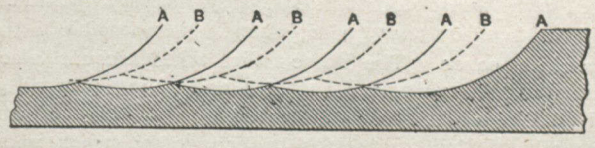
it follows that most machine wood work is done by rotating cutters. At first blush the idea of using such cutters, as they are now used, for making plane surfaces, doubtless seemed out of the question. The best that we can do, however, is to appproximate perfection; and it has been found that a surface composed of a series of short curves is about as near plane as we can get it. Modern woodworking machinery is run at such high speeds that, even with the fastest feed the curves are so short as to be barely perceptible. Not only plane surfaces, but surfaces curved in the opposite direction to that of the cut are so perfectly made that light sanding removes all traces of the cutter. This is as much as can be said of the best hand work; but good workmen are always—though, perhaps, silently—questioning present methods and seeking to do better. It is a mooted question, the answer to which depends largely on the skill of the operator, whether the two knives customarily used on planers and moulders do the work they are supposed to do, in shortening the curves of which the finished surface is made up.

While the making of machines has gone entirely from the realm of the woodworker, there are many niceties of adjustment to which he must attend if he is to produce good work, says "Woodworker." High speeds call for perfect balance, exact radial adjustment of the cutting edges and accurately fitting journals, as well as rigid frames and



bearings. Our brother craftsmen of the machine shop usually attend to the latter item—if we are not too niggardly as to paying the price—but the other conditions must be looked to by the operator. Of course, cutting edges must be kept keen, and as thin as the nature of the work will allow.

As to the other matters, the oldest of us are apt to be occasionally at loss. Even if we were to work wood for eons beyond this life (which, for most of us, would be climatically impossible), we would still have something to learn. In the case of saws, if they are kept reasonably near round and the teeth are kept moderately symmetrical, they are not apt to get sufficiently out of balance to attract attention; nor does a slight lack of balance bear materially on the quality of the work done by them. With planers, moulders and the like, the case is different, as any imperfection in the running balance is pretty sure to show its effects on the work.

Roughly estimated, the outward pull of each ounce in weight of a planer knife, when running, is something like five hundred pounds. This is a fact well worthy of careful consideration; though we are too apt to consider it lightly, if at all, till we have listened to the song of a flying knife or nut as it grazes our ear. Let us consider, for a moment, the result of having an ounce more of weight on one side of a cutter-head than on the other, and of having a consequent pull of five hundred pounds toward that side.

As a first consideration, this pull, except in so far as it is opposed by the pull of the belt and the working strain, tends to wear the journals all on one side. Certainly, combined as it may be in practice, it tends to wear them out of round. While the direction of this pull is constant, relatively to the head, it changes, relatively to the machine frame, through a whole circle, some 4,000 times a minute. It requires no argument to prove that a machine frame must be very heavy and rigid to resist such a pull, or even one of one hundred pounds, without appreciable shaking. We must bear in mind, in this connection, that "standing balance" is not necessarily "running balance." If one knife is heavy at one end, while the other is heavy at the opposite end, they may be of exactly the same weight and still make your cutter-head very badly out of running balance. Perfect running balance is attained, if attained at all, only when, if the cutter-head were sliced up into infinitely thin sections, each section would balance; and running balance is what counts.

Again, all bearings, in order to run at all, must float in an oil film of appreciable thickness. Direct running contact of metal to metal would be quickly disastrous, and the principal value of oil lies in the fact that it prevents such contact. To arrive at a just appreciation of the existence and thickness of this oil film, adjust a bearing so that it runs properly with ordinary machine oil; then flush this oil out thoroughly with kerosene and gasoline, and lubricate with a fine grade of sperm oil. You will find that the fit is appreciably less close.

This oil film is liquid; and, with the heat resultant from rapid motion, becomes more so. Hence, it will be seen that a constant strain toward one side, even of much less than five hundred pounds, will cause the oil to flow away from this side and toward the other, so that the journal will run concentrically with the box. In a properly adjusted and lubricated box this movement of the journal from the centre, i.e., the difference between the mechanical centre of the head and its running centre, is very slight; but let us note how slight a movement of this kind is required in order to make a difference in results.

Referring to the accompanying sketch, the shaded portion represents a section of a board, being planed. The cut of the knife extending farthest from the running centre is shown by the heavy lines, A, A, A; while that of the other is shown by the dotted lines, B, B, B. The feed per revolution, greatly exaggerated for the sake of clearness, is the distance between the points A, A.

Even in this exaggerated diagram the difference in the radii of the curves described by the cutting edges is very slight; yet it will be seen that the shorter one does not reach the finished surface at all, though it removes nearly its half of the surplus material.

In practice, where the feed rarely exceeds an eighth of an inch per revolution, the displacement due to the flow of a very thin oil film would cause the heavier knife to do all the work which shows on the finished surface. If, now, the heavier knife is set out a trifle more than the other, a still smaller displacement would be required. When the feed is an eighth of an inch per revolution of the head, there need be a difference of only about one one-hundredth of an inch in the radii of the circles described by the cutting edges in order that the cut of one of them may not show on the job. We are all prone, especially while young, to assume that we can make exact measurements and adjustments; but we learn, with years, that it is easy to err a hundredth part of an inch. An absolutely perfect running balance is practically impossible; and, with ordinary lubricants, it is very doubtful if the oil film is ever less than one one-hundredth of an inch thick. Taking all these facts into consideration, the man who can show the trace of more than one knife on a job of finished machine work has just cause for pride.

The probability that the desired result will be attained only once or twice in a lifetime doesn't make it any the less worth trying for; but it seems vain to deny some foundation