

PHYSICS

Chairman: R. E. MARTIN, Hanover College

Professor K. W. Meissner, Purdue University, was elected chairman of the section for 1946.

Theoretical calculations regarding electron accelerator. E. S. AKELEY, Purdue University.—In the accelerator patented by Hansen in 1937, energy is imparted to an electron by letting it pass a number of times through a cavity resonator. Woodyard thought of modifying this arrangement by placing a number of such resonators end to end and removing the inside end plates, thus forming a wave guide closed at both ends. He showed that electrons of several hundred million volts could be produced, and pointed out that the cost of such an accelerator should increase approximately proportional to the voltage, while the cost of accelerators of the type of the cyclotron or betatron would increase approximately proportional to the cube of the voltage, so that for particles of very high energy, the linear accelerator should be cheaper than the other type.

One of the most important considerations in the design of a linear accelerator is the shape of the cavity, which must produce a longitudinal electric field with which the electron is always in phase. Also the energy dissipation due to the finite conductivity of the walls of the guide should be as small as possible. For this purpose the stationary electro-magnetic modes that can exist between two infinite parallel conducting planes of infinite conductivity have been studied. The relative intensity of the modes excited can be fixed by connecting the planes by a conducting surface of revolution of infinite conductivity. The mode required to accelerate the electrons is the one whose wave length along the axis of the guide is equal to the wave length of the same radiation in the absence of the planes. If only this mode is excited, the conducting surface of revolution must meet the planes at infinity. However, if this mode and one other mode is excited, the surface can be chosen finite. The general character of surfaces of this type are discussed. Numerical integration is used to compute their shape quantitatively and to determine the energy dissipation.

Jet Propulsion. ROBERT D. BECKMAN, Allison Division of General Motors Corporation.—In this paper jet propulsion is shown as a practical application of a fundamental law of physics which has been known for over two thousand years. Several gadgets, model airplanes on a wire, and a small race car on a track feature the demonstrations. Also, a series of slide films designed to give a clear idea of the jet propulsion principle are used.

A Two Meter Grating Spectrograph. JESSE B. COON, Bloomington.—A two meter grating spectrograph having an Eagle type mounting has

been designed and built. Some of the mechanical features of the mounting will be described. A method of obtaining a good intensity of 2100A radiation in the fourth order without overlapping will be discussed.

The structure of tellurium as a function of temperature. L. G. DOWELL AND J. ORNDOFF, Purdue University.—Experiments on electrical conductivity, Hall effect and thermo-electric power of tellurium show a behaviour not to be understood on the basis of a simple metal or semi-conductor structure. To investigate this problem in connection with possible changes in structure Lark-Horovitz suggested:

- a. Structure investigation of tellurium layers produced and investigated in a high vacuum.
- b. Tellurium deposited in a high vacuum but heated in air to various temperatures.
- c. Tellurium powder heated in air at 200° and 400°.

The results show that

- a. A vacuum deposited layer kept in vacuum all the time shows no change in structure throughout the whole range of temperature investigated.
- b. There is no change in the vacuum deposited layer heated in air up to 200°. After heating to 360° in air, new lines appear which are not tellurium but fit some of the tellurium oxide lines or some more complicated pattern.
- c. Tellurium heated in air up to 200° shows no change, but after heating to 360° or 400° for an hour and one-half, a whitish deposit appears and the powder then reveals diffraction lines which are identical with the ones obtained under b.

This shows that any theoretical explanation of the electrical properties of tellurium heated in air has to consider the existence of additional layers of material, and electrical investigations of tellurium deposited in a high vacuum and investigated also in high vacuum are necessary to decide the question whether the complicated electrical behavior is due to a complicated structure in the level of electron donors or acceptors themselves, or whether one is dealing with a mechanical mixture of the semi-conductor tellurium and an oxide or other compounds.

Refractions in a Compound Lens. MASON E. HUFFORD.—It is shown that a thick lens can always be found which has the same cardinal points as a compound lens. The formula of a thick lens is developed using a new algebraic method. New geometric methods of showing the relationships of the cardinal points of a thick lens to its radii of curvature are developed. These relationships are applied in the case of a solid spherical lens.

Electron-diffraction study of the "polish layer." K. LARK-HOROVITZ AND T. S. RENZEMA, Purdue University.—In a study of polished surface we investigated beryllium, boron, germanium and silicon surfaces. We have obtained from these surfaces electron diffraction patterns appar-

ently identical with the patterns obtained from polished metal surfaces by many investigators. Beryllium and boron were chosen by reason of their small atomic radii to challenge the view that the "polish pattern" indicates that the polish layer is an amorphous state of the substrate.

The pattern obtained from polished silicon is not that to be expected from extremely small silicon crystallites nor can it be attributed to SiO_2 , amorphous or crystalline. Washing a polished silicon surface in a hydrofluoric acid solution produces a weak silicon powder pattern suggesting the polished surface may be composed of finely divided silicon (insoluble in HF) and materials which are soluble in HF (polishing debris of silica or silicates.)

If a polished silicon surface is heated in air, a surface is produced which is visibly and electrically different from a surface which has been only polished. This surface, however, gives the same pattern as the latter surface even during a progressive removal by etching. Electron diffraction evidence suggests that the heat treatment oxidizes the fine silicon particles which seem to be included in the polish layer. K. Lark-Horovitz and K. W. Meissner have shown by optical methods that the layer formed when polished silicon is heated in air is definitely SiO_2 , or a silicate.

Electron diffraction patterns produced by absorbed films of diffusion pump oil and other oily materials have been studied and the effect of rubbing such films observed. Various degreasing solutions and techniques have been tested.

Recent developments in the use of the atomic beam in spectroscopy. L. G. MUNDIE, Purdue University.—With the development of spectral apparatus having a resolving power of several million while still retaining a considerable spectral range, the need for a light source capable of emitting lines of very small width becomes apparent. The atomic beam is ideal for this purpose, for the Doppler broadening may be reduced at will by simply increasing the collimation of the beam. Line widths comparable with the natural width of the spectral line may be achieved in this way.

An atomic beam light source has been developed and is described in some detail. The problem of power dissipation in the grid has been solved by making the elements of fine nickel tubing through which distilled water is forced. The relatively high vacuum needed is achieved by independent pumping of the furnace and excitation chambers.

This apparatus has been used successfully in the case of Sn, Pb, Cd, Mg, Ca, and Al. In the case of Mg the hyperfine structure of many of the lines has been carefully investigated using Fabry-Perot interferometer, and the theoretical interpretation of the results are discussed. Intensity anomalies present within a p-p' multiplet in the case of Mg were not present in the corresponding multiplet of Ca. The investigation of Al by this method presents greater difficulty with respect to furnace construction. While the results are not yet complete, they should be of considerable theoretical interest.

Significance of symbols in physical equations. DUANE ROLLER, Wabash College.—According to Bridgman, physical symbols always denote numbers. Wallot (1926) and Lenzen (1940) are among those who contend that the symbols may represent physical quantities directly. Difficulty in converting certain electrical equations from a rationalized to a nonrationalized form has been interpreted as indicating that the symbols involved must necessarily represent numerical values only. However, an analysis indicates that this interpretation is incorrect. Any physical equation can be written either between physical quantities or between numerical values. The only requirements are consistency and unambiguity in the use of one scheme or the other.

A quantitative method for the spectroscopic analysis of potassium-sodium solution. WAYNE SCANLON, Purdue University.—A rapid and accurate method of quantitative analysis of sodium and potassium was developed which gives direct measurements of concentrations ranging from 10 mg/100 cc. to 200 mg/100 cc. The solution containing the sodium and potassium is sprayed into a flame where the resonance lines of these elements alone are appreciably excited. The resonance lines of sodium at 5890 and 5895 A° and those of potassium at 7664 and 7699 A° are separated enough in the spectrum to permit their isolation almost completely by means of color filters. The light from the flame is by this means separated, one color falling on a red sensitive photo-electric cell and other on a yellow cell. The photo electric current is measured by means of a high sensitive galvanometer.

The illumination gas and air mixture that gave the most stable conditions were determined. These could be maintained steady enough to permit calibration of the galvanometer scale in terms of concentrations of potassium and sodium.

The amount of solution required is small, as little as 1 cc. being sufficient. The results obtained on test solutions showed errors not greater than about 3 per cent to 5 per cent.

Some remarks on the focussing of ions in a magnetic field. W. M. SCHWARZ, Indiana University.—The focussing properties of magnetic fields of various shapes are known. In particular the properties of a sector shaped field have been worked out by Stephens for the case of electrons. The equations are readily adapted for mass spectrograph work, and some interesting conclusions can be drawn from them after their form has been modified.