

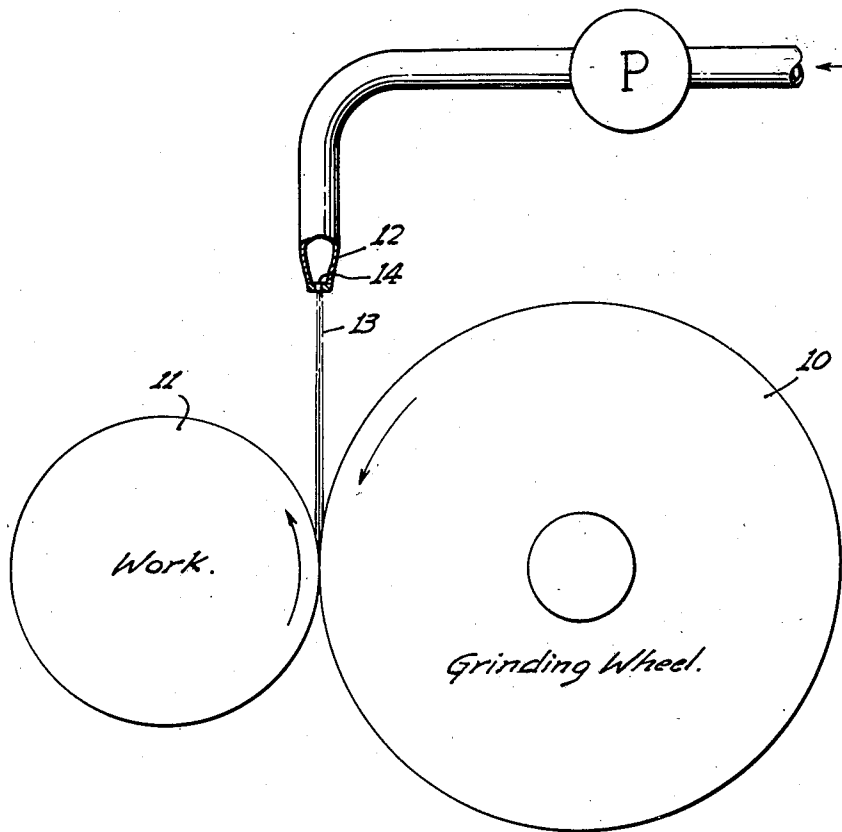
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APPLICATION OF CUTTING FLUIDS IN GRINDING OPERATIONS

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APPLICATION OF CUTTING FLUIDS IN GRINDING OPERATIONS

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This invention relates to improvements in method and apparatus for the application of cutting fluids in grinding operations, having the achieved objects of a more effective extraction of heat and consequent improvement in surface finish of the work, increased rate of feed and depth of cut, and reduced wear of the grinding wheel, as well as substantial elimination of splash that has heretofore generally required the use of full guards which hindered examination of the work and cut.

More particularly, the invention comprises the application of one or more small, non-spreading, high speed jets of fluid to the line of contact between a grinding wheel and work piece, to strike with high impact effect and without loss of energy such as would occur in a large stream flowing over the wheel and the oppositely moving surface of the work. In order to accomplish these results, two factors are of paramount importance: the jet must be thin and non-spreading so that substantially all of the stream strikes the apex of the wedge-shaped space between the wheel periphery and the work piece, and also, the jet must be discharged at a velocity greater than the speed of the grinding wheel (minimum speed of wheel 150 to 160 feet per second) or, in terms of pressure, at least 250 pounds per square inch at the orifice.

It has heretofore been the general practice to discharge a copious, low pressure stream of liquid over the rotating grinding wheel with the object of having the wheel carry the liquid to the line of contact with the work. It has also been proposed to supplement the large, low pressure stream by a smaller and more forceful jet which commingles with it or which is itself directed separately onto the grinding wheel ahead of the line of cut. In neither case, however, is the requisite condition established for forcing the fluid under pressure across the line of grinding contact and thus cooling to the degree achieved by the present invention. The reason for this, it has been discovered, is that a low pressure stream discharged into the space between the wheel and work has insufficient energy to drive the liquid across the line of grinding contact, both because its initial velocity is low and also because the work is rotating in a direction opposite to that of the liquid stream and so tends to pull the liquid away from the line of grinding contact. Such pull exerts a considerable retarding effect, for the stream is large and it necessarily contacts a relatively large surface of the work moving away from the point of cut even though at the same time it is being carried forward mechanically by the grinding wheel. But since its flow onto the wheel is usually at slower speed than the surface speed of the wheel, it is accelerated at most to the speed of the wheel, which is insufficient to develop the pressure necessary to force the fluid over the line of grinding contact. Furthermore, much of the liquid may be thrown off the wheel by centrifugal force.

Past practice has been to spread the liquid as it was flowed onto the wheel so that it would wet the entire width of grinding surface; hence, wide, heavy streams were conventionally applied. The present invention em-

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plloys, instead, a small high speed jet which is directed to strike a spot close to the line of cut, at the apex of the wedge-shaped space between the wheel and work. Here the high energy stream is abruptly diverted and flows laterally across the grinding surface. As a result of this abrupt change in direction upon impact, the kinetic energy of the jet is converted to static pressure which is exerted over the width of the wheel to drive the liquid across the line of contact between the wheel and the work.

It is important that the jet be non-spreading and that it be discharged at a suitably high pressure at the orifice or, in equivalent terms of speed, at a minimum velocity which bears relationship to the speed of the grinding wheel. This will be described hereinafter with reference to the accompanying drawing which schematically shows the arrangement of apparatus, but which for more ready understanding of the operation omits conventional features of the grinding machine and coolant circulating system.

Referring to the drawing, the grinding wheel 10 and work piece 11 are shown rotating in counterclockwise direction as indicated by arrows. A nozzle 12, which is suitably mounted on the grinding machine, is directed to discharge a jet 13 of liquid downwardly to the apex of the wedge-shaped space between the wheel and the work. In order that the jet may be thin and non-spreading, nozzle 12 includes a sharp-edged, thin disc orifice 14 or a short rounded approach orifice.

As the jet strikes the contacting surfaces of the wheel and work, it is diverted laterally and flows in both directions from the point of impact and parallel to the line of cut. In its abrupt turn through an angle of 90°, or substantially that, the kinetic energy of the projected jet is converted to static pressure of the order of 200 to 300 pounds per square inch. In order that a static pressure of that magnitude may be realized, the liquid must be discharged at a pressure of from 250 to 600 pounds per square inch at the orifice, or more than 100 pounds per square inch above the pressure required to impart a velocity to the jet which is equal to the surface speed of the grinding wheel. Operating surface speeds of grinding wheels range from 160 feet per second minimum to 270 feet per second maximum and at the lower speed a jet discharged at 135 pounds pressure has a speed just equalling that of the wheel, which is insufficient. At a pressure of 250 pounds per square inch at the orifice, however, sufficient static pressure is developed at the grinding line to accomplish the objectives of this invention, when the wheel is turning at the lower speed. Further, lateral flow of the liquid wets the grinding surface of the wheel throughout its width notwithstanding that the stream is not large and copious as was heretofore considered necessary for spreading the liquid over the grinding surface.

In such application of single or multiple thin, high speed jets, the cutting fluid is placed substantially in its entirety so close to the line of cut that it is forced between the wheel and work surfaces by the static pressure which is developed and, although splash is eliminated or largely avoided, the grinding wheel surface at the line of cut is completely wetted.

What I claim as my invention is:

1. Apparatus for applying a cutting fluid in grinding operations, said apparatus comprising, in combination with a grinding wheel and work piece, a nozzle directed at approximately right angles to the line of contact between the wheel and work piece, said nozzle having a sharp-edged, thin disc orifice, means for supplying a cutting fluid to said nozzle for discharge therefrom in a thread-like stream at a pressure of at least 250 pounds per square inch, said nozzle being positioned to direct the jet issuing therefrom into the space between the surfaces of the grind-

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ing wheel and the work piece and to the line of grinding contact.

2. Apparatus for applying cutting fluid in grinding operations comprising a grinding wheel, means for rotating the same at a surface speed of 160 to 270 feet per second, a nozzle positioned to direct a jet of cutting fluid to the line of grinding contact between said wheel and a work piece and at approximately right angles to such line of contact, said nozzle having a sharp-edged, thin disc orifice for projecting the fluid from a source of supply to the line of grinding contact in a thin, non-spreading stream at a pressure of from 250 to 600 pounds per square inch thereby to impart kinetic energy to the issuing jet which upon impact of the jet substantially at the line of contact and its diversion for flow in lateral direction is converted to static pressure of the order of 200 to 300 pounds per square inch which is exerted along such line of contact.

3. The method of applying cutting fluid in grinding operations wherein the grinding wheel rotates at a surface speed of from 160 to 270 feet per second, which comprises projecting the fluid in a thin, non-spreading jet from a source of supply to the line of grinding contact between the wheel and a work piece under pressure of from 250

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to 600 pounds per square inch at emergence from an orifice, directing the jet to a point intermediate the ends of the line of grinding contact, and impinging the jet substantially at the line of contact and at right angles thereto, whereby the jet is abruptly diverted to lateral flow across the grinding edge of the wheel and its kinetic energy is converted to static pressure which is exerted to force the fluid between the contacting surfaces of the wheel and work piece.

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