

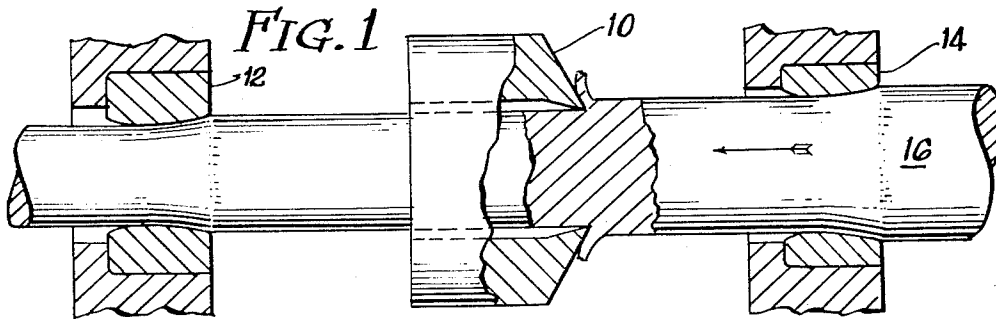
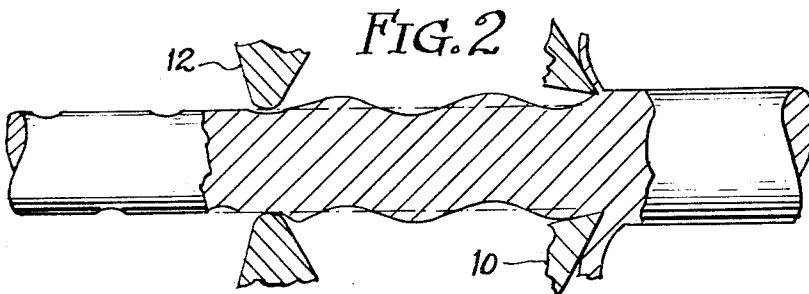
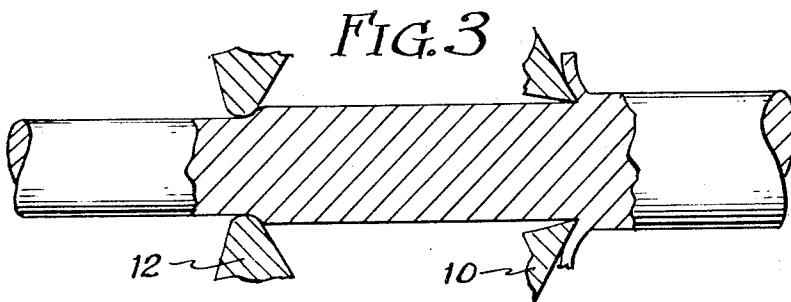
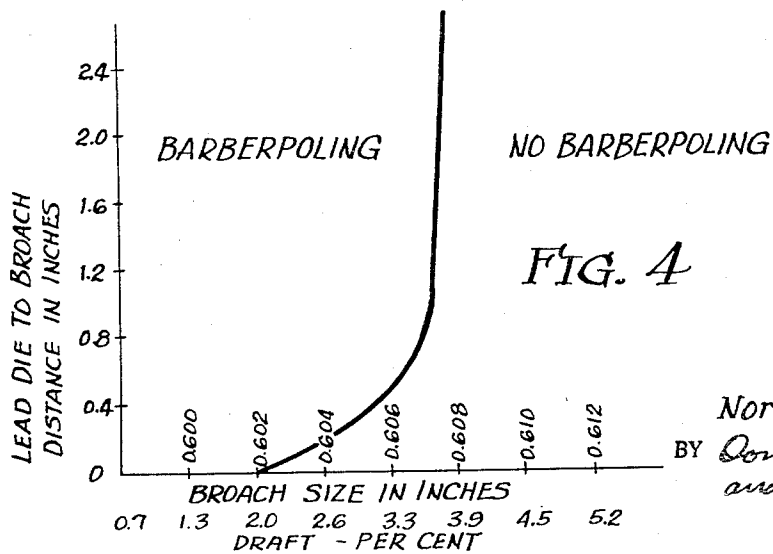
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METHOD AND MEANS FOR SURFACE FINISHING OF STEEL

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METHOD AND MEANS FOR SURFACE FINISHING OF STEEL

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4 Claims

ABSTRACT OF THE DISCLOSURE

The method for removing surface metal from steel bars and rods by the use of a combination of dies comprising a lead die, a finishing die and a shaving tool between the lead die and the finishing die for removal of surface metal and in which the amount of reduction taken by the lead die is at least equal to the difference between the surfaces of the work and the center or the out-of-roundness of the metal and in which the amount of reduction that is taken in the finishing die is increased until the undesirable characteristic of barberpoling is no longer experienced but in which the amount of reduction is at least 4 percent.

This is a continuation of my copending application Ser. No. 268,906, filed Mar. 29, 1963, now abandoned, and entitled "Method and Means for Surface Finishing of Metal."

This invention relates to a metallurgical process referred to in the field as cold finishing as applied to bars and rods and it relates more particularly to the process of treatment of bars and rods of uniform cross section to effect reduction to desired dimensions simultaneously with the development of an improved surface finish and a desired combination of physical and mechanical properties in the metal bars and rods and especially steel bars and rods.

In the performance of such cold finishing operation, it is desirable to pretreat the surface of the metal bars and rods to effect removal of surface imperfections. The above has been effected by the usual pickling operations, but the removal of surface imperfections requires the removal of surface metal at least to a depth of the imperfections or impurity. This has been achieved by a machining operation, such as by cutting or milling with conventional lathe or milling machines, but such operations have been found to be slow and expensive such that it has been desirable to seek a more rapid and efficient means or method for the removal of surface metal in such metal bars and rods of repeating cross section.

In the Shaw et al. Patent No. 3,055,102, issued Sept. 25, 1962, entitled "Metal Finishing Means and Method for Use of Same," description is made of the efficient and rapid removal of surface metal from metal bars and rods by the advancement of the metal of repeating cross section continuously through a cutting or shaving tool which preferably engages the entire periphery of the bar or rod for removal of metal from the outer surfaces or for removal of surface metal from the inner periphery of a tubular or the like metal member.

In the aforementioned Patent No. 3,055,102, description is made of an arrangement which makes use of the continuous shaving tool for the removal of surface metal in combination with a reduction die, such as a draw die or extrusion die, immediately following the shaving tool whereby the lead die and the reduction die operation to guide the metal bars and rods through the shaving tool while simultaneously effecting a reduction step following the removal of surface metal. While removal of surface

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metal is achieved at a high rate, in the system described, it has been found that with steels unstable cutting conditions are often encountered, such as the type hereinafter referred to as "barberpoling." The term has been applied to this type of instability because of the physical appearance of the finish of the bars or rods at the exit side of the shaving tool.

Many theoretical concepts have been advanced for the conditions leading to the "barberpoling" in the steel surface metal removal system of the type described. One such concept describes "barberpoling" as the result of a sinusoidal cutting action of the tool relative to the work. It is believed that the bar or rod is advanced through the shaving tool while, at the same time, the bar or rod moves axially back and forth against the cutting action of the shaving tool. The combination of such motions between the bars or rods and the shaving tool produces a spiral type of cut which is often found in the surface of the metal bars or rods hereinafter referred to as the "work."

There are a number of forces and conditions which may lead to "barberpoling," some of which may yet be unknown or unidentified. As a result, no attempt will be made to designate the cause for "barberpoling" or other instabilities and the description will be limited to the means for minimizing and preferably eliminating the same. This effect is most pronounced with steel bars and rods as compared to bars and rods formed of other softer metals, such as aluminum, copper, and the like. Thus the concepts of this invention will be limited to steel as distinguished from other metals.

Such instability which leads to wandering of the metal or "barberpoling" is undesirable because of the lack of control which results in metal removal whereby excessive amounts of metal are removed from one side of the bar or rod while little, if any, metal is removed from the opposite side such that imperfections or unwanted metal are allowed often to remain in the surface that is advanced to the reduction die or other finishing tool. Further, such "barberpoling" and instability introduces undesirable contours in the surface of the metal which remains or otherwise has an undesirable effect on the surface of the metal before and even after the subsequent finishing steps, such as by drawing or extrusion for reduction and finishing the bar. Thus it is extremely important to eliminate such instability in metal removal without depreciating from the many advantages available from the continuous removal of surface metal by the described shaving process and means.

Thus it is an object of this invention to provide a method and means for carrying out the continuous removal of surface steel by a shaving operation of the type described without "barberpoling" and without instability and it is a related object to provide a method and means of the type described wherein the shaving tool and work are concentrically maintained in a stabilized state during shaving for removal of surface metal in an amount to provide a concentric axis about the center of the work.

More specifically, it is an object of this invention to provide a method and means of the type described wherein surface steel can be substantially continuously removed from the surface of steel bars and rods having uniform cross section in length without the workpiece wandering from side to side relative to the shaving tool; which provides a shaved metal bar in which the periphery is parallel to the axis of the bar following the shaving operation; in which the metal or bar or rod is processed in advance of the shaving operation to present to the shaving tool a surface which is relatively smooth and concentric; in which the shaving operation for the removal of surface metal is achieved in combination with the reduction of the metal in a previous and subsequent metallurgical step for reduction of the cross section of the bar, and it is a related

object to balance the final reduction with the shaving step, with or without a previous reduction step, to minimize instability in the various steps of metal removal and reduction in cross section of the metal bar or rod.

These and other objects and advantages of this invention will hereinafter appear, and for purposes of illustration but not of limitation, an embodiment of the invention is shown in the accompanying drawings, in which:

FIG. 1 is a schematic view of the arrangement of parts embodied in the practice of this invention;

FIG. 2 is a schematic sectional view of the type of "barberpoling" that is experienced by present practice in metal removal in the use of a shaving tool followed by advancement of the steel through a draw die for reduction in cross sectional area;

FIG. 3 is a schematic sectional view similar to that of FIG. 2 illustrating the greater concentricity that is obtained by the concepts of this invention during the metal removal and reduction step; and

FIG. 4 is a curve illustrating data which relates "barberpoling" to the amount of reduction in the trailing die and the distance between the shaving tool and the reduction die mounted in advance of the shaving tool.

Before entering into a discussion of the invention, reference will be made briefly to FIG. 1 of the drawings for a description of the elements embodied in the practice of this invention. In the illustrated modification the shaving tool is indicated by the numeral 10. The reduction die immediately following the shaving tool will be referred to as the finishing die 12. The die 14 immediately in advance of the shaving tool 10 will be referred to as the lead die or guide die.

In operation, the steel coil 16 is advanced continuously sequentially, first through the guide die 14, then through the shaving tool 10, and finally through the finishing die 12. Both the guide die 14 and the finishing die 12 are preferably draw dies of conventional construction. While not equivalent, one or the other or both of the dies 12 and 14 may be other types of reduction dies such as extrusion dies or rollers between which the steel is advanced for reduction in cross sectional area.

Following the discovery of the "barberpoling" and after studying its various possible causes and effects, numerous investigations were conducted along various pathways in the attempt either to reduce the amount of wandering between the shaving tool and the work or preferably entirely to eliminate the "barberpoling" effect. These investigations included:

(1) Determination of the effect of linear speed of the metal relative to the shaving tool by variation in the linear speed of the work advanced through the tool.

(2) Determination of the effect of lubricant pressure at the time that the work is advanced through the shaving tool by varying the pressure of the lubricant on the work.

(3) Effect on the stability of the cutting operation by variation in the rate of flow of the lubricant onto the work at the point of contact between the shaving tool and the work.

(4) Determination with respect to the relationship between the draft or amount of reduction taken in the lead die and the amount of "barberpoling" taking place during passage of the work through the subsequent shaving tool.

(5) The relationship between the amount of reduction taken in the finishing die following the shaving tool and the instability of the cutting operation during advancement of the work through the shaving tool.

(6) The relationship between the distance between the lead die and the shaving tool and the amount of "barberpoling."

(7) The effect on instability during the cutting operation by variation in the contour of the shaving tool including its rake angle, its clearance angle, and its land or broach clearance.

(8) The variation of the geometry of the finishing die

following the shaving tool on the instability of the cutting operation.

The extensive investigations resulting from the many variations of each of the conditions heretofore described have established that the linear speed of the work relative to the tool and the rate of flow of lubricant have little, if any, effect on the stability of the cutting operation and that the conditions of the foregoing may be varied over fairly wide limits without material effect on the stability of the cutting operation.

The conditions that appear to exercise most control over the "barberpoling" and instability reside in the amount of draft or reduction that is taken in the reduction die which immediately follows the shaving tool. It has been found that when the amount of reduction taken in the finishing die or the reduction die immediately following the shaving tool is about 4 percent or greater, the "barberpoling" or instability in the shaving operation is substantially completely eliminated independently of the many other variables which have been heretofore discussed.

It has been found further that the described instability can also be substantially eliminated with reductions of less than 4 percent in the finishing die when the amount of reduction is related to the distance between the guide or lead die and the shaving tool whereby one is dependent upon the other to eliminate "barberpoling." More specifically, it has been found that when the lead die to shaving tool distance is 0.15 inch or less, and up to 1 inch, stability in the cutting operation can be achieved with reductions less than 4 percent down to as low as 1.5 percent thereby to cover the range of between 1.5 percent reduction to the 4 percent reduction at which the lead die to cutter distance is no longer critical. At reductions of less than 1.5 percent in the finishing die, "barberpoling" continues to be experienced independent of various of the variables heretofore described.

The foregoing is illustrated by the curve shown in FIG. 4 of the drawings. The data charted in FIG. 4 was made with coils of MXB-1113 steel. The coil was reduced from $2\frac{1}{32}$ inch diameter, hot rolled size, to $1\frac{3}{32}$ inch diameter in a die-cutter-die arrangement of the type illustrated in FIG. 1. A lubricant of the type described in the aforementioned Patent No. 3,055,102, at 900 p.s.i. pressure was used with a coil speed of 190 feet per minute. A shaving tool having a rake angle of 13° was employed throughout the experiments. The shaving tool to lead die distance was varied up to 2.2 inches and the amount of reduction taken in the finishing die was varied from 1.3 to 6.5 percent.

It will be seen from the data that "barberpoling" was experienced under all conditions when the reduction taken in the finishing die was less than about 1.5 percent. Between 1.5 percent to 2 percent and about 4 percent reduction, "barberpoling" was materially reduced or substantially eliminated only when the lead die to shaving tool distance was less than about 1.5 to 1.6 inches. When the amount of reduction taken in the finishing die was greater than 4 percent, cutting was achieved without "barberpoling" independent of the distance between the lead die and the shaving tool, all independent of the rake angle of the shaving tool and substantially independent of many of the other variables heretofore discussed.

While the following is not concerned primarily with stability of the cutting operation as the steel is advanced through the shaving tool, it has been found that the amount of reduction taken in the lead die 14 bears upon the successful use of the shaving technique and on maximizing the physical and mechanical properties of the steel that is produced.

To the present, the lead die has been employed chiefly as a guide means for aligning the steel with the shaving tool for advancement of the steel in a centered relationship. For such purposes, it has been deemed to be sufficient to exert such pressures during passage of the steel

through the lead die as might result in a possible reduction of as much as 1 percent.

It has been found that use of the lead die as a reduction die in advance of the shaving tool operates materially to improve the shaving operation as well as the metallurgical process. In accordance with this further concept of this invention, it is desirable to make use of the lead die to take a reduction in an amount whereby the steel issuing from the lead die will have a center to surface distance or radius no greater than the minimum center to surface distance or radius of the steel fed into the lead die. Thus, any out-of-roundness, kinks, or other deviations in surface contour of the steel fed into the system will be substantially completely obviated by the lead die thereby to provide for the feed into the shaving tool of a steel of uniform and constant cross-section. In round bars or rods, the amount of reduction taken in the lead die can more specifically be defined as the difference between the maximum and minimum radii of the steel or the out-of-roundness of the steel. Very often the deviation will greatly exceed the 1 percent or less reduction heretofore taken by the lead die whereby the steel that would be fed to the shaving tool would have portions of various cross-sections. This would operate to vary the thickness of the chip removed by the cutter and thereby initiate instability in the cutting operation. This would also operate sometimes to feed steel to the cutter wherein the amount of variation exceeds the depth of cut whereby portions of the steel surface would therefore not be engaged by the cutter to leave imperfections in the steel surface intended to be removed by the cutter prior to feeding to the finishing die. By the practice of this invention to take an amount of reduction which will eliminate such undesirable characteristics, greater stability is achieved in the cutting operation; the chip that is removed by the cutter will be substantially uniform all around thereby to insure the removal of surface metal from the entire surface of the work; and the steel which is fed to the finishing die will uniformly present fresh steel from which impurities and imperfections have been removed during the cutting operation thereby to insure a product having more uniform and improved physical and mechanical properties.

It will be understood that the amount of reduction taken in the lead die will depend upon the maximum deviation in the contour of the feed stock but, for best practice, it is desirable to take a reduction which exceeds 3 percent and preferably 5 percent. It is undesirable to take a reduction in the lead die which exceeds 15 to 20 percent.

It will be apparent from the foregoing that the process

of surface metal removal and reduction is markedly improved by maintaining certain critical conditions with respect to the amount of reductions that are taken in both the lead die and finishing die and, in some instances, the spaced relationship existing between the lead die and the shaving tool whereby greater stability is achieved during the cutting operation and whereby an improved product is secured.

It will be further understood that other changes in the details of construction, arrangement, and operation may be made without departing from the spirit of the invention, especially as defined in the following claims.

I claim:

1. A process for finishing work in the form of steel bars and rods of repeating cross section throughout their lengths by the steps of passing the work through a lead die wherein a reduction in cross section is taken, passing the work through a shaving tool in axial alignment with the lead die which operates to cut off metal from the surface of the work, and passing the work through a finishing die in axial alignment with the lead die and the shaving tool and in which a final reduction in cross section is taken of the shaved work, the improvement in which the amount of reduction taken in the lead die is at least equal to the differences between the surfaces of the work and the center and in which barberpoling is eliminated during the processing of the steel bars and rods by increasing the amount of reduction taken in the finishing die until barber poling no longer takes place, and in which the amount of reduction taken in the finishing die is at least 4 percent of the cross section of the original work.

2. The finishing process as claimed in claim 1 in which the reduction is taken in the finishing die by drawing the work therethrough.

3. The finishing process as claimed in claim 1 in which the reduction is taken in the finishing die by extruding the work therethrough.

4. The finishing process as claimed in claim 1 in which the amount of reduction taken in the lead die is more than 3% but less than 15%.

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