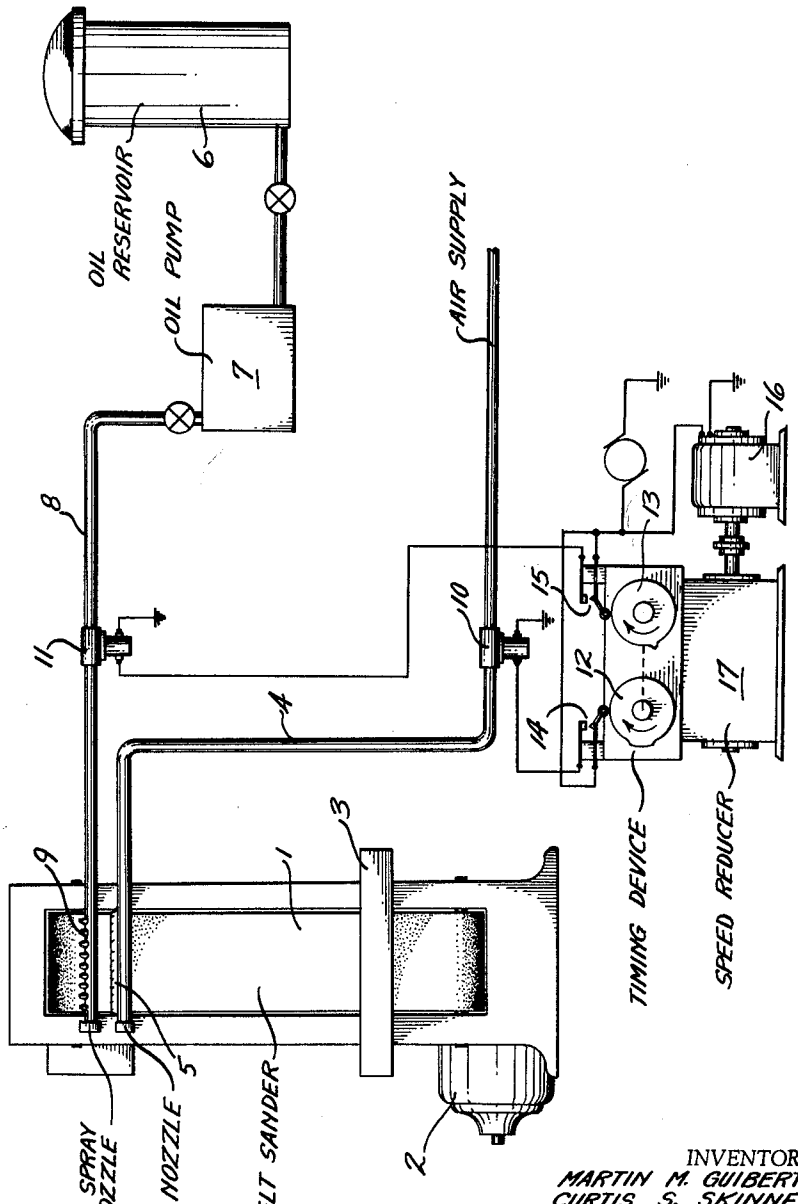
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REJUVENATION OF ABRASIVE SURFACES

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REJUVENATION OF ABRASIVE SURFACES

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This invention concerns grinding procedures, in general, and more particularly affords increased efficiency in a number of respects in the grinding of a readily oxidizable metal with an abrasive element such as a grinder disk or sander belt. The increased efficiency is demonstrated by an increased rate of removal of metal from a workpiece, by a much longer useful life of the abrasive element, by avoidance of down-time for rejuvenation or replacement of the abrasive element, and by the resultant lowering of grinding costs.

The invention, although usable when grinding ferrous metals, demonstrates its advantages most strikingly in the grinding of readily oxidizable metals, particularly aluminum and its alloys. Because its advantages are especially necessary when the workpiece is of a material the ground-off metal particles of which are readily oxidizable, it would also be highly advantageous in grinding magnesium, or any other metal or alloy which oxidizes at low temperatures, such as are developed at the point of grinding.

Abrasive elements employed in such operations, whether abrasive coated disks or belts, or wheels in which abrasive particles are embedded, tend to become loaded with dust in the form of oxidized metal removed from the ground surface, mixed with metallic particles, which gradually decreases its efficiency, lessening the quantity that can be removed by grinding in a given period of time, involving periodical shut-downs for rejuvenation of the abrasive surface, or its replacement, lessening the over-all useful life of the abrasive surface, and increasing the cost of removing the required amount of metal. Grinding operations such as this are often used in the finishing of wing skins for aircraft, and in like operations, and the decrease in efficiency in the grinding operation increases materially the cost of such an airplane, particularly when aluminum alloys or the like are used.

It is the object of this invention to provide a method and apparatus for use in the work and under the conditions outlined, which will prolong the useful life of the abrasive elements far beyond that heretofore expected or attained, largely eliminate shut-downs, increase by several times the amount of metal that can be removed in a given period of time, increase by one hundred or more times the total amount a given tool can remove during its useful life, all by enabling or effecting periodical removal of the oxide dust and rejuvenation of the abrasive surface without interruption of the grinding operation.

Also, it is an object to provide apparatus automatically operable through successive time sequences, related to the size of the abrasive particles used, and other factors, to effect rejuvenation of the abrasive element.

The drawing is a diagrammatic showing of a typical machine useful in carrying out the process automatically; the production machine may vary somewhat therefrom, although in principle it will be the same.

The grinding of metal workpieces, particularly when they are of aluminum or its alloys, or of similar readily oxidizable metals, is a process of removing by abrasion small particles of the metal, part or most of which become oxidized at the relatively low temperatures prevailing at the point of grinding. These oxide particles, and particles of unoxidized metal, tend to collect between the abrasive particles, and to agglomerate or weld on the surface of the abrasive element. Eventually they so clog

that surface that the rate of metal removal from the workpiece drops, and other factors having to do with the efficiency of the operation are adversely affected. The procedure heretofore, at this stage, has been to use a solvent to flush out the particles, or an air blast to blow them away, to apply a vacuum to the abrasive surface, or to apply abrasive sharpening tools. Such procedures have proven so ineffective as to be commercially impractical, until the use of a particular type of oxidizer followed by and in combination with an air blast, as set forth in detail hereinafter, was hit upon.

The type of abrasive element employed, whether disk or belt, and the particle size of the abradant, are largely immaterial. Coated abrasive elements, such as a sander belt or disk, have been cleaned very successfully (the belt type is preferred, because of its uniform speed), yet the process works well with a grinder wheel in which abradant particles are embedded. The particle size is important only in the respect that finer particles tend to require rejuvvenation at shorter intervals than coarser particles, although pressure would have some effect on this factor.

In essence, according to this invention, rejuvenation of the abrasive element is accomplished by applying to the element a type of lubricant which effects or facilitates oxidation and/or sulfurization or other chemical conversion of the metal particles to the oxide or other compound, of a nature which then collects as a dry dust upon the abrasive surface, and periodically blowing this dust from the surface by a blast of high velocity air, or the like, before it clogs the spaces between particles. The preferred procedure is to continue grinding without interruption, but at intervals first to blow the dust from the abrasive surface, and after cessation of the air blast to apply a small metered amount of an oil lubricant of a particular nature to the abrasive surface over a short period of time. The period of a cycle will vary with factors such as the abradant particle size, and the like, but with a vertical platen grinder belt using 36-grit particles, running at 3690 feet per minute, the time cycle required approximately ten minutes over all. Of this time the air blast, at 100 p.s.i., was operative (the grinding continuing uninterrupted) for 30 seconds, the oil spray at 20 p.s.i. in the form of a heavy spray began after say 10 seconds, and lasted 5 to 7 seconds, after which grinding continued for the remainder of a 10-minute cycle, before initiation of the next cycle. These figures are to be understood as illustrative and not restrictive.

The preferred arrangement is to use a relatively high pressure air blast, as indicated above, directed at some 45° counter to the direction of the sander belt, and quite close—say, only ⅛ inch distant—to the abrasive surface; the oil spray should be directed perpendicularly to the abrasive surface, from a distance of say 1½ to 2 inches. Maximum air pressure at the air nozzle is important. A heavy oil spray, rather than a fine mist or fog, is preferred at the oil nozzle. The most suitable cycle time, in relation to linear inches of abrasive surface (other factors being equal) is one minute to each ten linear inches of abrasive surface; for example, 100 inches of belt length or wheel periphery should enable a ten minute cycle.

The oil lubricant found most suitable is a mineral-based oil product produced by Stuart Oil Co., of Chicago, Illinois and sold under the name "Excelence NF." Other oils work with only slightly less efficiency. Such oils are, for example, Mobil-Met 29 and 27, and Anacut, each diluted with kerosene in the ratio of five parts of kerosene to one part of the oil, to a viscosity of SAE 3 or 4. The characteristic which is common to these oils is their ability to chemically oxidize and/or sulfurize more completely the metals (such as the aluminum or the magnesium mentioned) which are readily oxidizable at the temperatures prevalent at the point of grinding. Thereby particles re-

moved by abrasion are converted to dust in the form of the oxide, primarily, and perhaps to a sulfate, at the temperature prevalent at the point of abrasion.

The fine dust particles so produced do not tend to agglomerate nor weld. Many drop from the abrasive surface, and such as collect there in time are but loosely adhered. Upon the application of a high velocity air blast, at say 3700 feet per minute, and under a pressure of 100 p.s.i., as described above, they are blown off. The succeeding application of the oil lubricant coats the abrasive surface with a fresh supply of the oxidation-facilitating product, using the latter term to include sulfurization as well as oxidation.

It is preferred that any given cycle be constant in time succession and duration, to which end a typical automatic machine, shown in the drawing, has been devised. This includes the vertically moving sander belt **1**, driven by a motor **2** at the optimum rate of speed, and a table **3** whereon the workpiece may rest while it engages the abrasive element **1**. Air from any convenient pressure source is delivered by way of duct **4** to a nozzle **5**, directed towards the abrasive element **1** at an angle of 45° counter to its movement. The metered oil lubricant is delivered as a heavy spray, at 20 p.s.i., from a reservoir **6**, as by a pump **7**, by way of duct **8** to a nozzle **9**, directed towards the abrasive element.

Timing means are provided for effecting sequential discharge of air and oil lubricant, at regular intervals. By way of example, a solenoid valve **10** in the air duct **4**, and a like valve **11** in the oil duct **8**, are biased to close, but are opened at proper intervals and for desired periods, by a suitable timing device, such as the cams **12** and **13**. Cam **12** closes switch **14** to hold open air valve **10** for the necessary period of time, and at the required interval, and cam **13**, after closure of air valve **10**, closes switch **15** to hold open oil valve **11** for the necessary short period of time. The two cams **12** and **13** are conveniently mounted upon the same shaft, and can be driven from the synchronous motor **16**, through the speed-reducing gear at **17**. Thereby the timing of the air blast at nozzle **5** and of the oil spray discharge at **9**, is controlled, and the length of a cycle determined, either as given in the example above, or otherwise as may be found necessary.

Timing means, and control mechanism for regulating the amount, especially of the oil, discharged at the nozzles, of any other suitable type may be used.

Assuming the abrasive element **1** to be employed in grinding material from a workpiece of the nature specified, which is supported at **3**, after a period of time that varies with the pressure, the speed of the abrasive element, the coarseness of its grit, the length of the belt, and similar factors, the abrasive element collects a dust which is primarily the oxide of the metal of which the workpiece is made. The air blast at **5** begins, and blows this dust from the abrasive element **1**. Thereafter the oil lubricant is discharged at **9** onto the abrasive element, now largely clear of the potentially clogging dust. This oil has the property of chemically facilitating the conversion of the ground-off metal particles into the dust-like oxide, using the latter term in the broad sense, as indicated above. So much thereof as does not drop off collects slowly, and is again blown off before the grinding efficiency is too greatly reduced—say by the time such efficiency is lowered to 75% of its optimum. This process is repeated at regular intervals, automatically.

Heretofore the normal wing skin grinding operation in production included the steps of: (1) finishing and blending dry with a disc grinder, (2) finishing dry with a double-headed vibratory sander, and (3) vibratory finishing wet, with a solvent. It has been found by tests under production conditions that the use of the method of this invention

produced a number of advantages over the old method. It permitted elimination of step No. 2, with a saving of four man hours per 210 square feet of aluminum alloy wing skin. The use of Excelene NF oil, which is the preferred liquid applied, required only one pint for finishing 200 square feet, as against one gallon of the solvent previously used, and the Excelene NF cost fifteen cents less per gallon, resulting in a saving in cost of approximately 90%. The amount of metal removed in a given time was increased by at least four times over the amount removed in the same period of time by dry grinding, and in one test 29.9 pounds was removed by the method of this invention, as against 0.59 pounds by dry grinding. The useful life of the abrasive element was extended by at least three times, this alone reducing their cost by 75%. In one test it was found that after 19 hours and 19 minutes of grinding by the process of this inevntion, the useful life of an abrasive belt had been reduced by only an estimated 5%. In addition, economies resulted from avoidance of shut-downs, and of time spent in removing and replacing a worn-out barasive element.

We claim as our invention:

1. The method of increasing the efficiency and extending the useful life of an abrasive tool such as a sander belt in the grinding of a workpiece that is primarily of aluminum, which method comprises applying an oxidation-assisting oil as a spray to the abrasive surface of the tool, following the application to that surface of an air blast to remove ground-off and oxidized particles.

2. The method of claim 1, in which application of the air blast occurs after an interval in excess of nine minutes from the preceding oil application, and lasts for approximately thirty seconds, and is followed after an interval of approximately ten seconds by application of the oil spray during approximately five seconds.

3. Mechanism for use in the grinding of metal workpieces, to extend the useful life of the abrasive tool employed, which comprises, in combination with such an abrasive tool, an oil spray nozzle located for discharge of an oil lubricant upon the abrasive surface of the tool, an air blast nozzle also located for discharge of air onto the abrasive surface, and means operable after a predetermined period of grinding to effect for limited times discharge of air followed by discharge of oil at the respective nozzles.

4. Mechanism as in claim 3, wherein the abrasive tool is a unidirectional sander belt.

5. Mechanism as in claim 3, including means automatically operable at the initiation of each air blast, to effect discharge of air from the air nozzle for a predetermined period, and discharge of the oil for a predetermined period from the oil nozzle, following cessation of the air blast.

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