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EFFECTS OF STOCK REMOVAL RATES ON BELT LOADING FOR ABRASIVE PLANING HARDWOODS

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ABSTRACT.— Belt loading increases up to a point and then decreases as stock removal rate increases for red oak and yellow-poplar.

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Abrasive planing hardwoods precludes knife planing defects and may upgrade the lumber enough to offset the added cost. A common problem with abrasive planing, however, is "belt loading"— the accumulation of waste material on the belt, decreasing its abrasiveness and hence shortening belt life. If belt loading could be eliminated, or at least reduced, abrasive planing of hardwoods would be more efficient.

In a study of abrasive planing ponderosa pine (Stewart 1976), belt loading increased and belt life decreased as depth of cut was increased up to a point. However, as depth of cut was further increased, belt loading decreased and belt life increased until the rate of stock removal caused excessive stress in the belt and greatly reduced belt life. A study was undertaken to determine if the belt-loading pattern for hardwoods is similar to that for ponderosa pine.

METHODS

Air-dry (12 percent average moisture content) red oak and yellow-poplar boards 3½ inches wide and 5 feet long were surfaced to a uniform thickness of 7/8 inch. Red oak and yellow-poplar represent high and moderate density hardwoods, respectively.

The red oak was machined at 45-feet-per-minute(fpm) feed rate and six depths of cut (0.005, 0.010, 0.020, 0.040, 0.080, and 0.120 inch). Yellow-poplar was machined at three feed rates (60, 75, and 90 fpm) and the same depths of cut as red oak. The abrasive belts were aluminum oxide, 18 by 103 inches, grit size No. 36. The nominal belt speed was 5,800 feet per minute.

RESULTS

The belt-loading pattern for both hardwood species did indeed prove to be similar to that for ponderosa pine. Belt loading increased up to 0.040-inch depth of cut at 45 fpm feed rate for red oak and 0.080-inch depth of cut at 60 fpm feed rate for yellow-poplar. (Higher forces developed at lower stock removal rates when planing red oak, hence beltloading for red oak began to decrease at a lower removal rate than for yellow-poplar). Beyond these feed rates and cutting depths belt loading decreased for both species. Apparently, either the depth of cut or feed rate may be increased to reduce belt loading (fig. 1).

DISCUSSION

Belt loading may be similar to the formation of "built-up edge" (BUE) in metal cutting. The BUE is a result of the normal loads on the tool face leading to adhesion between the chip and tool (Armarego and Brown 1969). The adhesion is probably similar to a pressure weld and/or a result of Van der Waals forces, which cause two surfaces to adhere when they are pressed together. The mechanics of adhesion of sliding systems (Armarego and Brown 1969), such as where the workpiece and tool meet, involves:

1. The tool rubbing a freshly cut surface from the workpiece.
2. Plastic deformation of the workpiece material when forming the chip.
3. High temperature and pressure at the sliding interface of the tool and workpiece material.

The same relation between cutting speed (stock removal rate) and belt loading that we found appears to exist also for metal work (Cook 1966). At very low speeds a BUE may not form. At a relatively moderate, critical cutting speed BUE begins to develop. As the cutting speed increases, more of the BUE is carried away and may disappear.

Other things that reduce belt loading include increasing air velocity for removing waste to reduce pressure between the sliding belt and workpiece (this may also reduce the temperature of the wood) and increasing belt speed which reduces chip load and also reduces belt pressure. However, both these methods require increased energy to maintain the same productivity.

So, for the present at least, it appears that, when abrasive planing hardwoods, belt loading can be reduced and belt life prolonged by using high stock removal rates. Extensive testing will be required to determine the optimum rates and conditions for hardwooods.

LITERATURE CITED

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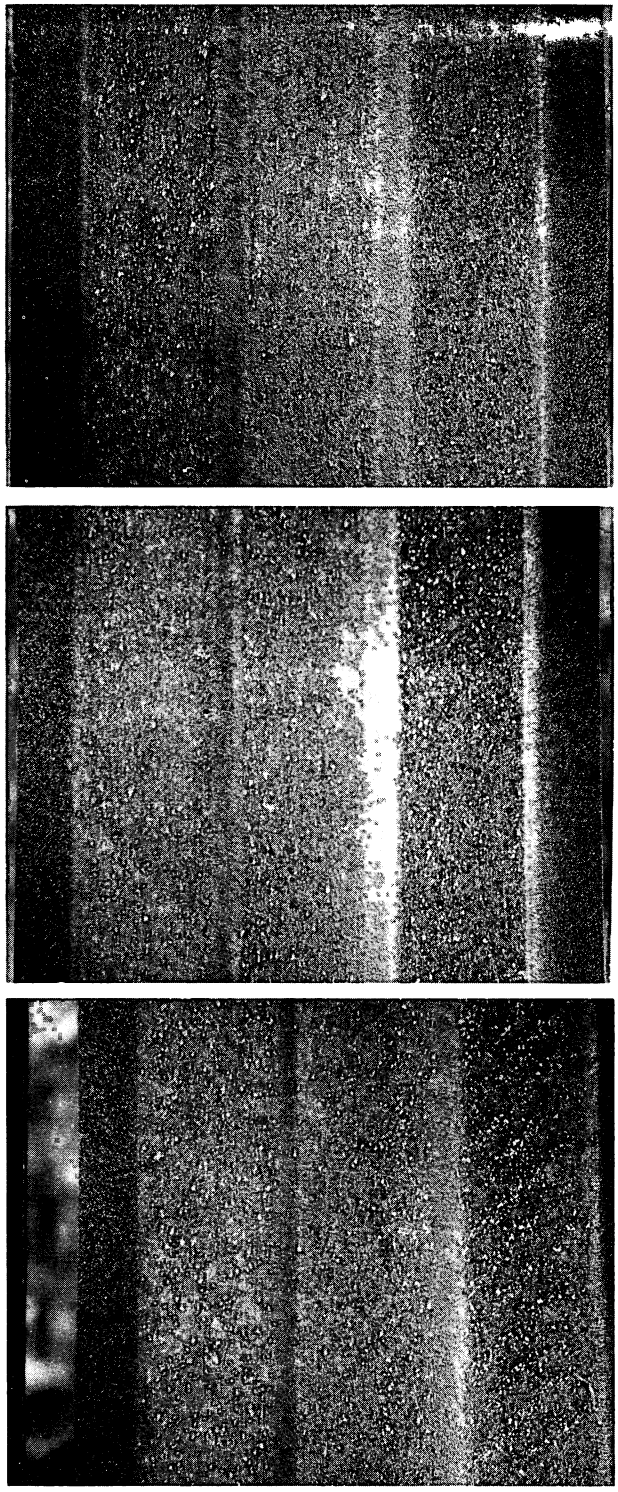

Figure 1.—*Loading of the Grit No. 36 aluminum oxide belts up to a point as stock removal rate increases for yellow-poplar: (A) Yellow-poplar, 60 fpm feed rate and 0.040-, 0.080-, and 0.120-inch depths of cut; (B) Yellow-poplar, 75 fpm feed rate and 0.040-, 0.080-, and 0.120-inch depths of cut; and (C) Yellow-poplar, 90 fpm feed rate and 0.040-, 0.080-, and 0.120-inch depths of cut.*

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