AAPT
APPARATUS COMPETITION
1965

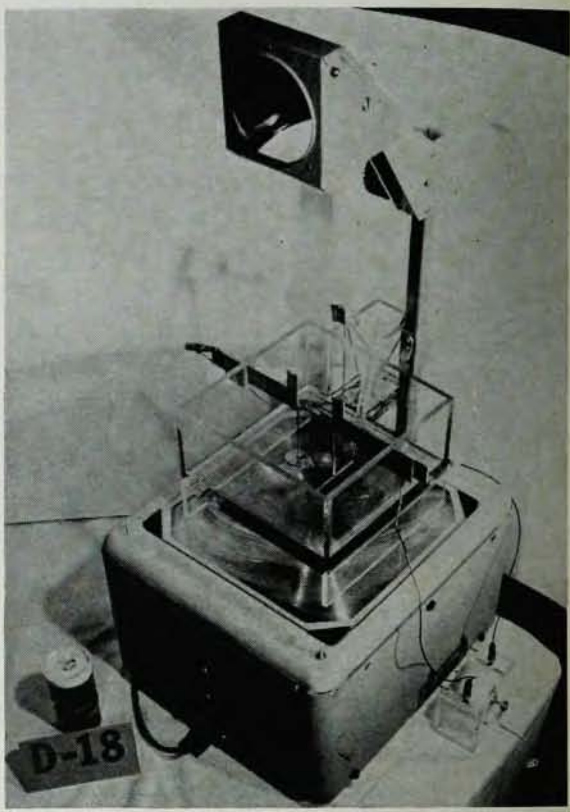
The fourth biennial physics apparatus exhibit was held last January during the joint annual meeting of the American Association of Physics Teachers and the American Physical Society in New York. Dr. Christensen has served since 1963 as head of the AAPT-AIP Center for Educational Apparatus in Physics while on leave from St. Olaf College in Minnesota, where he is associate professor of physics.

By F. E. Christensen

During the middle of January 1965, equipment arrived at the Hotel Statler-Hilton in New York City for another physics apparatus exhibit and competition. One entry was received from Switzerland, the others from the United States. The entries, with one exception, were submitted by physicists from academic institutions.

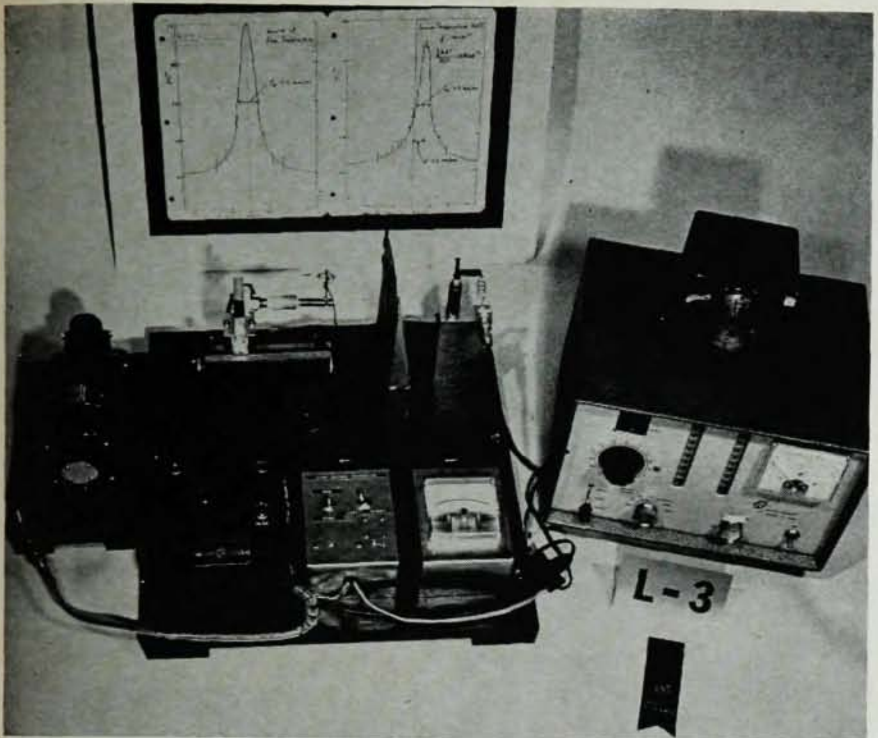
The 1965 exhibit was the fourth biennial showing. As in previous years, the competition was held during the joint annual meeting of the American Physical Society and the American Association of Physics Teachers. The project was conducted by the AAPT Committee on Apparatus* and was jointly sponsored by the American Association of Physics Teachers and the American Institute of Physics, with partial support from the Ed-Set Division of Budd-Stanley Company, the Central Scientific Company, the Macalaster Scientific Corporation, and the Welch Scientific Company.

By mid-afternoon of Tuesday, January 26, the exhibit was completed and turned over to a panel of judges whose members were Walter H. Brattain of Bell Telephone Laboratories, Howard A. Robinson of Adelphi University, and James H. Werntz, Jr., of the University of Minnesota. After eight hours of intensive work by the judges, the evaluation of the entries had been made. As in previous competitions, first, second, and third prizes ($300, $200, and $100, respectively) were awarded in each of two categories—lecture-demonstration apparatus, and laboratory apparatus. In addition, four entries in the laboratory category received honorable mention. Entries were judged on such criteria as merit of apparatus as a teaching device, design features,

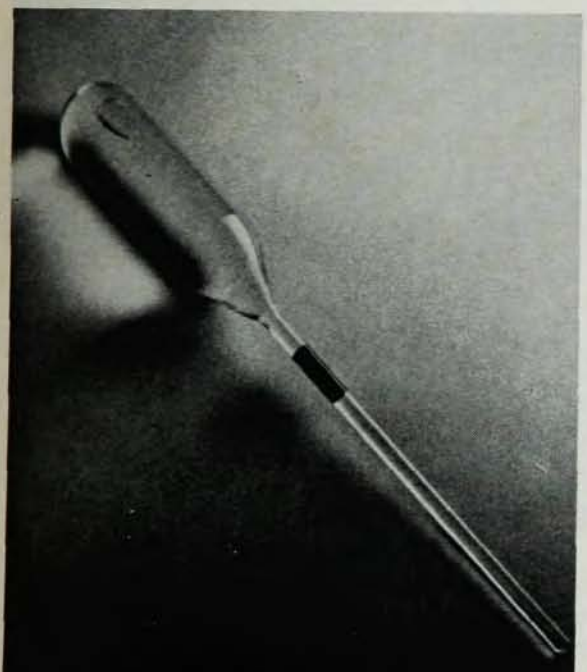


The first prize in the lecture-demonstration category was awarded for this electrostatic field display submitted by Harold M. Waage of Princeton University. Pairs of electrodes of different configurations are submerged in mineral oil contained in a transparent plastic box and are connected electrically to a simple voltage generator. Electric field patterns are made visible by introducing particles that remain suspended in oil for long periods of time. The apparatus was used in conjunction with an overhead projector.

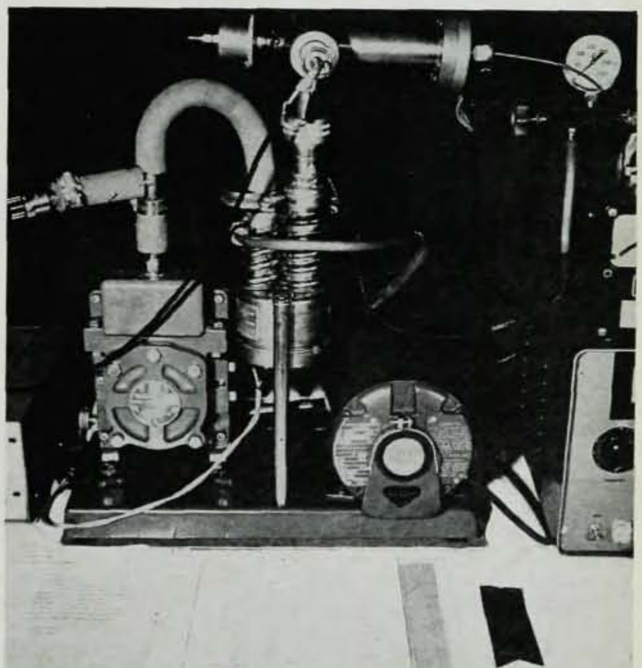
* Members of the 1964-65 Apparatus Committee were: Walter R. French, Jr., Nebraska Wesleyan University; W. C. Kelly, American Institute of Physics; John G. King, Massachusetts Institute of Technology; Harry F. Meiners, Rensselaer Polytechnic Institute; H. V. Neher, California Institute of Technology; Alan M. Portis, University of California; Allan M. Sachs, Columbia University; Howard P. Stabler, Williams College.



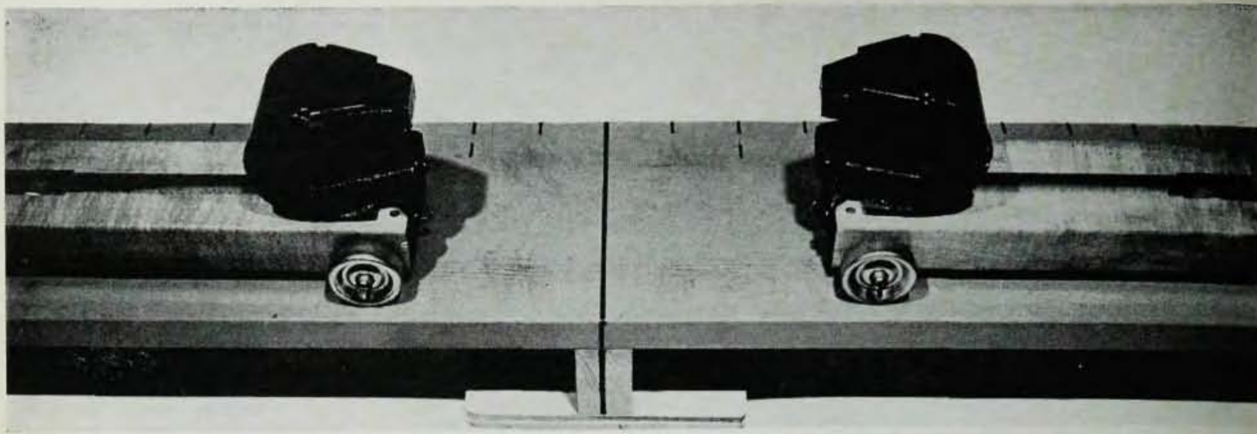
Mössbauer experiment to show the relativistic time dilatation received the first prize in the laboratory apparatus category of the competition. Submitted by Joseph W. Weinberg, Berol L. Robinson, and John K. Major of Western Reserve University, the apparatus consists of a nuclear resonant Geiger counter and a simple, variable-speed mechanical drive carrying a heating element (a soldering iron). A cobalt-57 source is diffused into a stainless-steel button which is attached to the heating element. When the cobalt source is heated to 450°C, a differential thermal agitation makes it possible to demonstrate the time dilatation. The effect causes a shift of the resonance peak comparable to the line width of iron-57 resonance. Resonance is restored by introducing a Doppler shift to compensate for the time dilatation. The count rate at resonance is four times that of background.



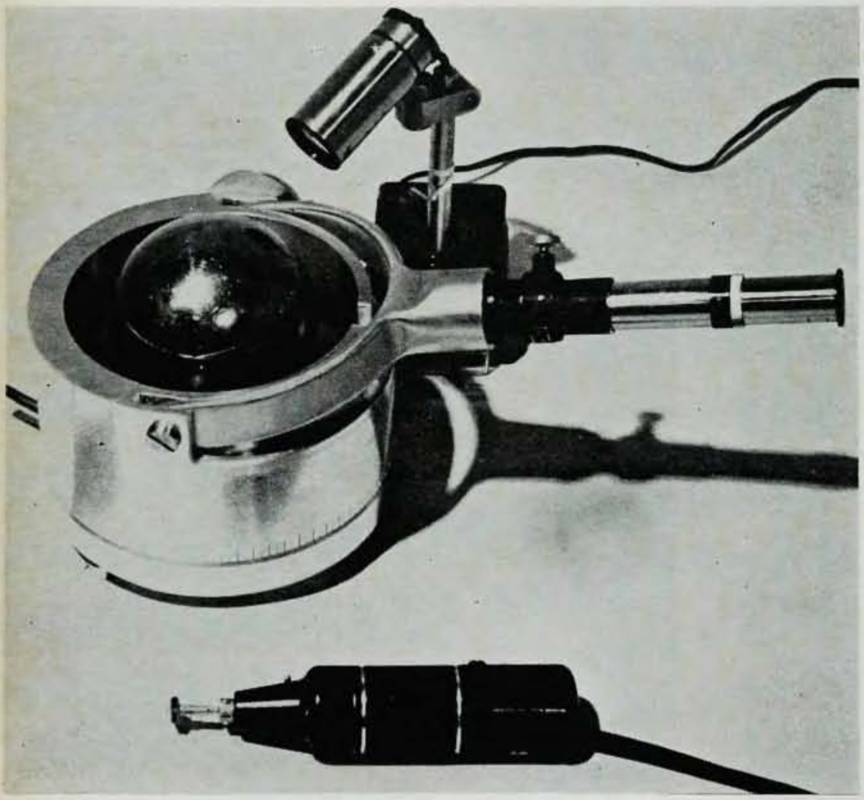
Second prize (lecture demonstration) was awarded for entry by B. Hahn, University of Fribourg, showing negative pressure in a liquid. A glass bulb and capillary tube comprise a closed system filled with a liquid (freon-113). If bubble is visible, as is usual at room temperature, a small addition of heat will cause the bubble to disappear, and the liquid will fill the entire volume. Upon cooling, cohesion between the glass and the liquid molecules causes deformability of the liquid, giving rise to negative pressure. The formation of a bubble can be triggered by a particle, such as a neutron, which causes the liquid to break prematurely at −5 to −10 atmospheres.



Bailey L. Donnally of Lake Forest College received the second prize in the laboratory-apparatus category for having submitted this experimental setup for determining the Lamb shift in hydrogen. Donnally's apparatus is designed to show the fine structure of hydrogen in state $n = 2$. This is accomplished by using an atomic beam and an energy-level crossing scheme. The Lamb shift can be calculated upon finding the magnetic field at which the $2S_{1/2}(m = -1/2)$ and the $2P_{1/2}(m = +1/2)$ energy levels cross. In addition, by finding the magnetic field at which the $2S_{1/2}(m = +1/2)$ and the $2P_{3/2}(m = -1/2)$ energy levels cross, one is able to calculate the zero-magnetic field splitting of the $2P_{3/2}$ and the $2P_{1/2}$ energy levels.



Demonstration (above) of motion of center of mass with reaction carts won third prize in lecture apparatus category. It was submitted by Edward R. Nye, Ronald Cain, and George Freier of the University of Minnesota. Newton's third law of motion is illustrated with two carts (of equal or unequal masses) balanced on a seesaw. Strong U-shaped magnets are mounted on the carts so that when they face each other on the track a strong force of repulsion results. When the carts move apart, the seesaw remains in balance.



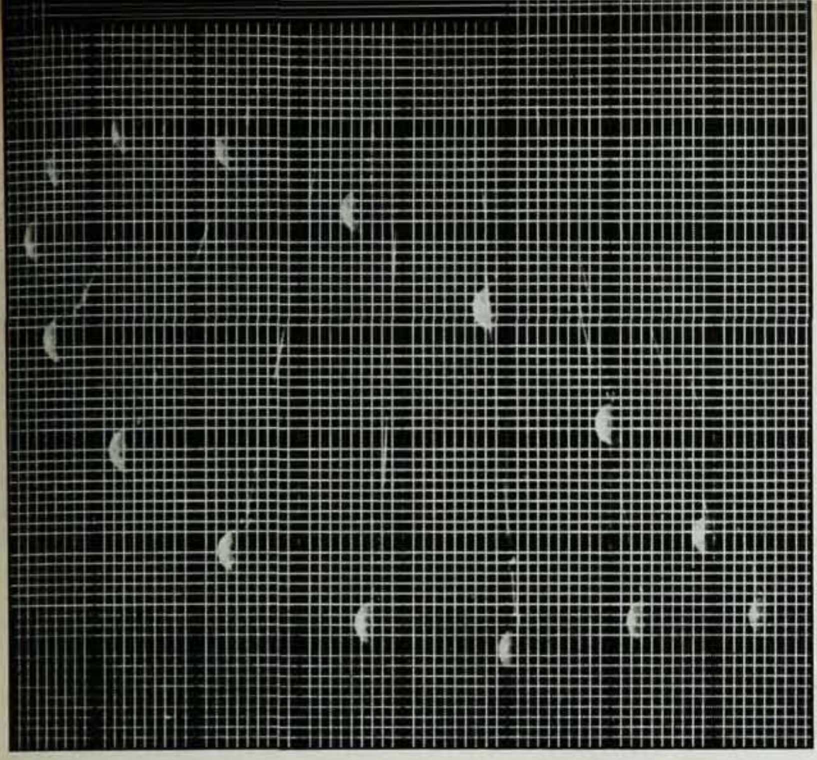
Third prize in the laboratory category was awarded for an air-bearing gyroscope used to determine the earth's rotational axis and angular velocity. The apparatus, submitted by Harold A. Daw of New Mexico State University, consists of a steel ball floated on air, and a gimbal-mounted telescope. With the ball rotating at approximately 3000 rpm, the rate of relative motion of its spin axis is measured by the telescope. This information makes it possible to determine the magnitude of the earth's spin.

performance, and originality of design. The names of the exhibitors were withheld during the period of judging.

The biennial competitions are desirable for several reasons: to apprise manufacturers of new or modified apparatus, to motivate the development of new apparatus and experiments, and to disseminate information on the construction of equipment.

A few of the items on display at the previous exhibits have been quickly adopted by manufacturers and put on the market. Teaching physicists have shown themselves to be eager to learn of new experiments that can be added to their laboratory curriculum. At the 1965 exhibit the participants were especially generous with their time, giving information on construction of the apparatus and on the theory of the experiment.

New products of various kinds cause modifications in apparatus design. The research laboratory is constantly supplying new experiments which are adaptable to the undergraduate laboratory. Two recent examples of this are the laser and the Mössbauer-effect experiments. Mössbauer-effect apparatus, as used in two different experiments, was displayed at the 1963 and 1965 competitions.



Four entries in the laboratory category received honorable mention. The study (above, left) of relationship of force to mass and acceleration involves a mass (ball) suspended by rubber band, Polaroid camera, strobe light, and grid to indicate position of ball. Motion of bouncing ball is confined primarily to vertical plane. From successive positions of ball recorded on film, one can determine forces acting on ball. It was submitted by E. R. Huggins of Dartmouth College, as was the electron gun, constructed with solder-glass equipment (above, right). Electrons, emitted by cathode, give up their energies in collisions with gas molecules (nitrogen). By observing length of luminous column within gas, the student can determine mean free path and size of the nitrogen molecule. Knudsen pressure-gauge apparatus at left was submitted by Barry Block and Philip Roos of the University of Maryland. The student is asked to construct gauge, consisting of vane mounted on a fiber and placed near a hot body, and, from data at various pressures, plot a graph that relates true pressure with gauge pressure. According to the perfect gas law, pressure is proportional to vane's angular rotation. From graph, the student can determine region in which gauge is operable and estimate size of gas molecules. The NMR device (below) for studying stimulated emission and relaxation time was designed by Bailey Donnally of Lake Forest to observe proton resonance absorption in flowing water. Stimulated emission results from inversion of spin population during adiabatic fast passage. Measurement of the amplitude of signal produced by marginal oscillator can be used to determine negative absolute spin temperature. Relaxation time for protons in water can be determined from dependence of signal on length of time the water has been subjected to a magnetic field.

It is hoped, through exhibits of this kind, that ideas generated on one campus will find quick acceptance by other physics departments, research laboratories, and manufacturers.

The success of the exhibit is due in no small measure to the time and effort given by the participants, themselves, during the time of the showing; for this, the sponsors of the competition are indeed appreciative. Thanks are also extended to the judges and to the assistants, especially members of the Apparatus Center (Mrs. Rose B. Halwer and Mrs. Katherine Douris), and T. W. Williams, III, and Sam Tramm of Columbia University.