T-nuts, Figure 1, are widely used in furniture construction, particularly in those applications where the nut must be anchored to the furniture structure or where the nut will be inaccessible once the furniture is covered, e.g., with upholstery. Despite their widespread use, information is lacking concerning both the static and dynamic holding strength of T-nuts. Since such information is essential for the rational product engineering of furniture, a brief study was undertaken to obtain preliminary estimates of the static holding strengths of representative types of T-nuts in a variety of woods and wood composites. In general, the study was limited in scope and was intended to provide empirical estimates of T-nut holding strength rather than definitive design factors. Results are given in the report which follows.

Overview of the study

In general, the study could be divided into three parts. In the first part, the holding strengths of a single size of T-nut in a variety of substrates were determined in order to obtain information about the relative holding strengths of various woods and wood composites. In the second part, the holding strengths of a variety of sizes of a single type of T-nut in a single high-strength substrate were determined in order to obtain estimates of the maximum holding strengths of the nuts as a function of size. Finally, in the third part, the holding strengths of a variety of sizes and types of T-nuts in a single substrate were determined in order to obtain first estimates of the variations in strength that must be anticipated when nuts are casually selected from a representative portion of the global T-nut population.

Fig. 1. Photograph showing several types of T-nuts included in the study
Bild 1. Abbildung verschiedener hier untersuchter T-Gewindemuttern

Fig. 2. Diagram of apparatus used to load T-nuts from the "top"
Bild 2. Schema der Prüffapparatur für die Festigkeit von T-Gewindemuttern bei Belastung „von oben“
2 Description of test specimens
The size of the specimens used in the study was not strictly controlled, but most specimens measured from 2-1/2 (64 mm) to 4 inches (100 mm) wide by about 6 inches (150 mm) long. Thickness varied from 3/4 inches (19 mm) to 1-1/4 inches (32 mm). All of the material was conditioned to an average of 6 percent moisture content. Once conditioned, a hole was drilled through the center of the specimen to receive the T-nut. Diameter of the "pilot" hole was equal to the diameter of the shaft of the T-nut it was to receive. A clamping device was used to press the T-nut into the wood or composite.

The 1/4-inch (6.4-mm) T-nuts used in the first part of the study were of a single type and were obtained from a single source. The T-nuts used in the second part of the study were of several types but were obtained from the same source as those used in the first part of the study. Sizes included 6-32 (0.138 in., 3.5 mm), 8-32 (0.164 in., 4.2 mm), 10-24 (0.190 in., 4.8 mm) and 1/4 (6.4), 5/16 (7.9 mm), 3/8-inch (9.5-mm) nuts. The T-nuts used in the third part of the study were of several types which were obtained from several domestic and international sources. Sizes included 4-40, 6-32 (0.138 in., 3.5 mm), 8-32 (0.164 in., 4.2 mm), 10-24 (0.190 in., 4.8 mm), and 1/4 (6.4), 5/16 (7.9 mm), and 3/8-inch (9.5-mm) nuts.

3 Description of method of test
All tests were carried out on a Riehle universal testing machine. Two methods of test were used. An exploratory test indicated that the two methods yielded identical results.

In the first method of test (Fig. 2) the nuts were loaded in much the same manner as they are used in service. The apparatus used in this method of test consists of a specimen holding fixture which is attached to the lower crosshead of the testing machine and a length of high strength threaded rod, one end of which is attached to the upper crosshead. The fixture which held the specimens was constructed of two 8-inch (200-mm) lengths of steel channel welded together to form a box section 8 inches long (Eckelman 1978; Eckelman and Cassens 1984). A 2-inch diameter hole was used for all specimens long (Eckelman 1978; Eckelman and Cassens 1984). A 2-inch diameter hole was drilled through the center of the web surface. A 3/4-inch diameter bolt passed vertically downward through the second hole and was anchored by means of rounded nut to the ball seat of the bottom crosshead. A length of threaded rod, anchored to the ball seat of the top crosshead, was then inserted into the fixture and centered over the hole with the flange face of the T-nut exposed on the bottom surface. A flat headed ma-

4.2 ram), 10-24 (0.190 in., 4.8 mm), and 1/4 (6.4), 5/16 (7.9 mm), 3/8-inch (9.5-mm) nuts.

hole drilled through its center, (Fig. 3). This fixture was constructed of an 8-inch (200-mm) length of steel channel with a 2-inch (50.8-mm) diameter hole drilled through the center of the web surface.

In practice, a specimen was placed on top of the support fixture and centered over the hole with the flange face of the T-nut exposed on the top surface. A flat headed ma-

Fig. 3. Diagram of apparatus used to load T-nuts from the "bottom"

Bild 3. Schema der Prüfapparatur für die Festigkeit von T-Gewindemuttern mit Belastung „von unten"