work under 20 inches in diameter, and of the kind usually found in any machinery building plant, whether it is a navy yard, railroad shop, or automobile building plant; not that the means are of no value in larger work, but being out of the writer's range of experience, such work was not considered in designing the tools described.

A more exact description of the range of work for which this tool is intended would be: lathe and turret lathe work under 20 inches, and over 4 or 5 inches in diameter, and less than 8 or 10 inches in length; also work up to 2 and 3 feet in length, of diameter under 3 to 3½ inches and generally over ¾ or 1 inch.

It includes three classes of work: a, chuck work, having diameter generally exceeding length, and held wholly by a chuck or face plate; b, bar work, which is held in a chuck and steadied by back rests; and c, work having dimensions similar to bar work, but which must be turned on center points, with or without following and fixed steady rests.

In engine lathe practice these shoulders are "squared up" by a side tool after the other turning has been done by a round nose or diamond point tool, but in the turret lathe for bar work these shoulders are produced by the same tool that takes the stock removing cut.

The tool used in turners for bar work cuts on the same principle as the engine lathe side tool; that is, its rake or top slope is almost wholly side slope, and its cutting edge stands at an angle of 90 degrees to the axis of the work.

In the engine lathe a tool of this character has generally been unsatisfactory for rapid turning, yet in the turret lathe this very tool seems to be universally used for all bar work. The difference in performance seems to be due to the difference in mounting. It works well where there is no chance of vibration, but trouble begins when it is used in a machine like the engine lathe or turret-chucking lathe in which the work is supported by one part of the machine and the tool by another, and the true path of the cutting tool through the metal is dependent on the entire structure of the machine, there being nothing to prevent quivering.

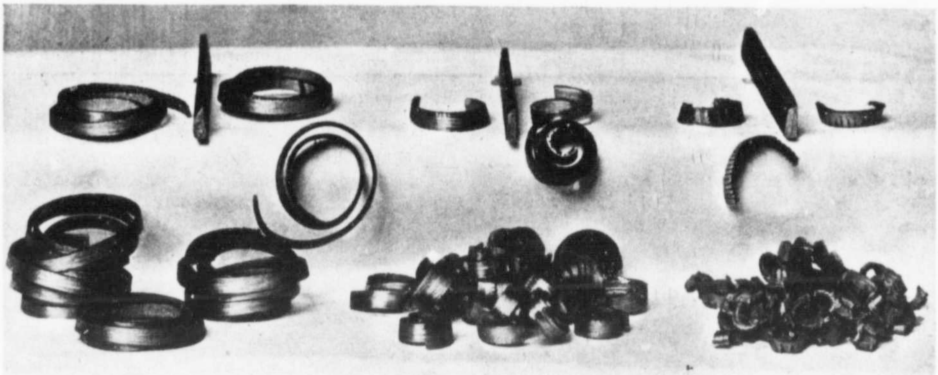

Fig. 2. Samples of Chips and Cutters: Cutting Angles from Left to Right 45 Deg., 60 Deg. and 75 Deg. These Chips were Produced in an Engine Lathe with Holder Shown in Fig. 12. The Chips were Confined Edgewise Between the Body of Work and the End of the Holder. The Breakage of Chips Taken by the 45 Deg. Tool were due to Chips Getting Caught Between the Work and Tool Holder, Usually due to the Irregular Winding of the Chip. The Chips Produced by the 60 Deg. Tool Wound up till the Circle was Greater than the Chip Could Take Without Breakage.

It will be noticed that this excludes all of that kind of larger and heavier lathe work in which the principal duty of the lathe is the rapid removal of the stock. In the particular branch of work under consideration the rapid removal of stock is important, but not paramount.

Although the field of work includes all kinds of steel and cast iron, this paper will deal only with the standard open hearth machinery steel of about 20 points carbon

In work supported on centers and in chucking work, the connection between the work and tool includes a number of joints, both for sliding the tool in relation to the work, and for the rotation of the work. Each of these joints has more or less slackness, and each of the slides and other members is more or less frail in structure. With a mounting of this kind the cutting edge of the tool does not pass through the metal without swerving and flinching.

Type of Tools Used.

In the class of work under consideration each piece has several diameters, with shoulders which should be accurately spaced and formed. Nearly all the shoulders required in this class of lathe work are the so-called square shoulders.

The no-clearance tool to be described is a side tool without clearance. Its under face bears flatly against the work, thereby preventing the lateral quivering which has previously made this type of tool inefficient.

Means for Improving Efficiency.

A machine's efficiency is proportional to its strength to resist its working stresses. There are two ways to increase this efficiency; a, by strengthening the machine; and b, by reducing the stresses for a given result.

In the writer's previous work the strengthening of the machine has been accomplished by the elemination of unnecessary features, and placing the necessary joints for obtaining the various motions in the least objectionable positions. But since this has been so fully outlined in a semi-commercial treatise entitled The Evolution of the Machine Shop, it is unnecessary to make further reference to the special forms of design therein set forth, except to say that a single-slide scheme of lathe design was adopted to eliminate the complicated and frail construction of the multi-slide tool carriage which is