Title: Localized Frictional Heating

Creators: Brophy, Jere E.

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Localized Frictional Heating

By JERE E. BROPHY, E.E. IV

A PROCEDURE used by the Bell Aircraft Corp. for cutting hardened steels has recently been described by A. A. Schwartz, chief of tool research of that company.

Frictional heating is used as the cutting device on hardened steels. A band saw, normally used for wood, and designed to operate at a peripheral speed of 12,000 feet a minute is used with a blade that is of soft tempered spring steel.

The saw is enclosed in a steel housing for safety when the blades eventually break at this high speed. The blades have ten teeth per inch. Thus, at this speed, 24,000 active teeth per second are in the material only 1/12,000 of a second if the material is assumed to be 0.200 inches thick. This high speed prevents the heat from being conducted to any great extent into the neighboring material. As this action is a melting and burning process, the hardness of the saw or the work has little effect on the action except as the coefficient of friction changes. Therefore, the saw blades are selected to withstand constant flexing around the wheel for the longest possible time.

A wide set is desirable on the teeth of the blade. This is done to minimize the side friction on the blade. It would be possible to operate with no teeth, but this would introduce a large amount of frictional heating on the side of the blade which would not be used to advantage. Moreover, the spaces between the teeth carry air down into the cut making the operation a burning one. This is similar to supplying an excess of oxygen for cutting with a torch.

Tilting the work when starting a cut is beneficial since its presents a thin edge to the saw for starting. The metal being cut may be of any hardness, however the harder tempered steels have a higher coefficient of friction and thus are sawn more easily than the soft steels.

One of the important advantages of this method in sawing thin sheet steel, is that the very high speed of the saw prevents catching and jerking the piece to the extent that thin metal pieces may be held in the hand while cutting without resting on the table; also, the saw may enter at any angle desirable.

In high carbon steels, some of the surfaces near the edge of the cut may become hardened. However, maintaining proper speed and feed will limit this hardening to 0.001 or 0.002 inches in depth.

This frictional heating method has even intruded into production welding. A small shaft may be welded to a larger one by revolving the large shaft in a lathe at about 500 rpm. and pressing blunt tools against the shaft from opposite sides to bring the shaft up to welding temperature. In this way a weld may be made in about 20 seconds and due to the pressure a better weld is formed.

This method is not new but has been overshadowed by the flame cutting method and perhaps forgotten. At about 1900, it was claimed to be the only practical method of cutting armor plate, since the "hot saw" had not yet been invented. Bush hammers for use in concrete construction are still sharpened by means of a disc of boiler plate revolving at high speed. Actually, this melts the material by frictional heat.

This method perhaps will be better understood by looking at the fundamentals behind it. Friction is a product of pressure and a coefficient of friction determined by the nature of the materials at the point of friction. The area of contact has little effect on the friction except as it affects the pressure. Thus the heat generated in frictional heating or burning depends on the pressure, the kinds of material, the distance moved and not on the area of contact or the speed.

With a definite amount of heat generated to be used in melting or burning a given amount of material, this heat must be concentrated as much as possible to prevent dissipation to the surrounding material. In sawing, radiation losses will be small since the working area is small. Convection, similarly is negligible, but conduction will be high, since heat can flow into neighboring material in at least three directions. However, this heat flow has a definite speed, therefore a very high speed must be used on the saw to raise the material to the required temperature for burning.

Since temperature is a quotient of the quantity of heat over the mass of the material, speed must be used to keep the heat concentrated in a minimum mass and to supply a larger quantity of heat per unit of distance. The heat in the blade is spread over the entire length and radiation and convection tend to cool it in its completion of a cycle.

This method may come into further prominence as a result of the great need for such a procedure at the present time.