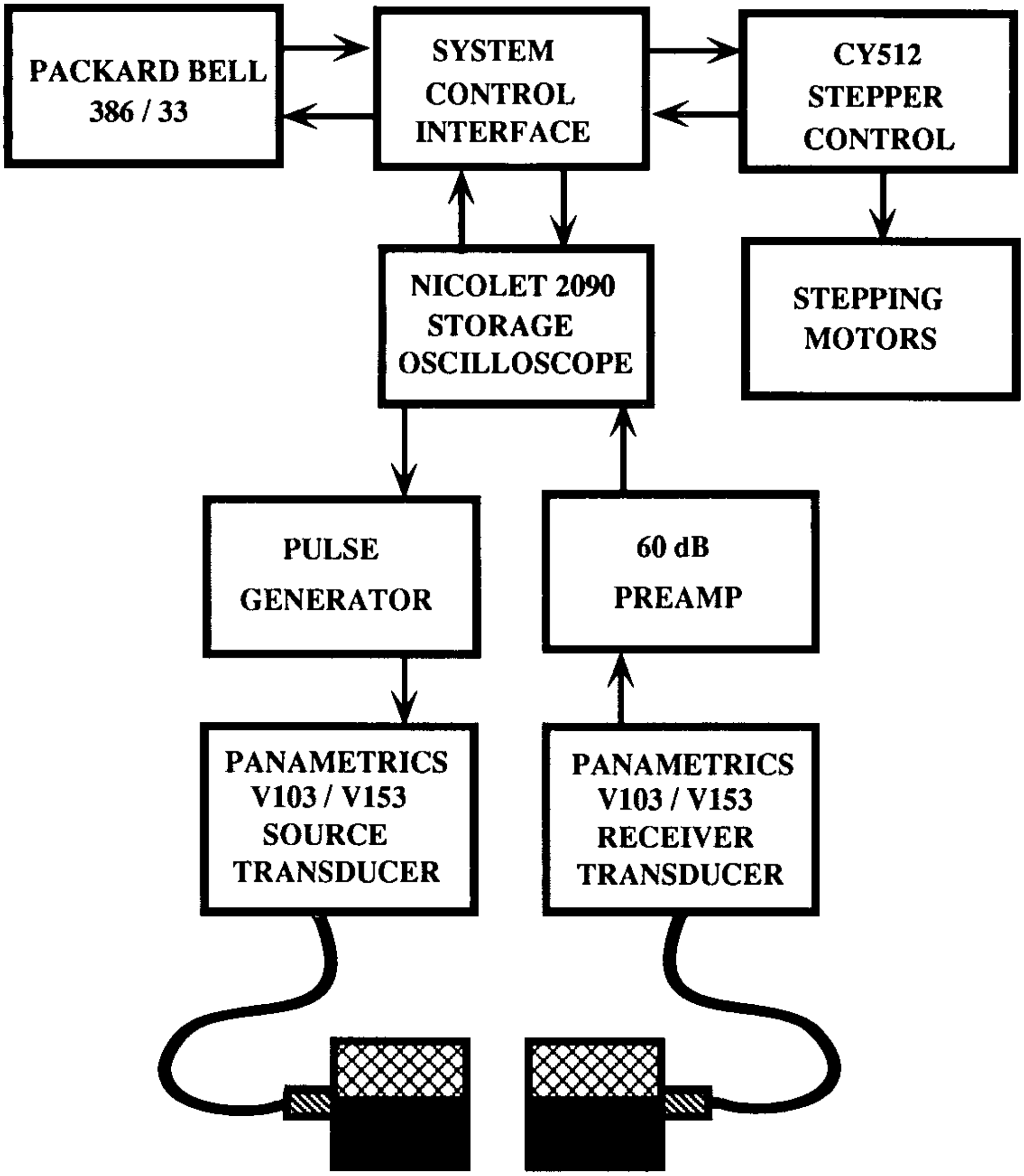

FIG.1 A schematic flowchart of the modelling system.

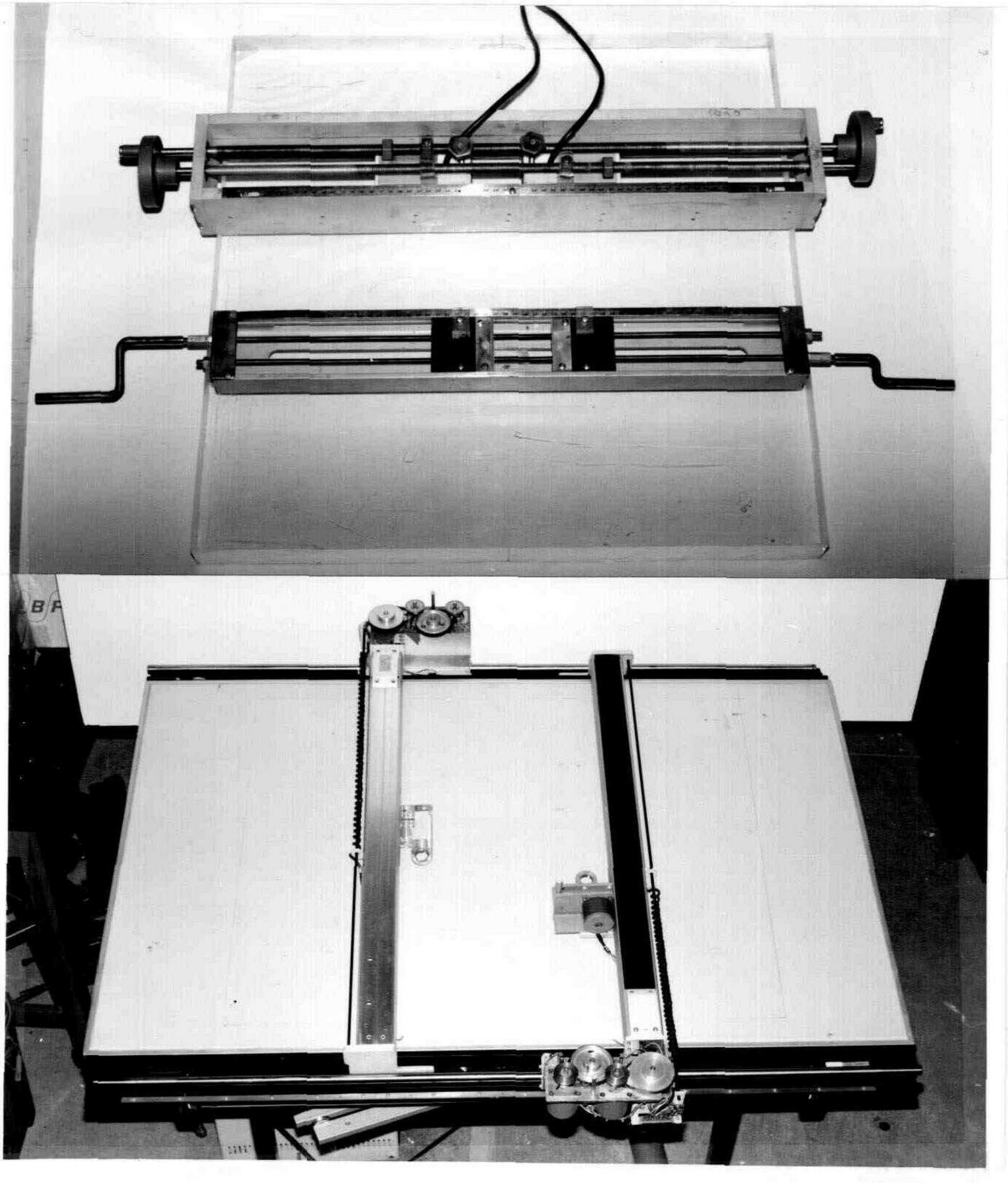

Fig.2 Top photo Mark II (upper unit) and Mark I. Lower photo Mark III.

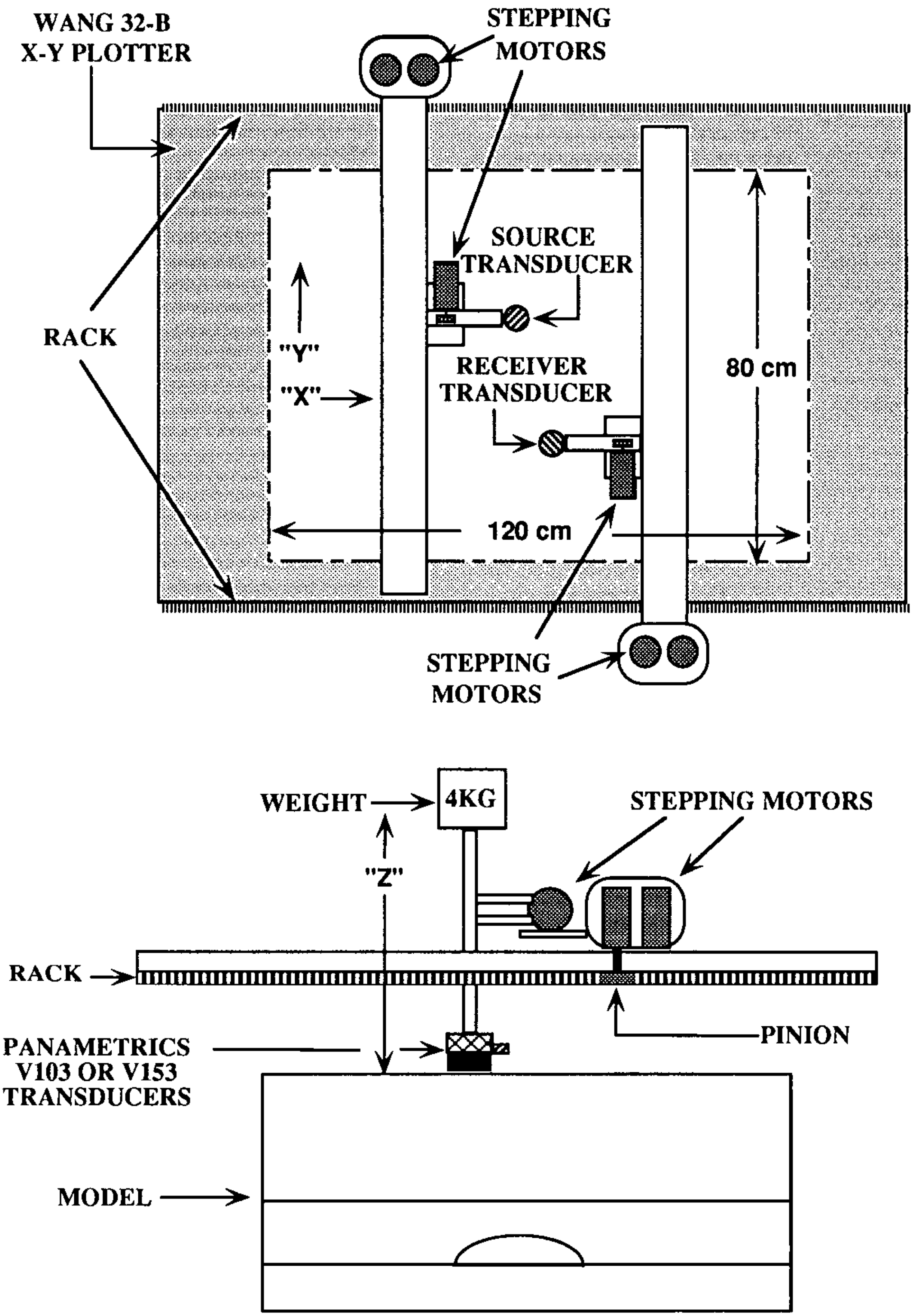

FIG.3 Plan and side view of Mark III physical modelling system.