even in the same field. That this was expected developed from conclusive evidence that a scientist or engineer is unable to describe with precision the parameters of the subject in which he is interested. Our observations regarding the literature search mechanisms of a scientist or research engineer obviously cannot be expressed with "engineering precision." We have observed that many users think first in terms of the outstanding specialists of the day; others think in terms of the outstanding research organizations, whether government, academic, or industrial. These thoughts constitute the users' knowns or points of departure. But when the users are *not* aware of the people or the facilities, their search mechanisms are irregular. While we would like to have been able to observe that a user's search pattern could be said to follow directly from one point to another, taking the shortest distance, we observe, rather, that the user's thought process is more like the Brownian movement. We suspect that this circumstance will become recognized in time as the very crux of the information-retrieval problem, and that it will be described as the identification mechanism—a personal-individual action.

Those who make the most valuable and timely identifications are the creative scientists and research engineers. Evidence of our observations is revealed by the circumstance that in the many searches made each day over a period of 9 years, or more than 2,300 days, or in excess of 10,000 searches, the same retrieval sequence never has been duplicated.

To summarize our experiences in developing and operating scientific-information centers, we have found it essential not to contaminate the information input or restrict the user's imagination. Information processed into an information system should be, so far as possible, in the words of the original author or abstracter and not a coded version of what someone thought the author said. We have found that the user must not be expected to define precisely the parameters of his interests. Rather, the user should be able to proceed quite naturally and with ease from one thought to another, selecting and rejecting information, based on the information itself, which must be provided in a thought-stimulating environment. We expected and found that, if the user is recognized as an integral part of the information system, the quantitative aspects of the problem of storage and retrieval of huge numbers of information inputs disappear. The solution of our information problem was obtained by acquiring a better understanding of the qualitative needs of the user of information and by a study of the nature of scientific information.

Mechanics of Answering a Technical Inquiry*

By CARL T. OLOFSON
Battelle Memorial Institute
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This paper is directed to those who have had the experience, or may face the experience of seeking all available information on a specific subject—"as soon as possible." When we get these urgent requests we may find ourselves in a peculiar position, like the person who has mislaid some important documents. We know that the information exists, but where can we go to find it quickly enough. You may be interested to hear how an urgent technical inquiry was answered using an information center at Battelle.

Seeking Information for the Inquiry.—Prompt dissemination on manufacturing processes for new and established materials is a task continually faced by engineers, metallurgists, and chemists. This is especially true in the aircraft and missile industry. Here, the pressure for increased performance and greater reliability is ever present. It is here where newly developed high-strength, thermal-resistant materials with only limited production experience must be used for components facing unusual temperatures, pressures, and perhaps corrosive environments.

A case in point is the fabrication of high-pressure gas containers for aircraft and missiles. Typical examples of these pressure vessels are shown in Fig. 1 as a group of spheres and cylinders. The spheres are fabricated by joining machined hemispheres which previously had been forged, or deep drawn, or spun into preliminary shapes.

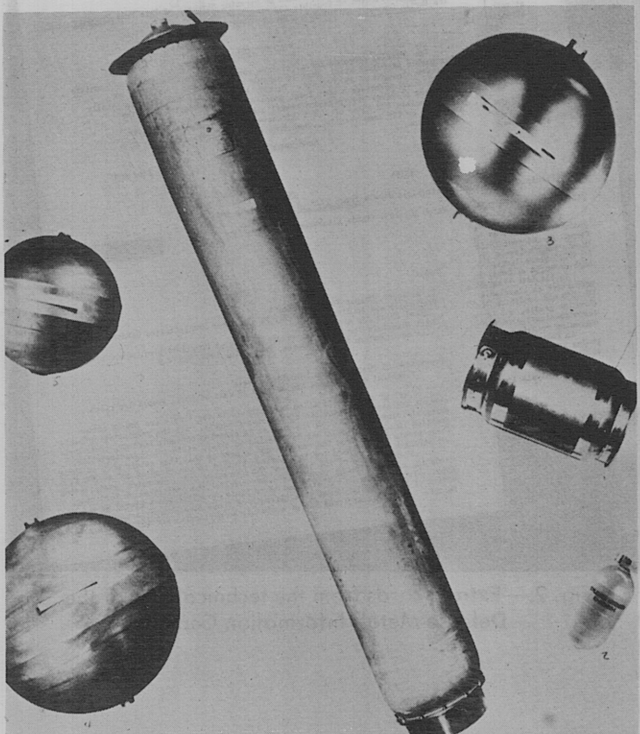

Fig. 1.—Examples of pressure vessels (courtesy of Menasco Manufacturing Company).

* Presented before the Division of Chemical Literature, ACS National Meeting, St. Louis, Mo., March, 1961.

The types of cylinders shown probably were made by bend-rolling sheet metal into a cylinder, welding the abutting ends, and then welding a deep-drawn or spun dome to each end of the cylindrical structure. These spheres and cylinders must be strong enough to withstand high pressures—yet light enough to minimize the dead weight of the container itself.

During the development of a space vehicle which is now operational, we received a request for information on how to fabricate one of these high pressure gas cylinders out of precipitation-hardenable stainless steel, namely, PH15-7Mo. An initial investigation revealed that although this type of stainless steel had been fabricated into pressure vessels by several shops, no information or data were available on the techniques used, or on the results achieved. Obviously, we had little to start on.

Since this inquiry originated from a National Defense Contractor, our first step was to use the facilities of the Defense Metals Information Center (DMIC) at Battelle—and particularly that portion of DMIC's technical information file storing extract cards and documents on stainless steel. Incidentally, the file room houses more than 40,000 extracts of information on space-age metals obtained from a corresponding number of reports, technical articles, and papers. These cards contain the important parts of each document, and are filed according to the clue word system shown by the underlines on cards pictured in Fig. 2.

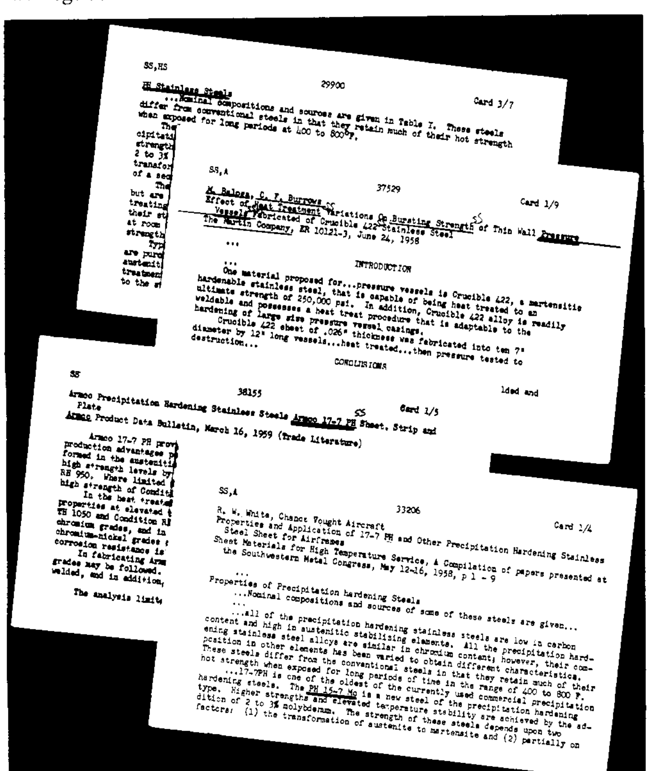

Fig. 2.—Extract cards from the technical files of the Defense Metals Information Center

Our first step was therefore clear—search the DMIC extract cards filed under appropriate and related clue words. Accordingly, we started on those cards which contained the clue words *pressure vessel* and *PH15-7Mo.* We also searched additional cards, which included those filed under another precipitation-hardenable stainless steel, *17-7PH*, as well as those cards filed under a 17-7 austenitic stainless steel, AISI-Type 301. From past experience we knew that these steels can be formed in the annealed condition using about the same working conditions, but with possible modifications to compensate for their differences in properties. We also knew that cards filed under these clue words, by virtue of the filing system used, contained the information we needed.

We made notes of the important information and data found in these cards as we went through them. The cards were in sufficient detail so that further reference to original reports was not needed. However, inspection of the original report sometimes does become necessary, especially when large amounts of data or numerous graphs are presented.

Inspection of cards under the clue word, *Type 301* revealed the existence of two important references devoted to the fabrication of the better known stainless steels. The information in both books proved to be quite extensive. The specific information used for this inquiry included the forming characteristics of Type 301 and the bend rolling, deep drawing, and spin-forming of this metal.

The whole effort was then consolidated and worked into a preliminary outline. This outline was designed to describe the modifications in forming which appeared necessary to compensate for the difference in properties between Type 301 stainless steel and the PH stainless steels. We incorporated the comments from other Battelle staff members, wrote up the finished outline, and then sent it directly to the person needing the information. We also enclosed two reports published by the Defense Metals Information Center as background material—one relating to high-strength steels for the aircraft industry, the other describing the engineering properties of precipitation-hardenable stainless steel.

Mailing the reply is not the end of this story. If one person in the Aerospace Industry needed information on making pressure vessels out of precipitation-hardenable stainless steels, then surely others in the industry would need it too. At least that has been our experience in six years of service as the metals information center to our country's aircraft and missile industry. Consequently, the outline was reproduced as a DMIC memorandum and distributed to those engineers in defense industries likely to be interested in it. This was determined from the interest code of the DMIC mailing list. This memorandum came to the attention of the editors of *Tooling and Production Magazine.* Sensing the timeliness of the subject, they requested and received permission to publish this information in their Annual Pressworking Issue of October, 1959.