TECHNICAL NOTE NUMBER 164
FOREST PRODUCTS LABORATORY - U. S. FOREST SERVICE - MADISON, WISCONSIN

COMMON STYLES OF WOODEN BOXES

There are seven forms of nailed wooden boxes so universally used that they may be called the standard styles of nailed boxes. These boxes can be adapted to a wide range of uses, and it is the experience of the Forest Products Laboratory that in meeting the majority of packing problems they are the most efficient of the nailed boxes. The advantages and disadvantages of each style, as revealed in laboratory tests and observations of boxes in commercial service, are given below.

In style 1, the grain of the ends and sides runs approximately parallel to the top and bottom surfaces. One of the common failures in this type of box is splitting of the ends and sides, or failure of the joints in these parts, since the only resistance to such failure lies in the strength of the joints, if present, or in the strength of the wood in tension across the grain, which is not large and is extremely variable in any species of wood. The smaller holding power of nails driven into end grain as compared with side grain is another source of weakness.

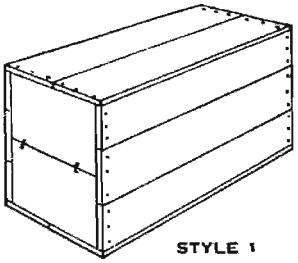
To improve on style 1 ends, and guard against the liability of complete failure from splitting of ends and sides, rectangular and sometimes triangular corner cleats nailed to the inside of the end (style 5) are added when the character of the contents permits. This construction does not increase the displacement of the box and is, therefore, not objectionable in that respect. If these cleats can be made large enough, the sides may also be nailed to them, which, of course, increases the strength of the nailing at this point. These inside cleats should be shorter than the inside depth of the box, so that if the sides and ends shrink, the cleats will not cause an

opening of the joints. In all boxes with cleated ends, the nails holding the cleats to the ends should be long enough to permit a good clinch, and should be spaced approximately the same as the nails in the adjacent edges of the box.

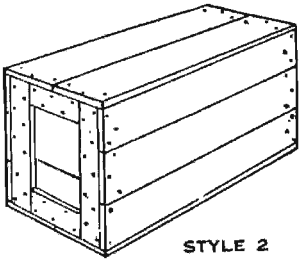
The most common method of preventing box ends from splitting and of supplementing the holding power of nails driven into the end grain is the addition of two outside cleats on each end as shown in style 4. These cleats should be of the same thickness as the end so that the same size of nail may be used in them. The nails should be staggered in the ends and cleats; this permits a closer spacing of the nails and results in a stronger joint than is obtained by driving the nails in a single row. The holding power of the nails is supplemented most effectively by the use of denser woods in ends and cleats.

The cleats in style 4 boxes should be long enough to come nearly flush with the outer surfaces of the top and bottom. They will thus aid in keeping the top and bottom in place and will also take some of the thrust which comes on the nails in the top and bottom when the box is dropped on a corner. If the cleats are made to come exactly flush with the outer surfaces of the top and bottom, and shrinkage occurs later, it may cause the ends of the cleats to project beyond the top and bottom, and they may be pulled loose if the box is handled so that they catch on some object. The amount that the cleats should be cut short to allow for shrinkage depends on the moisture content of the lumber at the time the box is constructed and the storage conditions afterward. Usually an allowance of from 1/8 to 3/16 inch at each end will be sufficient.

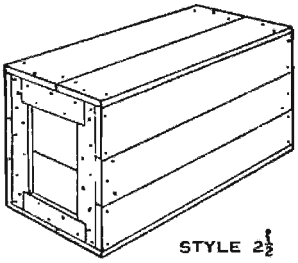
The addition of the two horizontal cleats in styles 2, 2½, and 3 permits a reduction in the thickness of the end boards from the thickness of the cleats to that of the sides, top, and bottom, in which case all the nails should be driven into the cleats. Or the cleats and end



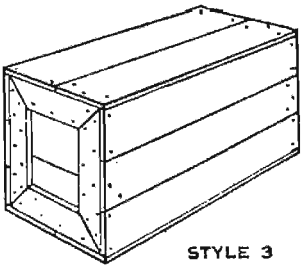
STYLE 1



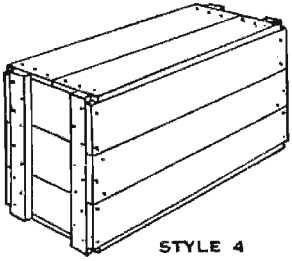
STYLE 2



STYLE 2½

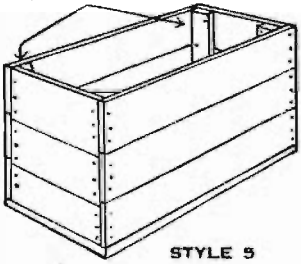


STYLE 3

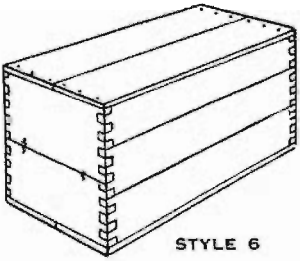


STYLE 4

ALTERNATE FORMS OF CLEATS



STYLE 5



STYLE 6

boards may be the same thickness and the nails staggered in two rows. The usual failures in these styles of boxes are pulling of the nails from ends and cleats, shearing out of the nails to the ends of the sides, top, and bottom, and splitting of the end boards along the inner edges of the horizontal cleats, which allows a cleat with part of the end board to pull away with the top or bottom. The resistance to failure by splitting of the end is due to the strength of the end board in tension across the grain, supplemented by the action of the vertical cleats. In nailing the vertical cleats to the ends in styles 2 and 2½, it is possible to get more nails near the top and bottom edges of the box than in the mitered cleats of style 3. This more effectively prevents the box end from splitting along the horizontal cleats.

Style 2½ has the advantage that when the bottom and top are being nailed to the cleats, the notches or steps in the vertical cleats will take the thrust that otherwise would come on the nails holding the horizontal cleats. This thrust is sometimes very severe, especialy when several nails are driven at the same time into a cleat made of dense wood.

In manufacturing boxes with square ends, style 3 has the advantage that all four cleats are the same length, hence interchangeable When a very symmetrical end is desired rather than the strongest end, the mitered cleats are preferred.

The box shown in style 6 has sides and ends joined together by a series of tenons called "locks," which interlock and are held together by gluing. The top and bottom are usually fastened by nailing The lock corner, if properly glued gives a more rigid box than nailed corners there being no appreciable distortion before failure occurs Tests show that many failures in lock-corner boxes occur because ends and sides split, nails pull from or split the edges of too thin ends, locks open, and matched joints lack sufficient strength.