

that you cannot, by a single pipe, pump water from a greater depth than about 30 feet. We understand the reason, and the law is clear and unimpeachable. And yet it has been successfully broken, by putting a pump near the bottom of the well, and actuating it by compression waves, sent down the column of rising water. The law should have been phrased: You cannot draw water by suction,⁵⁶⁴ etc. Smith said, "Practically all designers agree that a problem can be handled best by first stating it in the most accurate engineering terms possible, because the delineation may reveal clues to the solution. Beyond this point logic begins to yield to hunches."⁵⁶⁵ GE and Gordon stress definition, in the most varied and general or abstract terms⁵⁵⁹ (§ 619).

[597] A still more humdrum method, and the best of all, for dealing with a problem of invention, is to look it up and find it already solved, which is probably the case with most problems seriously envisaged. Wider availability of this method of solution involves better indexing and translating services, especially to reach the Russian sources, better international contacts, an international library such as we proposed (§ 346), an international patent office or at least patent searching (§ 495), electronic invention to facilitate all such searching, library work, and translating (§ 166, 500), and/or larger firms', Government or trade association laboratories (ch. 11), to conduct all-sweeping inquiries. In the also likely event that the problem has not been solved, the looked up mass of proposals and knowledge will doubtless provide information and hunches for a solution—always provided that the trammels of past thinking may be somehow eluded, by such methods as the earlier discussed.

[598] We speak of solving problems; but do we know when a problem is solved, in view of constant progress being made? We know true solution best in the best of sciences, mathematics. It is known by simplicity, indubitability, wide applicability, and it is elegant, affording the mathematician a certain esthetic pleasure.⁵⁶⁷ The case is quite similar in physics, chemistry, and also engineering. In Kettering's laboratory a motto was posted: "This problem, when solved, will be simple, because every one we have ever solved has been simple."⁵⁵⁵ The best solutions of a mechanical nature have a delightfully simple, logical, and basic character, and a beauty of form, seen best in shapes evolved by long experience and perfecting, such as the violin, arches, the full-rigged ship.⁵⁶⁹ Such perfect solutions do not prevent the occasional arrival of new and better ones on radically different principles, as when the sailship begot the steamship, airplane and parachute; the arch, the curved cantilever, and the violin will yield one day to the synthetic music plant based on drawn curves (§ 344, 5).

WHAT SORT OF MINDS ARE NEEDED?

[599] We have discussed heretofore the remedies for progress inherent in the psychology of invention, and in chapters 10 and 11 the most external means, that of improving the institutions to support invention and research, especially by empowering trade associations.

⁵⁶⁴ It is a safe guess that the invention was actually made not by seeking to pump deep wells, nor to get around that law, but by experiments first with hydraulic activation of machines, next with compression waves in liquids, then with using these for actuating mechanisms, then with seeking all possible uses for this procedure.