HOKE'S LAW AND YOUNG'S MODULUS APPARATUS

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It is not often advisable to try to do too many things in one experiment especially in general laboratory work of first year physics but the combining of Hooke's Law and Young's Modulus does seem highly desirable provided satisfactory apparatus is available. Engineering students should test experimentally both of these important physical principles because of their broad application to engineering problems. It does not however appear advisable to take the time for two separate experiments when the time allowed for laboratory work is so limited.

Hoping to find a satisfactory answer to this problem the writer began experimenting to determine whether or not a convenient simple accurate piece of apparatus could be discovered that would meet the demand. The different types of Hooke's Law apparatus, Young's Modulus apparatus and Hooke's Law and Young's Modulus apparatus were studied carefully and their defects noted. Most of these pieces were found unsatisfactory for several reasons. The cathethometer method was unsatisfactory for two reasons, first the elongation could not be read very closely and second it was difficult to keep the cross hairs on the index point on the wire. The optical mirror method was troublesome and very tedious. The micrometer and spirit level apparatus gave trouble in adjusting the wires and in setting the level. The two-wire vernier type was far from satisfactory. The problem appeared to be one of finding an entirely new kind of apparatus. After considerable time and experimenting the following piece of apparatus was worked out and it has proved highly satisfactory.

With this apparatus the testing of Hooke's Law and Young's Modulus for different kinds of wires has been carried out accurately, quickly and with no trouble or delay to the student. In many
cases the readings "ran so true" that the "on and off" readings gave practically no error. In most cases after the wire had been "run" once the zero readings for on and off would check to the degree of accuracy that the readings permitted.

A glance at the figure shown above will make clear how the apparatus works, how simple it is and how easily manipulated by the student. We have found that it gives no trouble, is easily understood and the results obtained are highly satisfactory.

A small wheel A about twenty centimeters in diameter with an axle B about two centimeters in diameter is carried by a rod G, the latter resting in support D. D also carries clamp for holding wire to be tested. The lower end of rod G is held loosely by collar and set screws at E. This is arranged so that if support D gives any under load, rod G will give the same amount and wheel A will give the same amount. This corrects on wire any give in support D. The wire to be tested is clamped at D, wrapped around B twice and carries weight holder F at lower end, below axle B. Weights can be put on and taken off without disturbing reading conditions. The whole apparatus is well constrained yet perfectly free for the one-motion desired, that of the elongation of the wire to load.

The small drawing shows how the elongation of the wire is measured. The readings on the wheel are taken in degrees and the ratio of the degrees read for each load to three hundred
sixty degrees equals the ratio of the elongation for that load to $2 \pi r$ where $r$ is the radius of the axle B. The writer shall be pleased to submit further and more detailed information regarding this apparatus as well as tables of results obtained by freshmen students using the apparatus if anyone desires it. We are now securing the best and most satisfactory results from testing Hooke's Law and Young's Modulus with this apparatus.

NEW METHODS WITH THE IMPULSE BALANCE.

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The Impulse Balance is an apparatus which measures the force required to stop a stream of water. It is adapted to verifying the Second Law of Motion in the form involving force and rate of change of momentum, instead of the more usual form involving force, mass and acceleration. An early model of it was described in School Science and Mathematics, pp. 520-521, 1914. Since that time numerous improvements have been made. The apparatus at present consists of a vane of one-sixteenth inch brass plate fifteen inches long and two and one-half inches wide, to which is soldered, near the bottom, a funnel of sheet brass two inches in diameter, with a small re-entrant funnel at its mouth and with an outlet at its base. A square hole near the top of the vane admits a supporting bracket, and above the hole there is a fixed counterpoise and an arm projecting at right angles to carry an adjustable counterpoise, the whole being so proportioned that the vane hangs vertically from the bracket when the adjustable counterpoise is not in use. The oscillations of the vane are closely limited by the prongs of a forked stop. A small swift stream of water, regulated by a needle-valve, flows from a nozzle carefully reamed to a cylindrical form, and is directed horizontally into the funnel, so as to strike squarely on the vane. Its impact drives the vane against the further prong of the stop, and the water, completely deprived of its horizontal momentum, is discharged vertically downward from the outlet at the base of the funnel. By properly placing the adjustable counterpoise on the arm, the torque on the vane due to the water may be compensated, and the vane brought back to its equilibrium position between the prongs. Knowing the diameter of the nozzle and the quantity of water discharged during a measured interval of time, both the speed of the water