

be indispensable to every worker in the theory of rings, but may also be used in connection with an introductory course in abstract algebra.

REINHOLD BAER

*An essay on the psychology of invention in the mathematical field.* By Jacques Hadamard. Princeton University Press, 1945. 143 pp. \$2.00.

Professor Hadamard points out at the beginning of his little book that he is handicapped in the study it deals with by not being a psychologist. Perhaps I should point out that I am handicapped in reviewing him by being neither a psychologist nor a mathematician. But as he bravely goes on, so must I; both of us converging on that question of extraordinary interest in the history of ideas: How do great discoveries and inventions come about?

Hadamard's answer—limited, of course, to the mathematical field—is based on a variety of evidence: the testimony of contemporary mathematicians, the writings of previous psychologists, philosophers and scientists, the interpretation of certain characteristics (logical or intuitive) in the work of famous discoverers and, finally, the author's own minute introspection.

From a careful analysis and comparison of these diverse materials, Professor Hadamard concludes that the general pattern of invention, or, as it might also be put, of original work, is three-fold: conscious study, followed by unconscious maturing, which leads in turn to the moment of insight or illumination. Thereupon another period of conscious work ensues, the purpose of which is to achieve a synthesis of several elements: the novel idea, its logically deduced consequences including proof, and the traditional knowledge to which the new item is added.

Hadamard's investigation, modest and tentative as are its results, seems to me of capital importance in the realm of criticism and cultural history. For what he has done is to show that the human mind tends to behave much the same way whenever it invents, whether in mathematical or in poetic form—a conclusion which does not deny differences of temperament. Our author, on the contrary, is at pains to distinguish among types of mathematical geniuses. He classes them as logical or intuitive, concrete or abstract, yet with enough flexibility to allow for deceptive appearances and for the overlapping of categories. But it is clear in the end that in any process of creation there lurks a mystery—a mystery at least equal to that of thinking itself.

It is worth noting that Hadamard is ever ready to accept as side-lights on his subject the reports of a Mozart or a Paul Valéry on their