Index Terms

Burrs
Burr Properties
Burr Prevention
Deburring
Flash
Deflashing
Trimming
Metal Removal
Edge Standards

ABSTRACT

An annotated summary of 204 articles and publications on burrs, burr prevention and deburring.

Thirty-seven deburring processes are listed.

Entries cited include English, Russian, French, Japanese and German language articles. Entries are indexed by deburring processes, author, and language. Indexes also indicate which references discuss equipment and tooling, how to use a process, economics, burr properties, and how to design to minimize burr problems. Research studies are identified as are the materials deburred.

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DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED
When Eli Whitney originated the concept of mass production, he generated the problem of mass deburring. Today burr and flash removal costs U.S. industry an estimated two billion dollars a year. Despite this high price, industry in general treats deburring as a necessary evil and relies on "art" and tradition rather than science to eliminate it.

The following bibliography is an extension of Deburring: An Annotated Bibliography, Volumes I through IV, which were published the years 1974-1976 by the Society of Manufacturing Engineers. This report represents another of several attempts to make burr removal* as reliable and predictable a science as metal cutting is. The information contained in the references cited will provide the reader with an understanding of burr formation, properties, and mechanics of each deburring process and a general comparison between the capabilities of each process.

The references listed in this bibliography describe one or more of the 37 principal deburring or deflashing processes, the equipment or tooling used, how to use a process, the economics involved, the formation of burrs, or measures taken to prevent burrs. As such, this report covers both burrs and deburring. Many of the deburring processes are also frequently used to improve surface finish, clean, and descale. Only those articles which are directly related to deburring, which contain the words "burr" or "deburring" in the title, or which present significant related data are included in this paper, however. While many articles discuss more than just deburring, the annotated comments in this bibliography essentially describe only the deburring aspects of each article.

A special effort has been made to include articles which define edge standards or edge related effects, since they are directly related to the deburring processes.

The references shown were unearthed in a search of the following documents. The words in parentheses indicate the topics searched in each index.

Engineering Index, 1976; 1977; January-June, 1978 (metal finishing)

Applied Science and Technology Index, 1977; January-June, 1978 (metal finishing)


Metal Finishing Abstracts, Vol. 18 (No. 5-6) 19; 20 (No. 1) (finishing, burrs, deburring, vibratory finishing, mechanical treatments)


*For brevity, burrs as implied in this introduction includes flash, dross, and allied protrusions. Deburring includes the removal of all these conditions.
(burrs, deburring, metal finishing)

Bibliography of Rubber Literature, 1971 (deflashing, finishing)

Internationale Bibliographie der Zeitschriften Literatur, 1977,
Part 1 (grat, entgraten)

Library of Congress Catalog - Books: Subjects 1920-1974;
(metals-finishing)

Standard U.S. abbreviations are used throughout this bibliography. The following is believed to be a complete listing of these abbreviations.

ASME - American Society of Mechanical Engineers
NTIS - National Technical Information Service
R.Z.M. - Referativnyi Zhurnal-Tekhnologii Mashinostroeniia
SAE - Society of Automotive Engineers
SME - Society of Manufacturing Engineers

Most of the foreign language articles have not been annotated because a translation was not available. Similarly, few of these entries are included in the indexes at the end of the bibliography.

Copies of 50% of the English language articles listed in this bibliography can be obtained from the library listed below. Probably 50% of the Russian, German, French and Japanese articles are also available from the same source. Repositories of the remaining citations can be identified by the librarians at Linda Hall Library. NTIS reports can be ordered from the address listed below.

Linda Hall Library
5100 Cherry
Kansas City, Missouri 64141

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151

The author is indebted to the librarians and staff of Linda Hall Library for their assistance in retrieving the hundreds of magazines which were reviewed. Their courteous and friendly assistance in deciphering some of the requests is gratefully appreciated.

While a conscientious effort was made to include all entries related to burrs and deburring, some significant articles may have been inadvertently overlooked. The author would appreciate notification of any additional publications on the subject of burrs and deburring which do not appear in Volumes I through V of this bibliography.
FORMAT OF BIBLIOGRAPHY

The entries in this bibliography are divided into six major and 37 subheading deburring categories, two categories on burrs, one on designing to minimize burr problems, and one category entitled "Unclassified". Within each of these categories, entries are listed by year of publication, subsequent sub-divisions and alphabetically by author, then title. Articles by anonymous authors are listed before any of known authors. Patents are described if no other published information was available.

The deburring entries listed in the table of contents are for the most part fairly widely accepted and known deburring processes. Barrel tumbling was also once known as barrelling, rattling and tubbing. Harperizing and spindle finishing have also been called gyro finishing. The terms electropolish deburring and electrochemical deburring are used interchangeably by some authors although there is a distinct difference in equipment, tooling and side effects produced. The reader is urged to review articles listed in these last two categories carefully to prevent confusion. Liquid hone deburring involves forcing water and abrasive over burr laden edges. It is a gentle process which does not rely on blasting or impact pressures. The "burr properties" category includes all references which describe such burr properties as length, thickness, shape or hardness. "Burr Prevention" lists articles which describe how to prevent burrs. In general, most of these articles actually describe methods of minimizing burrs. The "Unclassified" category lists articles which were not reviewed or which do not fit in the other classifications.

Each article is indexed by several classifications in addition to those listed above. These indexes, located at the end of this publication, indicate which articles describe equipment and tooling, present formal research results, describe how to use a process, list the workpiece material, present data, or include some economic analysis. Indexes by author and publication language are also included.

The format used in this issue of the bibliography is similar to that used in Volumes III and IV of this bibliography. The processes have been grouped into basic categories of type of removal process. Because of this reformatting process, "H" in this volume and Volume IV is not the same as process "H" in Volumes I or II.
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ABRASIVE JET DEBURRING

1958


Discussion of the weight change which occurs in blasting operations.

1960


1967


Excellent summary of blasting effects on part weight change.

1969


1971


1972


Describes the basic equation relating stock loss (by weight) to blasting parameters.
1974


Fine but brief technical guide to the use of steel blasting media.

1975


Author describes volume wear from blasting with quartz and SiC particles. Wear is proportional to the heat capacity per unit volume and the part temperature.


1976


Describes stock loss of pure metals due to abrasive blasting with 60 mesh silicon carbide abrasive.

1977


Brief description of national burr costs and the improvement of deburring costs by blasting large ring gears.


Describes one approach to blasting burrs off large gears.


Miniature blasting jet removes burrs from precision miniature parts.

The use of miniature abrasive blasting units removes burrs from small parts. Up to 500 parts can be deburred using only one pound of miniature glass beads.


Presents a number of deburring applications for micro abrasive blasting.

1978


Describes machine design of blasting unit as well as technical and economic considerations for abrasive jet deburring.
ABRASIVE FLOW DEBURRING

1977


A well done study of effects of abrasive flow deburring parameters on hole size, radius, and surface finish.


General summary of abrasive flow deburring. Article indicates stock loss can be held to 0.0002 inch.


Experimental study of extrude hone deburring parameters on stock removal and surface roughness.


General summary of abrasive flow deburring in precision industry.
LOOSE ABRASIVE PROCESSES

1977


Presents an excellent and in-depth overview of the development of mass finishing and their capabilities. This brief publication (24 pages) is the best single source of information available on capabilities of at least one manufacturer's products.

BARREL TUMBLING

1959


1970


1976


1977


Brief shop hint repeats the widely used fact that freezing rubber parts assists deflashing.


Presents a general commentary on deburring costs and some of the factors management needs to consider to control these costs.


Review of barrel finishing and burnishing and a vibratory finishing plant.
1976


Centrifugal barrel tumbling uses are described.

1977


Harperizing coil springs improves fatigue life.


Brief note indicates centrifugal barrel machine performs deburring on precision miniature parts. Unfortunately, someone made several errors in the quantitative information presented.


Very brief mention of one company's use of centrifugal barrel finishing.


Presents graphical and mathematical relationships for determining the stock loss and radius produced in centrifugal barrel finishing. The effect of burr size is also presented in mathematical form for 303 Se stainless steel burrs.


Describes gyro-finishing and recipro-finishing processes and their effect on burr size, edge radiusing, and surface finish.
1978


Harperizer is used to finish textile parts.

MAGNETIC LOOSE ABRASIVE DEBURRING

1975


Brief paragraph notes that magnetic abrasive deburring was effective in removing fine burrs.


Describes process operation of magnetic abrasive process and the effect of the process on surface roughness.

SPINDLE FINISHING

1960


Results of spindle finishing unit.

1977


Brief description of a spindle finishing machine.

1978


Translation of Vestnik Mashnostroyeniya, Vol. 57, No. 8, 1977, pp. 68-70. Describes a spindle finishing application in which media is "fluidized" by means of a layer of compressed air. Emphasis is on surface finish improvement.
VIBRATORY DEBURRING

1969


1970


1971


Liquid nitrogen machine is used in vibratory machine to deflash parts.

1975


Presents effects of ball burnishing tests on surface finish.

1976


This self-teaching course has some rudimentary information about deburring processes.


Zinc parts are vibrated at -129°C for 20 minutes. Article describes the parameters one must consider in the use of this process.

Basic discussion of the use of metal forms for tumbling type processes.


Contains a summary of the vibratory deburring machines offered by 21 American and European manufacturers.


Presents research results of vibratory finishing.


Discuss barrel tumbling and vibratory operations before electroplating.


Provides a review of actions in precision barrelling, and media separation.


Research shows part hardness increases after vibratory finishing operations.

Presents a review of vibratory equipment and methods.


Presents a summary of information presented at Fachtagung Entgraten '75 in Stuttgart, Germany, November, 1975. Blasting, tumbling, and spindle finishing are described and an extensive discussion of burr properties is given.

1977


General article on selection and application of tumbling abrasive compounds.


Five case histories of burrs are described to illustrate the rationale for attacking burr problems and to more fully define the limitations of some processes. These case histories emphasize tool design, side effects of deburring, deburring capabilities, machining sequences, hand tools and deburring of Teflon.


Describes the choices one has to make in selecting appropriate processes and parameters.


This paper emphasizes the in-depth analysis required to lower total deburring costs. Items which significantly influence cost in loose abrasive operations are described.

Presents an excellent summary of the considerations which must be made when evaluating wear of tumbling medias. Formulas and empirical data are presented to illustrate the comments.


Provides a review of vibratory finishing equipment, their operation and efficiency.


Describes the use of cryogenic tumbling processes on plastic, rubber and zinc parts.


An empirical analysis of part material and machine effects on burr size reduction, edge radiusing, and surface finish.


Describes applications for vibratory finishing.


Describes the osronaut version of vibratory finishing.


Presents survey results estimating numbers of machines and expendable supplies used in die casting, forging, and other related industries.
1978


Editor notes correct term in equation for vibratory economics for article which appeared in May magazine issue.


Presents method for making an economic analysis of vibratory finishing. The principal equation shown, however, is not correct as printed.
SANDING

1977


Sanding machine removes torch cut slag from steel plates.


Excellent summary of research performed on deburring by three-dimensional type abrasive wheels.


Slag from flame cutting is removed by belt sanding machine. Slag projects up to 1/8 inch above the part surface.


Basic discussion of wide belt sanders and the factors which affect the surface finish on parts.
MECHANICAL DEBURRING

1971


Describes the use of Group Technology in a Soviet foundry performing fettling, trimming and piercing.

1977


Router cutter is briefly described. This cutter has helix which cuts down from the top of a stack of parts and upward from the bottom of the stack.


Impact action device removes weld splatter from inside pipe. Article focuses on analytical analysis of device.


Brief mention of the fact that ballizing can be used to remove large roll-over burrs.


General summary of the machine requirements for trimming riser remnants from steel and malleable castings.


Describes the Reishaver contour chamfering machine.

Describes use of robots for deburring.

1978


Brief summary of use of high speed spindles to trim ammunition cartridges.


Presents a brief summary of a published paper on deburring by robots.


Provides a general overview of the variety of mechanized equipment available for deburring. This is one of the few articles which cover the majority of machines in this category.


Describes design and use of mechanized mechanical deburring unit.


Article highlights the fact that robots and N/C ECD offer promise for better deburring.
HAND DEBURRING

1950


Presents an example of an improvement in hand deburring methods.

1954


Presents standard data for estimating deburring time for simple conditions.

1958


Presents an example of a fixture used to speed hand deburring.

1978


Presents an in-depth analysis of hand deburring problems and how they can be improved.
BRUSH DEBURRING

1976


Presents a running commentary on brushes and appropriate usage. While basically a sales brochure, the information contained is more complete than typically found.

1977


Abrasive impregnated nylon and polypropylene brushes remove tough burrs from heat treated gray iron.


Excellent basic discussion on the systematic approach to solving burr problems.
THERMAL ENERGY METHOD

1976


1977


Brief summary of the actual burr removal mechanism in the Surf Tran process.


Very brief comment about performance of TEM deburring.


Very brief example of use of TEM deburring for removing zinc die casting flash.


Fluid drive components are deburred by TEM process.


Describes use of TEM deburring method on more delicate parts than previously possible.


Presents pictures and text illustrating how burrs are ignited in the thermal energy deburring method.

1978


Thermal energy method is used to "clean" off metal particles from hard-to-reach areas of parts.
CHEMICAL DEBURRING

1976

ELECTROCHEMICAL DEBURRING

1968


Describes equipment and applications of EC deburring.

1970


Describes EC deburring machines and some applications.

1976


1977


Presents several excellent case histories of ECD.


Presents some examples of edge quality produced by ECD as well as some features of parts which can be produced by ECD.


Describes tooling used in ECD, types of burrs which can be deburred as well as basic ECD requirements.


Basic discussion of ECD machine design and ECD.

EC deburring reduces deburring from 40 hours to 8 hours on aluminum aircraft fuel component.


Basic discussion of electrochemical processes includes deburring. A list of equipment manufacturers and their estimate of part capabilities for at least one of their existing machines is given.


New ECD machine utilizes universal tooling.
Basic elements of ECD are explained.


ECD operation, advantages and limitations are described.


Brief review of ECD and general trends relating to ECD.
ELECTROPOLISH DEBURRING

1977


   Includes some comments on electropolishing influences on deburring.


   Electropolishing removes tool grinding burrs and feather edges.


   Describes the effect of electropolishing on burr removal and stock loss. Factors which influence throwing power are also discussed.
MULTIPLE PROCESSES

1976


Presents the initial results of a major study to develop computerized selection of deburring processes. A new method of defining edge quality is presented, an in-depth presentation of burr measurement techniques is given, a number of typical burr sizes in different materials and processes is given, and the effect of workpiece geometry on burr size and removal is briefly discussed. The operation of a number of deburring processes is given with supporting data on effectiveness. The computer grid for describing deburring capabilities is also presented as is a plan for additional work.


This 40-page report summarizes in table format the status of burr technology in 1976. It describes the capabilities of 37 deburring processes, describes the status of available equipment, techniques for minimizing and preventing burrs, designing to accommodate burrs, standards for edge conditions, techniques for predicting burr size, plant-wide approaches for cost reduction and evaluating economics. Thirty-nine references and 14 tables are included. This is one of the most complete summaries of the status of burr technology available in 1976.


Reports on a Stuttgart meeting in 1975 on the subject of deburring.

1977

U4. *"Burr" (Chapter 6) in Machining Technique-Data File, Mechanical Industry Promotion Association, Tokyo, Japan, (in Japanese), April, 1977.

Presents a relatively complete yet concise account of burr formation and deburring processes.

Highlights of upcoming deburring conference.


Provides a convenient checklist of deburring processes by type of energy used to remove burrs.


Excellent summary of the status of deburring today. Article includes summary of process capabilities as well as survey results on economics and general status of deburring efforts.


This annotated bibliography lists 148 articles and reports on burrs, burr prevention, and deburring. Entries are indexed by type of process and 14 other categories. Publication language and author indexes are also included.


Describes the varied side effects caused by deburring processes. Concentrates on those related to plating processes.


Defines equations which can be used to predict deburring costs as well as cost elements associated with deburring.


Describes 41 needed research areas in deburring.


Describes how each deburring process affects such part characteristics as stresses, surface finish, contamination, cleaning, elastic limit, and size.

This extensive summary presents 11 tables defining the capabilities of the 37 major deburring processes. In addition, a summary of recent improvements in each process is cited. Future needs are defined and a summary of process operations is given for reciprocating finishing, flow finishing, hot wire deburring, orboresonant deburring, and EDM deburring. The major sources of burr-related literature are identified as are the sponsors of 20 recent conferences on this subject. One hundred and six references are given.


Presents some basic methods engineering solutions to deburring problems.


This 114 page report summarizes the status of burr-related knowledge in the U.S. and in Canada. It defines a number of standards and costs found in the airframe industry as well as other aerospace industries. A 202-entry bibliography is included.

1978


This new directory lists 205 pages of finishing equipment vendor information and product information.


This extensive article summarizes an extensive report on deburring tradeoffs. Article also focuses attention on special processes or tools for deburring.


Presents a summary of the major deburring processes in use today.
Burr Formation and Properties

1971


Excellent but brief summary of research on burrs formed by side flow.

1976


Authors briefly note that drilling aluminum sheet stock at high speeds can reduce deburring costs by 80 percent. A small burr occurs on the hole entrance side while the exit side is "clean".

1977


Extensive study of drilling stacks of various metals also lists burr dimensions produced.


Comments on burrs formed in abrasive cut-off operations.


The cutoff projection left when cutting off lathe parts is analyzed and compared to empirical data. The equations developed are in close agreement with the thickness of cutoff projection actually measured.


This 79-page report explains the formation of burrs in turning operations and presents the results of two major empirical studies of effects of machining conditions on burr properties. The implications of these results are also described.

Author briefly notes that excessive burrs in abrasive cutoff operations may be the result of too coarse an abrasive grain. Parts should also be clamped securely to eliminate motion during break-thru.

1978


Presents a brief discussion of burr formation factors which influence burr size and a summary of standards relating to burrs.


This paper illustrates the effect of high speeds on drilling torque, thrust, burrs and edge quality.


Article comments on broaching briefly indicates that provided the part exit edge angle is greater than 90 degrees burrs will be small.


Presents some basic information on West German research on burrs and deburring.
BURR PREVENTION AND MINIMIZATION

1958


Describes results of opposed ram punch presses on edge quality. This approach prevents burrs from forming.

1974


1975


1976


1977


Brief description of router cutter which minimizes burrs on profiled printed circuit boards.


Brief comment on the fact that electrochemical machining can produce many burr free small diameters.


Describes cutting tool which drills and deburrs top side of sheet metal holes.

General description of a tool having both left and right hand helix angles on a single cutter. This directs all cutting forces into the part.


Describes Rohbi bar stock cutoff clamping system for preventing cutoff burrs.


Plasma arc machining produces a three-dimensional contour on pipe ends which eliminates deburring and two other operations. No deslagging or deburring is required on most of these ends which are later welded. Nitrogen or CO\textsubscript{2} is used during the cut to blow off molten slag before it solidifies on the workpiece.


New hot forging process produces "flashless" forgings.


Article indicates that a new zinc diecasting approach results in flash free castings.


Describes approach to burr-free coil slitting.


Describes three approaches to truly burr-free punching and coil slitting.

Wedge rolling eliminates the flash which occurs with drophammer hammer forgings.


Describes router cutter which has both left hand and right hand helix to throw cutting forces into the part instead of out of the part. This minimizes or eliminates the heavy exit burr.

1978


Special die casting machine eliminates most of flash on a part as a result of controlling final liquid pressure.


Very brief discussion of Russian approach to flash free forgings.


Using N/C and cutting burrs off during the machining reduces deburring time.
DESIGNING FOR MINIMIZING BURR PROBLEMS

1963


This 600-page guide to equipment used in the plastics and rubber industry contains several pages of equipment related to deflashing and trimming.

1967


Humorous yet sincere article proposes some standards which are in use in one company.

1975


Burrs on 17-7 PH stainless steel spring washer resulted in part failure. Burrs on the tension side of part loading led to failure. When burrs were on the side in compression, no failures occurred.


Burrs on drilled hole in a spherical bearing link caused rough bearing operation.

1976


Appendix C of this standard contains a description of a brief standard used to monitor edge sharpness of commercial components.


This is a 95-page survey of potential markets for finishing equipment sales in Italy.

1977


Presents an excellent summary of known industry and company standards as related to burrs and edge conditions.


This document is an extension of an earlier report providing proposed industry definitions for burrs and related edge conditions. Twenty nine illustrations are presented to further explain the definitions. This report is composed of three sections: definitions, discussion of definitions, and an analysis of other published definitions. Twenty nine references are included.


Contains a basic discussion of the cost of burrs in Canada. Reasons for this cost are presented as are potential solutions.


Contains a summary of the people and information requirements for reducing burr related costs on a plant wide basis. In addition, methods which have been employed to reduce plant wide costs are discussed.

In a survey of 300 companies, 26% of those which used Group Technology performed deburring as one type of operation. Nineteen percent performed some other finishing operation.


Author notes that "burrs" formed by piercing offers stronger holding than drilled holes. The author is referring to lancing.


Describes the use of the Schafer system for defining edge conditions.


Describes standards and the lack of them within industry.


Indicates how 27 industries allocate their equipment dollars. Finishing equipment is included in the breakdown.


Consumer product safety commission indicates children have recently been injured by burrs and sharp edges left on heat register louvers.


Provides examples of how drill jigs should be designed with burr clearance.

Author indicates that when edges are ground on ceramic tools grinding marks should be parallel not intersecting at edges for longest tool life.
1968


1975


1976


   Describes machine used for edge polishing.


1977


General article on deburring potential.
REFERENCES ON EQUIPMENT AND TOOLING:

A7, 12, 13, 14, 17; B4; D1, 7, 13, 18, 27, 28, 32, 34, 35, 39, 40, 42, 43, 44, 48, 49; E1, 3, 4; F2, 5, 6-11; J7; Q1, 2, 6, 7, 9, 10, 12; U7, 15, 16; W1, 8, 9, 10, 11, 12, 16, 18, 20; X1, 6, 7.

REFERENCES PRESENTING RESULTS OF RESEARCH:

A1, 3, 6, 7, 8, 10, 15; B1, 3, 4; D1, 6, 12, 13, 16, 19, 23, 28, 33, 35, 41, 42, 45, 46, 49; E2; F3, 5; H4; J2; R3; U1, 2, 3, 4, 7, 8, 12, 15, 17, 18; V1-3, 5, 6, 8, 11; W1, 3, 15, 19; X13, 21.

REFERENCES PRESENTING CASE HISTORIES OR DESCRIBING HOW TO USE PROCESS OR TOOLING:

A13, 16; D1, 12, 38, 41; G1, 3; H2; J7; Q4, 8; U7, 8; X2, 3, 4, 19.

REFERENCES LISTING MATERIALS DEBURRED OR STUDIED:

1. Low Carbon Steel
   A9; D12, 26, 33; E1, 2; F5; J8; V6; W11, 16.

2. Stainless Steel
   D9, 12, 26, 38; U9; V5, 6.

3. Alloy Steel
   A9; B3; D33; R2; V5, 6.

4. Aluminum
   A10; D12, 26, 38, 46; E2; Q8; V2, 3, 9; W9, 20.

5. Copper, Brass, Bronze
   A10; D26; F8; V5, 6; W6.

6. Zinc
   D25, 44; J5; W13.

7. Refractories

8. Cast Irons
   F5; H3.

9. Titanium
   V3; W7.

10. Beryllium Copper
11. Plastics
   D3, 38; W9.

12. Powder Metals
   D44.

13. Wide Range of Materials
   D42; Q4; U1, 4, 13; W12.

14. Rubber
   D3, 5, 44.

ARTICLES PRESENTING DATA:
   A1, 3, 6, 7, 8, 10, 11, 14, 15; B1, 3; D1, 10, 12, 13, 16,
   19, 28, 33, 35, 41, 42, 46, 49, 51; E2, 4; F3; G2; Q8; R3;
   U1, 4, 7, 8, 9, 12, 13, 15; V3, 5, 6; W1; X5, 8, 11, 13, 18.

REFERENCES DISCUSSING ECONOMICS:
   A11, 17; D6, 23, 40, 49, 50, 51; Q9; U7, 8, 10, 13, 15;
   X11, 18.

REFERENCES DESCRIBING DESIGN APPROACHES:
   D38, 40; H4; U1, 2, 4, 8, 13, 15; V8; X1-21.

REFERENCES DISCUSSING BURR FORMATION AND PROPERTIES:
   D35; E2; H4; U1, 2, 4, 8, 13, 15; V1-11; W1, 3, 15; X5, 12.

REFERENCES DISCUSSING BURR PREVENTION AND MINIMIZATION:
   D38, 40; U1, 2, 4, 8, 13, 15; V2, 5, 6, 8, 9; W1-20; X8,
   12, 21.

REFERENCES DESCRIBING PLANT OR INDUSTRY WIDE APPROACH TO DEBURRING PROBLEMS:
   U13, 14; X12.

REFERENCES DISCUSSING SPECIFIC PROCESSES:
   Abrasive Jet
   A1-17; D35, 49; U1, 13, 17, 18.
Abrasive Flow
Bl-4; Ul, 13, 17, 18.

Water Jet
Ul3.

Barrel
Dl, 7, 24, 26, 29, 37, 39, 44, 49; Ul, 13, 17, 18.

Centrifugal Barrel
Dl, 6, 8, 14, 38, 39, 42; Ul, 3, 13, 17, 18.

Magnetic Media
D15-16; Ul3.

Spindle Finishing
Dl, 17-19, 35; Ul, 13, 18.

Vibratory
A9, 15; Dl, 6, 7, 20-51; Ul, 13, 18.

Flow Finishing
D1; Ul3.

Recipro Finishing
Dl, 13; Ul3.

Orboresonant
D48; Ul3.

Sanding
El-4; Ul3, 17.

Mechanical
D24, 49; Fl1-12; Ul3, 17.

Hand
D6, 40; Gl-4; Ul3.

Brush
Hl-4; Ul, 3, 13, 17.

Flame
Ul3.

Resistance
Ul3.

Hot Wire
Ul3.

Thermal Energy Method
Jl-9; Ul, 13, 17, 18.
Plasma Deburring
U13.

EDM Deburring
U13.

Chemical
M1; U3, 13.

Ultrasonic
U13.

Chemical Barrel
U13.

Chemical Centrifugal Barrel
U13.

Chemical Magnetic Loose Abrasive
U13.

Chemical Spindle
U13.

Chemical Vibratory
U13.

Electrochemical
D24; F12; H4; Q1-12; U1, 3, 13, 17, 18.

Electropolish
R1-3; U13, 18.

Electrochemical Brush
U13.

Electrochemical Barrel
U13.

Electrochemical Centrifugal Barrel
U13.

Electrochemical Spindle Finishing
U13.

Electrochemical Vibratory
U13.

Multiple Processes
U1-18.

Unclassified Listings
Y1-13.
FOREIGN LANGUAGE ARTICLES:

German
D8, 29, 30, 35, 39, 47; H4; J1; Q1, 2; R1; U1, 3, 18; V11; X9, 15; Y2, 4, 6, 9.

Japanese
D2, 17; U4; W1, 3, 14.

Russian
A2, 4; D16, 23, 28, 33; F3; Q3; W19.

French
D4, 34, 43.

Spanish
D21.

Italian
D7.

Norwegian
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