

Obviously, postulates for systems of substitute sight are not inventions of this writer. Many individuals have had ideas antecedent to those expressed here. But, within the past few years, speculations on such possibilities have been based on some optimistic developments in the fields of electronics, space technology and neurophysiology.

One such investigator, Shaw (1) patented a device employing photoelectric circuits which generate and send signals to the brain of a blind person producing the sensation of light. Another investigator, the neurologist Button, (2) has conducted experiments that enable blind persons to see light. This is accomplished by stimulating certain brain cells with voltages generated by photocells and conducted through wires to the brain. The reports suggest that the investigator planned additional experiments involving many wires to be connected permanently to the brain carrying visual currents produced by miniaturized electronic devices. The investigator predicted that in the "not too distant future" visual impressions obtained by the blind will approximate true vision with an apparatus as simple as the hearing aid.

It seems to the writer that the efforts of Shaw and the conclusions of Button were quite premature and possibly unrealistic on the basis of knowledge then current in the relevant fields of neurophysiology and the relatively macro-level of electronics technology when these statements were first made. This is directed particularly at Button's, (3) optimism and some of his later reports about implantation as an appropriate technique. The writers' views about such optimism are supported by Shipley, (4) who states that "the intimate neurodelicacies of sensory mechanisms seem honor bound to resist our mechanical intrusions." Cautious but more optimistic positions have been taken by Shrager and Susskind, (5) in their review in which the two following statements appeared:

"\* \* \* recent progress in neurophysiology makes it at least conceivable that artificial stimulation of the brain itself to provide a visual sensation might be achieved some day. Here, as in the case of devices [for guidance and reading], success will depend on the close cooperation of workers in psychology, engineering and physiology. This collaboration has been increasing in recent years, and interdisciplinary groups are growing rapidly." Page 262.

They further indicate:

"It should be stated at the outset that artificially stimulating "vision" in a blind person is not likely to become a reality in the immediate future."

A number of psycho-physiological problems, some directly, and some indirectly, related to stimulation of the brain to produce vision are discussed in the *Annual Review of Psychology* by Onley. (6) Obviously, these problems are not part of an organized presentation related to the possibilities of substitute sight, but they do imply some of the investigations that need to be undertaken next, if substitute sight is to be developed.

#### *Problems Formidable, Perhaps Insuperable*

The writer was apprised recently of some "off-the-record statements" made by extremely competent individuals who have been concerned with the application of science and technology to problems of artificial sight. Because of their "off-the-record" nature, the comments will be only paraphrased here.

One of the less optimistic individuals indicated that the consensus of his neurophysiological colleagues is that the neuroanatomical problems on connecting any conceivable "artificial eye" hardware in the visual nervous system are formidable, if not insuperable. Estimates of the time required to achieve the minimal useful knowledge for such purposes are thought to range from five to fifty years. His colleagues believe it will be harder to make the appropriate "connections" than to produce the necessary inputs.

Another scientist indicated that the knowledge of peripheral (primary sensory neuron) auditory physiology is nearing the level of sophistication necessary for developing artificial end organs. The major problems that do remain and which are claimed to be purely technical, included among others mode of connection, tissue tolerance without degeneration and numbers of channels needed. He indicated there was some question as to whether blind persons could learn to use effectively an input which, under the best of conditions, would not be identical to those from the "original model" even if the model was not technically superior to the substitute.

Still another scientist indicated there is no serious unsolved methodological difficulty at the apparatus and hardware end of the man-made interface but that