Abstracts of Technical Articles by Bell System Authors

Historical Background of Electron Optics.[1] C. J. CALBICK. The discovery of electron optics resulted from studies of the action, upon electrons or other charged particles, of electric and magnetic fields employed for the purpose of obtaining sharply defined beams. The original Braun tube (1896) employed gas-focusing, as did the low-voltage cathode-ray oscilloscope developed by Johnson in 1920. It was early discovered that an axial magnetic field could be used to concentrate the electrons into a beam, and this method came into wide use in the field of high-voltage cathode-ray oscillography. In 1927 Busch published a theoretical study of the action of an axially-symmetric magnetic field upon paraxial electrons, showing that the equation of the trajectories of the electrons was similar to that of the paths of light rays through an axially symmetric optical system. He concluded that such magnetic fields constituted lenses for electrons and presented experimental confirmation. In 1931 Knoll and Ruska presented a large amount of additional experimental material and used the words "electron optics" to describe the analogy. In 1932 Bruche and Johannson published the first electron micrographs.

The Davisson and Germer electron diffraction experiments (1927) employed electron beams formed by electron guns consisting of a thermionic cathode emitting electrons which were accelerated by potentials applied to a series of plates containing aligned apertures. The resultant beam was quite divergent. Davisson and Calbick made a theoretical and experimental study of the forms of such beams. They concluded that the distorted electric field in the vicinity of an aperture in a charged plate constituted a lens for charged particles (1931). The optical analogy was either a cylindrical or a spherical lens, according as the aperture was a slit or a circular hole. The theory was confirmed by photographing the forms of electron beams, and by construction of an electrostatic electron microscope whose experimental magnification agreed with the theoretical.

Coaxial Cables and Associated Facilities.[2] J. J. PILLIOD. (*Summary of Talk before St. Louis Electrical Board of Trade*, October 17, 1944.) Coaxial cables provide means of transmitting frequency bands several million cycles in width over a metal tube a little larger than a lead pencil, with a copper wire extending along its axis. Several of these tubes can be placed in a lead sheath.

The frequency band transmitted over coaxial cables may be split up so as to provide several hundred telephone circuits or, without such division,

[1] *Jour. Applied Physics*, October 1944.
[2] *FM and Television*, November 1944.

coaxial cables will provide for broad-band transmission service such as is required for television.

A cable is now being installed between Terre Haute and St. Louis which contains six coaxial tubes to provide telephone circuits, and which may, in the future, find use in connection with the provision of intercity television networks.

The structure of the tubes used with coaxial cables consists of a central copper conductor within a copper tube about $\frac{1}{4}$ in. in diameter, made from flat copper strip which is formed around the insulating discs. Around each copper tube are two steel tapes which supplement the shielding of the copper tube in preventing interference between tubes in close proximity. The central conductor is separated from the outer conductor by slotted insulating disks which are forced onto the wire. The cables are formed with an appropriate number of these tubes along with some small gauge pairs used for control and operating purposes.

In the case of underground cables buried directly in the earth, jute or plastic protective coverings are used to assist in reducing sheath corrosion. In some parts of the country it is essential to add a metal covering outside the lead sheath and the plastic or jute to protect the cables against the operations of ground squirrels or pocket gophers. In certain areas these animals have been found to carry away long sections of the jute covering and will chew holes in the lead sheath unless other metal protection is provided. Copper is sometimes used for this metal covering to assist in lightning protection.

Repeaters in the coaxial system are now located at intervals of about five miles. Power for repeaters in the auxiliary stations is supplied from the adjacent main stations located at something over 50 miles at 60 cycles over the coaxial conductors themselves.

Coaxial cables are in regular operation between New York and Philadelphia and between Minneapolis and Stevens Point, Wisconsin, a total distance of nearly 300 miles. A network of such cables totaling about 7,000 route miles and including a second transcontinental cable route is being planned over additional routes. The requirements of the armed forces, general business conditions, the volume and distribution of long distance telephone messages, the availability of the necessary manufactured cable and equipment, and other factors may modify the extent of this construction, the time of starting, and the routes which will be undertaken.

Western Electric Recording System—U. S. Naval Photographic Science Laboratory.[3] R. O. Strock and E. A. Dickinson. This paper describes the complete 35-mm film and $33\frac{1}{3}$ or 78 rpm. disk recording and re-recording equipment installed for the U. S. Navy at the Photographic Science Laboratory, Anacostia, D. C. Modern design, excellent performance, and ease of operation are features of the installation.

[3] *Jour. Soc. Motion Picture Engineers,* December 1944.