

discovery, in their honored, highest type are *very* hard. Few are capable of them,⁵³⁸ and still fewer succeed.

[577] To be sure, invention extends downward to a lower kind, which is simply the *logical* working out, from known elements and principles, for the best solution of a newly posed problem. A vast amount, probably the majority by cost, of all the \$14 billion for 1961 R&D, goes for this easier type of invention or discovery. A solution so arrived at is rarely patentable. This kind of invention is not our main theme, because it poses no problems for Economics nor Patent Law, except the problem of diminishing returns from shortage of suitable talent (§ 98-100). It is simply an industry whose problems need concern only its participants. We outsiders may simply rest assured that the more raw materials of money and well trained men are poured into that industry, the greater will be the output, of this lower kind of invention. Our present concern is all with the higher, much harder type, in which the inventor must outrun the world, not in a race where he is the only entrant to date, but where many may have tried on the same problem, perhaps for centuries, but no one has been able to put the pieces together.

[578] *Why* have they all failed, when a way really existed (though perhaps only recently) to put the pieces together, as was proved by the final success? Here is the nub of our problem of how to invent and discover. It lies *not* in that routine, logical industry, but in how to solve the *baffling* puzzles. If they were not baffling they would already have been solved as soon as wanted, by that logical method.

[579] A principal answer lies in the fact that *knowledge*, i.e., being well informed on the problem attacked, with all the scientific principles and parts that seem needed, with skill in dealing with such matters, and maybe practical experience too—all such *knowledge is ambivalent*, both good and bad, the inventor's indispensable help, and likewise his undoing.⁵³⁹ The *benefits* of knowledge, to lead to the best solution among all conceivable, without wasting time on ideas impossible or that have been tried before and found not to work—these benefits are so obvious that they need no further word. The harm, the ruin in full knowledge of the prior art, is that it tends powerfully to lead the inventor's mind along familiar channels, in endless reconstructions of his own previous mental hookups, which are usually also those which other men have thought of, and perhaps tried out and found wanting. They include all of one's personal thought-habits, the customs of one's world, and supposed "laws" of science, which may well be misunderstood, or even possibly false. Constructive thought consists of making appropriate connections between different memories stored in the mind. The farther apart, as it were, these memories are, and the less habitual, or totally untrodden, be the path between them, or say the less they seem to have to do with each other, the harder it is to make the (really appropriate) connection between them. The inventor needs, in short, freedom of *association*, a habit-free mind—and yet to combine this *somehow* with a mind stored with all possibly pertinent information.⁵⁴⁰

⁵³⁹ As the neon inventor Georges Claude said of these facts "qui vous renseignent . . . en vous cassant les ailes—which inform you, while breaking your wings." Qq. idées sur l'inv. et la recherche sci.; *Chimie et Indus.* 9: p. 1017 of 1009-22, Mar 1923.