2) are chrysotile (a white, usually long, silky fiber), crocidolite (a harsher blue fiber), amosite (brown and harsh), and anthophyllite, chiefly mined and used in Finland. In addition, some of these fibrous minerals also occur in the bearer rock of mines developed primarily for the exploitation of other minerals, such as talc, mica (18), and iron, as, for example, in the iron mines at the head of Lake Superior and in Labrador.

Differences in the physical properties of the various fibers determine their particular commercial usefulness. Thus, for example, chrysotile, which consists of long, mainly pliable fibers that split progressively into finer fibrils, lends itself to incorporation into textiles, whereas crocidolite and amosite, which are more acid resistant, are of particular value for marine insulation. Certain asbestos cement products may be made from blends of chrysotile and amosite and/or crocidolite. These differences in the physical properties of the fibers (and in consequence, in their aerodynamic behavior) may account for differences in the health effects of exposure; indeed, it has been argued that "only by relating experimental biologic evidence with the variations in physical size and form . . . can we ultimately arrive at valid medical conclusions" (18). This question is discussed in a later section of the present review.

Uses of Asbestos: Occupations at Risk

World production and use of asbestos have grown greatly since the late nineteenth century; between 1877 and 1967, asbestos production and use increased from 50 tons to 4,000,000 tons per year, an 80,000-fold increase. For industrialized countries, such as Britain and the United States, the increase in asbestos use between 1910 and 1970 was 7-fold (18, 19). This reflects increases in volume of manufactured goods as well as in the variety of uses developed for the material. These are outlined broadly in table 2.

Appreciation of the wide variety of uses of asbestos is important to the physician and serves as an indicator of the many occupations potentially at risk from exposure (table 3). These occupations include asbestos mining, milling, and handling in preparation for its use, either directly (as, for instance, in spraying when mixed with oil) or for its incorporation into the manufacture of a great variety of asbestos-containing products. The latter may be classified broadly into textiles, asbestos cement and other construction products, paper products, friction materials, and insulation products. It is also used in the chemical and plastics industries, where its binding properties (in particular, the positive charge of chrysotile) enhances its union with filler and pigment (Lindell, 7, p. 323).

Once incorporated into manufactured items, the fiber is relatively well bound and is therefore less likely to pose a health hazard to the many workers who use the newly manufactured products (see Secondary Uses, table 2), so long as the product is not sawn, disrupted, or cut in any way; however, asbestos fibers are virtually indestructible. Thompson, 5, p. 196) aptly describes this as a "half-life of an infinity of years." The fibers may be released into the atmosphere again when the original product is removed, replaced, or destroyed, as may occur in the construction and shipbuilding industries, in connection with demolition, repair, and/or refitting. Exposures of this sort, particularly if they occur in a contained environment, such as the hold of a ship undergoing refitting, may involve workers whose primary job has nothing to do with asbestos, e.g., welders or masons. Indeed, failure to appreciate these sources of exposure in both construction and shipbuilding industries (19, 20) probably accounts for the re-emergence of asbestos-related disease in the 1960s. There appears to be no direct information on the numbers of workers at risk in different countries, other than an estimate of 250,000 persons for the United States in 1972 (21).

The reason for including the information on the occupations at risk (table 3) in a clinical review is to offer the physician an overview of the uses of the mineral, so that when faced with an individual with an illness that may be asbestos related, he can formulate a systematic enquiry into the person's occupational history. The physician should thus cover possible exposures in mining, milling, and manufacturing, as well as in the application of manufactured products containing asbestos, directly, or at the time of demolition or replacement (19, 20, 22–26). The physician must not only seek the details of the patient's own jobs, past and present, but must also ascertain whether this work was carried out at the side of other workers whose jobs involved the handling of asbestos products or materials, particularly if in a closed or poorly ventilated environment.

TABLE 2
VARIETIES OF ASBESTOS: PROPERTIES, SOURCES, AND USAGE*