A PARTIALLY AUTOMATIC TREE RING INTERVAL COUNTER AND KEYPUNCH: (PATRICK)

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ABSTRACT

A microscope that enables an investigator to rapidly measure and simultaneously record tree ring intervals on data-cards is described. A resume of sources and magnitudes of errors is included.

INTRODUCTION

The use of statistical methods utilizing computers has rendered it possible to rapidly analyse a considerable amount of tree ring width data. This in turn has necessitated increased speed and efficiency in the measurement of ring series and in digitally recording this data. A Partially Automatic Tree Ring Interval Counter and Keypunch (PATRICK), was therefore developed to enable an operator to rapidly measure and simultaneously record increment widths on data-cards.

DESCRIPTION OF APPARATUS

The PATRICK shown schematically in Figure 1 consists of a motor driven specimen stage which is a Societe Genevoise dividing machine,[1] a screw position encoder that feeds pulses into a scaler unit,[2] an IBM 26 (printing) card punch, and a stereo-microscope with illuminator.[3] A variable speed drive motor enables the operator to vary the velocity of translation of the specimen stage from 0 to 1.0 mm/sec.

The drive screw of the dividing machine is connected to the motor by an electromagnetic clutch. The clutch plates are spring loaded and scoured to insure rapid separation when the clutch is disengaged. The screw is connected to a disc within the screw position encoding unit through a 1:4 gear train. Around the perimeter of the disc are 50 equally spaced holes. As the disc rotates, light from a point light source is transmitted through these holes, one at a time, to a photojunction. Each light pulse generates an electric pulse which is recorded in the scaler.

The scaler indicates the number of accumulated pulses corresponding to the distance traversed during a transect. The circuitry for transferring the scaler output to the punch is designed to leave the punch suitable for conventional manual operation when the PATRICK is not in use. (Details of the circuitry are available upon request.) Each card processed by the IBM 26 card punch records the radial coordinates of eight tree rings to five digit accuracy. Mathematical operations such as the determination of individual ring widths are performed by electronic computer.

A weight is attached to one end of the specimen stage to hold it against one side of the screw threads to eliminate backlash. Interval measurements are therefore conducted by translating the stage only in the direction opposing the weight. A fast automatic return cycle is initiated when the stage has moved across the entire length of the dividing machine.

A stereo-microscope, with a cross-hair reticle in one eyepiece, capable of magnification of 72 and 144X, and an illuminator are mounted above the specimen stage. In measuring a specimen, only one magnification at a preset focal condition is used during a particular transect to avoid errors introduced by parallax. The surface of the specimen must therefore be uniform to avoid the need for frequent focusing of the microscope; such specimen surfaces have been obtained by employing the sanding method of Bowers.[4]

The operator is provided with two switches. One switch disengages the clutch and, after a specified delay, causes the number recorded in the scaler to be punched on a data-card by the card punch. Only upon completion of the punch cycle can the clutch be re-engaged. This switching cycle avoids introducing spurious pulses into the card punch during the 3 sec. print and punch cycle. Although a magnetic tape read-out would be faster than the present data-card read-out system, the operator is now able to quickly determine whether the scaler output is being faithfully recorded. As each ring passes under the cross-hair of the microscope, the operator must only press the first switch button to initiate the punching cycle. A second switch disengages the clutch only. This switch enables the operator to stop the translation of the stage without punching a number on the card. This is advantageous when there are cracks in the specimen. The operator stops the stage on one side of the crack, moves the specimen so as to bridge the crack by means of a manually operated substage mounted on the specimen stage, and resumes measuring from the opposite edge of the crack. Once the microscope is properly focused and a convenient velocity of translation selected, the operator must only press a button as each ring passes under the microscope cross-hairs.

RESULTS AND DISCUSSION

Saxon[1] calibrated the drive screw and found the pitch to be 1 ± 10^{-5} mm. A micrometer scale attached to the drive screw allows the position of the stage to be measured to within .001 mm. Since the smallest increment of motion recorded by the pulse monitoring system is .005 mm, subsequent calibration of PATRICK employed this micrometer as a standard.

Tests were conducted to demonstrate the reproducibility and the magnitude of errors associated with starting, stopping, and variation of the motor drive speed by comparing measurements obtained from a 39.37 line/cm Ronchi ruling. A .0035 mm standard error, observed at very slow translational velocities, is the irreducible error introduced by digitizing the measured intervals in .005 mm increments. The digital shaft position encoder utilized in the present device was fabricated by our technical staff; encoders capable of measuring smaller increments are commercially available.[5] Although the operator anticipates the passage of the reference line under the cross-hair, the .050 sec standard deviation in his reaction time introduces the most significant velocity dependent contribution to the standard error. Standard errors in the reaction time to visual stimuli of this magnitude have been cited by Woodworth and Schlossberg.[6] This velocity dependent source of error could be eliminated by using a photo-electric trigger, sensitive to changes in the intensity of light reflected from the specimen, to initiate the print and punch cycle. The operator thus would only be required to visually discriminate against cracks or unusual flaws in the specimen. The PATRICK is not used sufficiently at this time to necessitate high translational velocities; this added expense is therefore not warranted at present. The operator's reaction time and the PATRICK'S time resolution contribute a velocity dependent standard error approximately 0.06v mm, where v is the velocity of translation in mm per sec. These factors combine to introduce a total standard error

$$\triangle w = \sqrt{(.0035)^2 + (.06V)^2} \quad \text{mm}$$

in each measured tree ring interval. This error is small compared to the natural ring width variation of species currently under investigation at the University of Wisconsin Tree Ring Laboratory.

In order to minimize cost, PATRICK was designed to utilize equipment already available. The present design, therefore, while entirely adequate, should not be considered optimal.

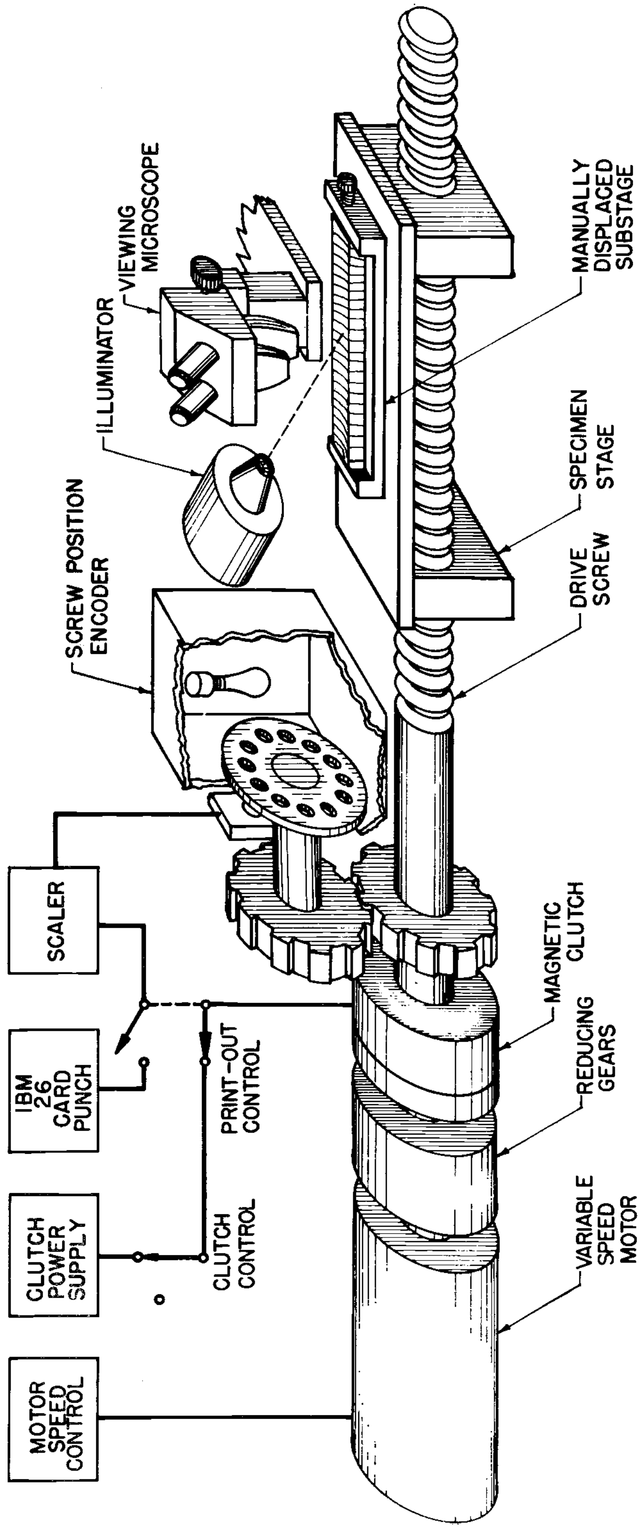

FIG. 1. Schematic Diagram of the PATRICK.

ACKNOWLEDGMENTS

This research was supported by the Atmospheric Sciences Division, National Science Foundation, Grant GP-444. Prof. J. E. Mack of the Physics Department provided the Societe Genevoise dividing machine. Messrs. H. H. Miller, K. R. Walker, R. L. Steventon and S. W. Lee assisted in the execution of the electronic aspects and Messrs. W. Hauser and J. Drake assisted in the execution of the mechanical aspects of this device. Their aid is hereby gratefully acknowledged.

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FOOTNOTES

1) D. Saxon, *The X-Ray Spectra of Some Heavy Elements.* Ph.D. Thesis, University of Wisconsin, p. 24. 1954.

2) Beckman Universal Eput Scaler and Timer, model 7360R.

3) Leitz Stereomicroscope (GRUKY). One eyepiece is fitted with a cross-line reticle. An American Optical Company Cyclospot Microscope Illuminator is attached to the microscope base.

4) [illegible] A. Bowers, New Method of Surfacing Wood Specimens for Study. *Tree-Ring* [illegible]*tin*, Vol. 26, Nos. 1-4, p. 2, June, 1964. Tucson, Arizona.

5) Available from W & L E Gurley Co., 514 Fulton St., Troy, N. Y.

6) R. S. Woodworth and H. Schlosberg, *Experimental Psychology*, pp. 8-39, 1954.