Abstracts of Recent Technical Papers from Bell System Sources

Cipher Printing Telegraph Systems for Secret Wire and Radio Telegraphic Communications. G. S. VERNAM.[1] This paper describes a printing telegraph cipher system developed during the World War for the use of the Signal Corps, U. S. Army. This system is so designed that the messages are in secret form from the time they leave the sender until they are deciphered automatically at the office of the addressee. If copied while en route, the messages cannot be deciphered by an enemy, even though he has full knowledge of the methods and apparatus used. The operation of the equipment is described, as well as the method of using it for sending messages by wire, mail or radio.

The paper also discusses the practical impossibility of preventing the copying of messages, as by wire tapping, and the relative advantages of various codes and ciphers as regards speed, accuracy and the secrecy of their messages.

Methods of High Quality Recording and Reproducing of Music and Speech Based on Telephone Research. J. P. MAXFIELD and H. C. HARRISON.[2] The paper deals with an analysis of the general requirements of recording and reproducing sound, with the nature of the inherent limitations where mechanical records are used, and a detailed description of a solution involving, first, the use of electrical equipment for the purposes of recording and, second, the use of mechanical equipment based on electric transmission methods for reproducing.

Probably the most useful feature of the paper is the complete description of the application of electrical transmission theory to mechanical transmission systems. A detailed analysis is made of the analogies between the electrical and the mechanical systems.

Electrical and Photo-Electric Properties of Thin Films of Rubidium on Glass. HERBERT E. IVES and A. L. JOHNSRUD.[3] Films which spontaneously deposit on glass surfaces in a highly exhausted cell containing rubidium are electrically conducting, and photo-electrically active. A study of the photo-electric properties of a rubidium coated

[1] *A. I. E. E. Journal*, Vol. 45, pp. 109–115, Feb., 1926.
[2] *A. I. E. E. Journal*, Vol. 45, pp. 243–253, Mar., 1926.
[3] *Astrophysical Journal*, Vol. 52, pp. 309–319, Dec., 1925.

plane glass surface shows the normal and selective effects less well differentiated than for the similar coatings which form on metal plates. A rubidium film formed on the inside of a glass cylinder is found to exhibit, in the dark, a pure ohmic resistance. This decreases under illumination in a manner which appears to be explained as due to the liberation of photo-electrons which under a potential gradient form an added current along the tube.

The Influence of Temperature on the Photo-Electric Effect of the Alkali Metals.[4] HERBERT E. IVES and A. L. JOHNSRUD. Special cells having a hollow central cathode were immersed in liquid air for an extended period to insure that any gases, if present, were condensed on the outer alkali metal coated walls. The temperature of the cathode was controlled by a stream of evaporating liquid air, whereby all temperatures between +20 and −180° C. could be attained and held constant and be measured. In these cells the variation of photoelectric current with temperature in sodium, potassium, and rubidium is continuous, without abrupt changes. The effect is relatively small for sodium, showing hardly at all for blue light or white light, but clearly for yellow light. The behavior of rubidium is similar to that previously reported for potassium.

In a second form of cell, potassium was collected in a deep pool. By slowly cooling the metal from the molten condition, smooth crystalline surfaces were obtained. With these annealed potassium surfaces, the variation of photoelectric current with temperature is represented by curves varying systematically in shape with the color of the light, and the effect is far greater than previously reported, amounting, for yellow light, to a variation of 10 to 15 times between room and liquid air temperature. When the surface is roughened curves of the previously reported type are obtained. Small pools give erratic effects, showing changes in opposite directions for different portions of the temperature range. It is concluded that the variation of photoelectric effect is intimately connected with the strains produced in the surface by expansion and contraction with temperature.

Positive Rays in Thermionic Vacuum Tubes..[5] HERBERT E. IVES. Thermionic tubes in which a quantity of alkali metal is present exhibit not only the normal electron current from the heated filament, but a positive current, which at low filament temperatures may be

[4] *Journal of the Optical Society of America & Review of Scientific Instruments*, Vol. 11, No. 6, pp. 565–579, Dec., 1925.

[5] *Journal of the Franklin Institute*, Vol. 201, pp. 47–69, Jan., 1926.

many times larger than the negative current. The electron current is in general reduced by the positive rays, but at higher filament temperatures the reduction of space charge by the positive causes a considerable increase of the current over a limited voltage range. By immersing the tube in liquid air the positive ray effects are almost eliminated, indicating that the alkali metal vapor is the source of the rays, which are probably produced by contact of metal atoms with the hot filament.

A New Directional Receiving System.[6] H. T. FRIIS. Reduction of static interference, or to state it more correctly, reduction of the ratio of static to signal, has been, almost since the beginning of the radio art, the most important problem in radio engineering. It is now well known that static disturbances have definite points of origin and that the impulses which are detected at a receiving station have definite directions of propagation. A receiving system having no directional selectivity is, therefore, affected by static impulses from all directions and, in spite of many inventions, it has not yet been possible to improve its signal-static ratio except by limiting the frequency band transmitted. A system which, however, is so designed as freely to receive waves arriving from a limited range of directions is susceptible only to static disturbances propagated within that range, and large improvements in signal static ratio have been claimed for different types of directive antenna systems during the past few years.

A directional receiving system for radio telephony in which directional selectivity is obtained by combining the output voltages from two antennas is described in this paper. The main feature of the system is the arrangement for controlling the output voltages of the antennas, so that they may be combined to neutralize each other or to reinforce each other as desired. A double detection (super-heterodyne) receiver is employed and the output voltages, which are combined so as to produce the directional characteristic, are the intermediate frequency currents due to the waves received by the antennas and the beating oscillator currents. The control of these output voltages is effected by operating upon the beating oscillator currents.

High-Power Metallography—Some Recent[7] *Developments in Photomicrography and Metallurgical Research.* FRANCIS F. LUCAS. The

[6] Proceedings of the Institute of Radio Engineers, Vol. 13, No. 6, pp. 685–707, Dec., 1925.

[7] *Journal of the Franklin Institute*, Vol. 201, No. 2, pp. 177–216, Feb., 1926.

usual conception of high-power metallography seems to be great enlargement, indistinct definition and lack of resolution. Such results, generally, have been classed under the heading "empty magnification" because they have failed to show more detail than has been shown at lower magnifications and with objectives of less resolving ability. Oftentimes the pictures would be unintelligible taken by themselves, but the reason they are recognized at all is because the same structures have been seen and identified by low- or medium-power methods. Such high-power results are like an elastic band which has been stretched unduly. As the band is stretched it becomes more and more attenuated and finally snaps. If the optical image is stretched by enlargement the details of the image become less and less distinct and finally the image breaks down altogether, so that the detail and the background blend together into a hazy outline of what formerly was a sharp image.

High-power metallography as presented in this article consists of so preparing metallurgical specimens that crisp, brilliant images may be obtained and photographed at high powers and of achieving approximately the potential resolving possibilities of splendid objectives.

By improvements in the method of preparing metallurgical specimens and in the technique of manipulating the apparatus, "empty magnification" is no longer synonymous with high-power photomicrography.

It is the object of this contribution to show the application of this new tool for metallurgical research to the study of metal structures which heretofore have not been resolved and the nature of which has led to much speculation and to wide differences of opinion. A clear understanding of the current conceptions of magnification and resolution is essential and a knowledge of the limitations which were regarded for many years as restricting the employment of high powers will prove of value in the interpretation of the results obtained. For this reason a brief discussion follows which not only shows the method of approach in the present development, but indicates the path along which we may work to secure a higher order of resolution. By resolution is meant that property of a lens system which enables it to distinguish or "resolve" as separate and distinct units fine structural details spaced very close together.

Research and Engineering.[8] E. B. CRAFT. Research in industry—which the author mentions is of comparatively recent origin—is defined as the application of methods of systematic and logical deduc-

1 Address before the Engineers' Club, Phila., Oct., 1925. *Engs. and Engg.*, Jan. 1926, Vol. 43, pp. 11–19.

tions to our every-day industrial and technical problems. Such research necessarily is of a highly specialized nature and requires special training. What is equally important, as is pointed out by the author, is the need of properly organizing and directing this group of specialized workers. Since research is a creative process and hence particularly individualistic, one of the important problems in what the author calls "organized research" is the supplying of such an atmosphere that the worker realizes his own welfare and advancement to be adequately cared for in this system of group working. A number of examples of organized research are mentioned (radio and wire telephony, telephotography, ocean telegraphy, speech and hearing, artificial speech, phonograph recording and reproducing) as apropos to the point in question. The close relationship between engineering and research and the impossibility of the one getting along without the other is made clear. For the worker, there is pointed out the necessity of management and for those in charge the soundness of industrial research as a business proposition. Industrial research far from being a luxury has become a necessity.