United States Patent [19]

Staskiewicz et al.

[11] **3,780,552**

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[54] **APPARATUS FOR CONDITIONING CONTINUOUSLY CAST BARS**

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[21] Appl. No.: **134,888**

Related U.S. Application Data

[63] Continuation of Ser. No. 733,605, May 31, 1968, abandoned.

[52] **U.S. Cl.** **72/40,** 164/70, 164/263

[51] **Int. Cl.**... **B21b 45/02,** B21b 45/04, B22d 11/12

[58] **Field of Search** 29/527.5, 527.6, 29/527.7; 72/39, 40; 164/70, 87, 263, 278

[56] **References Cited**

UNITED STATES PATENTS

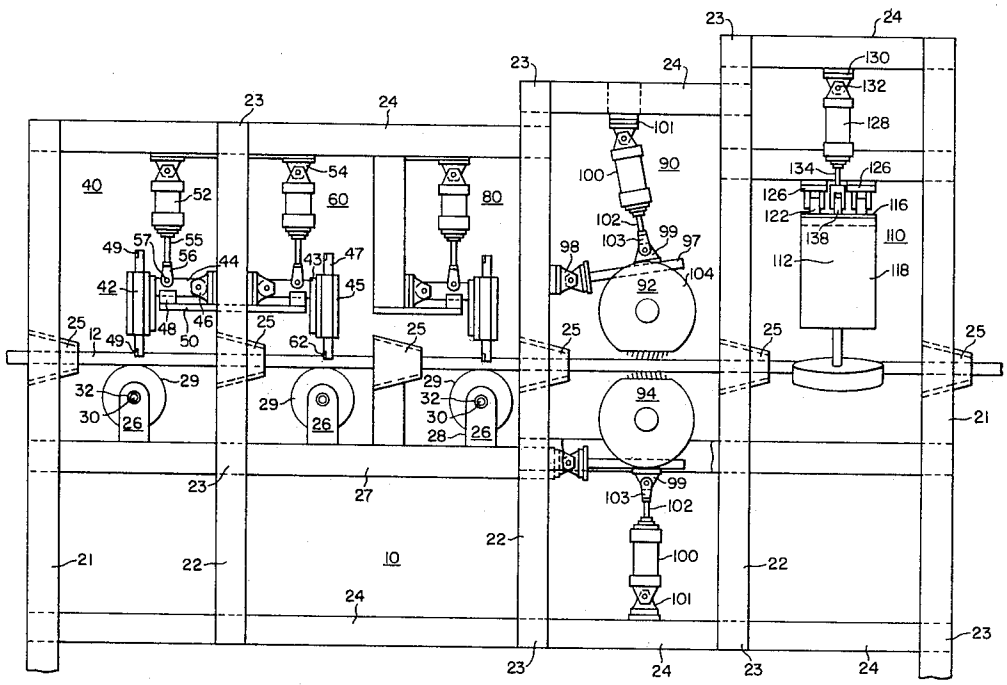
1,317,714	10/1919	Locke	72/40
2,045,277	6/1936	Lindner	29/527.6
2,680,938	6/1954	Peterson	72/39
3,331,123	7/1967	Cofer	164/70
3,336,778	8/1967	Follrath	72/39
3,469,620	9/1969	Ward et al.	164/70
3,479,852	11/1969	Conrad et al.	72/40
3,492,918	2/1970	Michelson	164/70
3,503,161	3/1970	Long	164/263
359,348	3/1887	Daniels	164/263

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[57] **ABSTRACT**

Apparatus is disclosed for conditioning a continuously cast bar particularly of the type formed employing a continuous casting wheel and a belt, and includes a plurality of working stations which form in the bar chamfered corners which are thereafter formed into a radius and the surface of the bar is conditioned prior to hot working.

12 Claims, 8 Drawing Figures



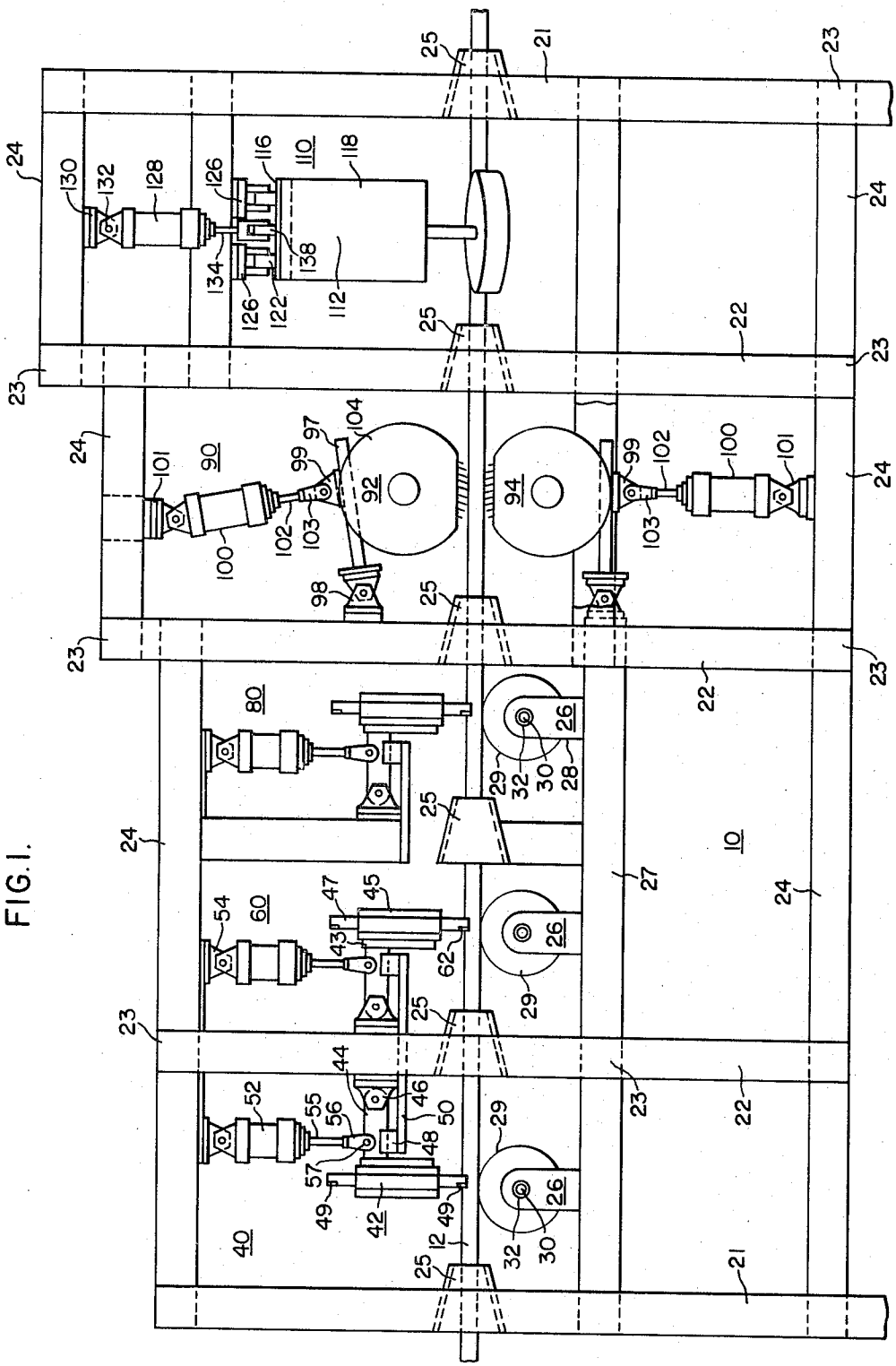

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FIG. 1.

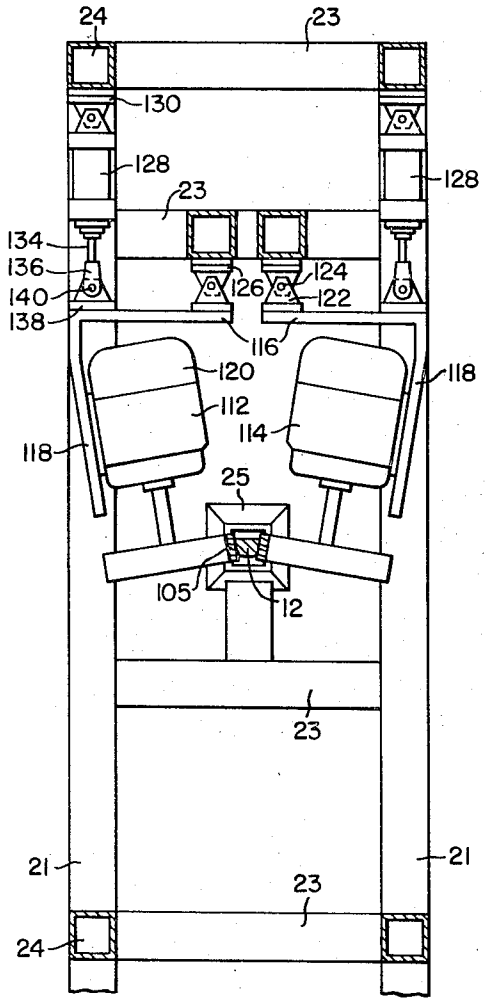


FIG.2.

FIG.3.

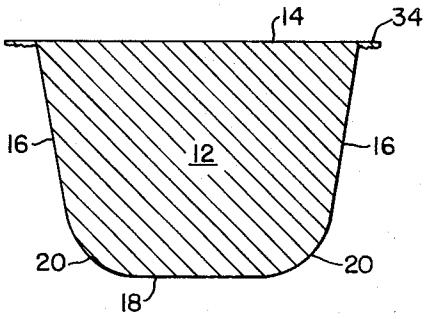


FIG.4.

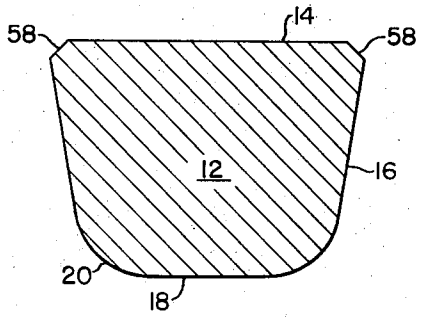
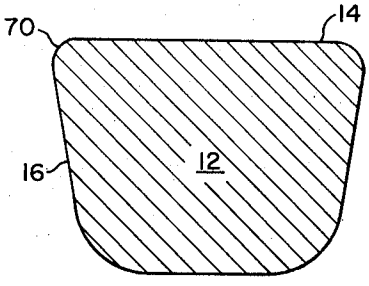


FIG.5.



WITNESSES

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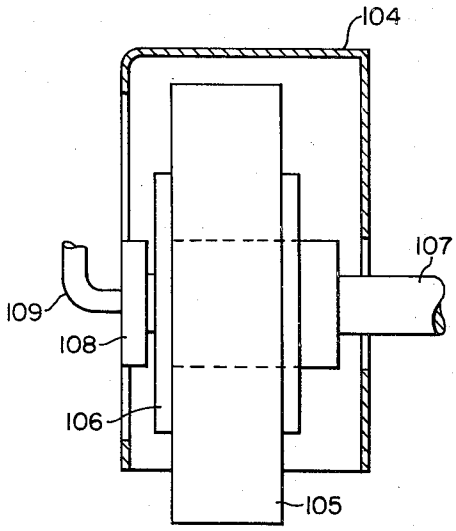
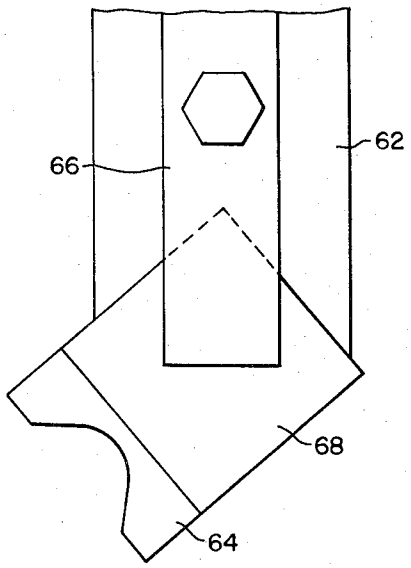


FIG.8.

FIG.6.



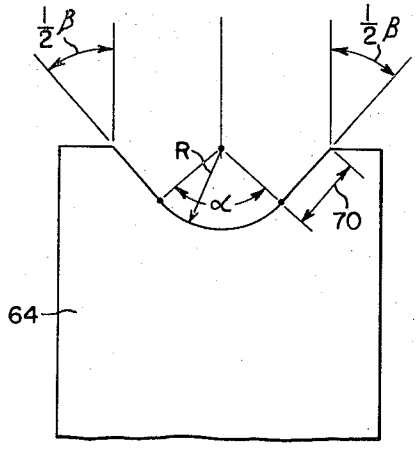


FIG.7.

APPARATUS FOR CONDITIONING CONTINUOUSLY CAST BARS

This application is a continuation of Ser. No. 733,605, filed May 31, 1968, now abandoned.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to apparatus which is disposed intermediate hot working apparatus and a continuous casting machine of the type in which the continuously cast bar is formed in a rotating wheel having a metal casting groove against which a flexible belt is disposed in close engagement. It will be appreciated that when continuously casting copper bar, for example, employing a wheel mold and a continuously moving belt which is disposed in seating engagement with the outer periphery of the wheel, close seating engagement of the moving belt with the moving wheel in which the metal is being continuously cast is not always possible. As a result thereof the cast bar as it emerges from the casting wheel may be characterized by having flashing at the edges where the belt meets the wheel. It becomes important to remove such flashing and other defects which can adversely affect the ultimate quality of the roller product being produced. This is especially true when continuously casting copper for the ultimate production of magnet quality wire. In this instance the continuously cast bar is directly hot worked into rod form without any intermediate reheating. Consequently, the continuously cast bar must be in condition prior to hot working in order to remove such "flashing," "scabs," "surface scale" or such other defects as may be rolled into the material, otherwise the defects would adversely affect the same and in some cases resulting in the necessity for scrapping large amounts of the finally produced wire. In addition thereto, any thermal cracking or casting voids which might occur are usually located at the corners of the top surface of the bar and such cracks should be removed in order to provide a uniform surface for subsequent satisfactory hot rolling. Moreover, because of the geometry of the cross-sectional area of the bar resulting from the continuous casting employing a grooved wheel and a flexible belt, the solidified bar emerges with sharp corners at the intersection of the side walls and the surface formed by contact with the belt. Since hot working to rod form involves the alternate formation of "rounds" and "ovals," the sharp corners of the bar can be folded over resulting in cold sheets, slivers and seams, either with or without entrapped scale, with the result that a poor quality product is produced.

SUMMARY OF THE INVENTION

The present invention relates to an apparatus which is disposed intermediate hot working apparatus a continuous casting machine which employs a grooved continuous casting wheel and a flexible belt capable of closing the top of the groove, thus providing a bar which has a substantially flat top surface, a pair of vertical inwardly tapering side walls and a substantially flat bottom surface, the flat bottom surface and the substantially inwardly tapering vertical side walls being joined by a smooth radius therebetween. Such casting wheels are shown in U.S. Pat. Nos. 3,322,184; 3,279,000 and 2,865,067. Such bar conditioning apparatus is disposed intermediate said continuous casting machine and a hot working rolling apparatus and it is

contemplated that the hot working apparatus will take the continuously cast bar which is conditioned by the apparatus of the present invention and hot work the same without any intermediate reheating, and said hot working commencing before the average temperature of the metal bar drops below 1,600° F. for copper.

The bar as it is delivered from the continuous casting machine is directed by means of guides to a first station of the bar conditioning apparatus which comprises means for supporting said bar and chamfering means which are deployed above the flat top surface of the bar and which when lowered into functioning contact with the bar provides a chamfered edge between the flat top surface and the vertically extending inwardly tapering side walls of the bar. The chamfered bar is next conveyed through guides to a radiusing station, said radiusing station including means for supporting the bar for movement through said station and a tool disposed thereat which tool is provided with a radiusing cutting means of predetermined geometry. The radiusing station is effective for producing a smooth radius whereby the flat top surface and the vertically extending inwardly tapering side walls are joined by means of a smooth radius therebetween.

After the bar has been given a smooth radius it is conveyed through additional guide means to a surface conditioning unit which in the present embodiment comprises two operations. The first operation comprises at least one pair of opposed wire brushes which are disposed on a horizontal axis on opposite sides, namely at the flat top and at the bottom surface of the moving bar and are rotated in such a manner as to remove mechanically all oxide, chips, scale, slivers, and similar defects from these surfaces of the bar. Each of the wire brushes is equipped for fluid coolant to be flowed therethrough for the purpose of aiding in the brushing action, removing the brushed or loosened scale and other defects and for effectively cooling the brushes thereby prolonging the life. The second operation comprises at least one pair of generally vertical axially depending brushes which are disposed on opposite sides of the moving bar and are inclined at a predetermined angle so that said wire brushes tangentially contact the vertically extending inwardly tapering side walls in a substantially line contact fashion. Thus, the maximum surface will be contacted by the wire brushes which are also fluid cooled and dispense the fluid in the same manner as the horizontally disposed brushes. As a result thereof the bar is provided with smooth radii at each of the intersections of the top and bottom surface with the vertically extending inwardly tapering side walls and all flat surfaces namely the top surface, the bottom surface and the vertical side walls are conditioned by mechanically removing superficial defects therefrom prior to the bar entering the hot working apparatus.

It is an object of the present invention to condition a continuous cast bar prior to hot working the same.

Another object of the present invention is to provide a means whereby a continuously cast bar may have all of the surface defects removed and all sharp intersections changed to a smooth radius prior to hot working the same.

A more specific object of the present invention is to provide apparatus in which the intersection between the flat top and vertically extending side walls of a continuously cast bar may be chamfered and thereafter

given a smooth radius and the entire surface mechanically cleaned prior to hot working the same.

Another more specific object of the present invention is to provide an apparatus whereby a plurality of stations are disposed in tandem for continuously chamfering, radiusing and mechanically brushing the surface of a continuously cast bar prior to hot working the same without any intermediate reheating, said chamfering, radiusing and surface brushing being accomplished before the temperature of the metal drops to below 1,600° F.

An additional more specific object of the present invention is to provide apparatus for chamfering, radiusing and conditioning of continuously cast bar stock which apparatus will accommodate vertical movement within limits from the pass line without loss of function of the apparatus.

Other objects of the present invention will become apparent to those skilled in the art when taken in conjunction with the following drawings in which:

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view in elevation of the bar conditioning apparatus of the present invention illustrating the several stations for accomplishing the foregoing objectives;

FIG. 2 is a right-hand end view of the apparatus of FIG. 1;

FIG. 3 is a cross-sectional view of the shape of a continuously cast bar, said bar being continuously cast in a grooved wheel having a flexible belt disposed in seating engagement thereover;

FIG. 4 is a view in section of the bar of FIG. 2 after the bar has passed the chamfering station;

FIG. 5 is a view of the bar as the same appears after having a radius applied to the chamfered corners thereof;

FIG. 6 is a partial view of the tool by which the radiusing of the bar corners is accomplished;

FIG. 7 is an enlarged view of the cutting insert of FIG. 6 illustrating the angular relationships therebetween; and

FIG. 8 is a view of the arbor and guard of the horizontal and vertical surfacing stations.

DESCRIPTION OF PREFERRED EMBODIMENT

Referring to the drawings and to FIG. 1 in particular there is illustrated a bar conditioning machine shown generally at **10** for conditioning a continuously cast bar **12** and which comprises a plurality of stations as will be more fully described. In the embodiment illustrated, it is preferred to have five independent stations, namely, a chamfer station **40**, a first radius station **60**, a second radius station **80**, a horizontal surface station **90** and a vertical surface station **110**. The bar conditioning machine **10** is designed for use in tandem with a continuous casting machine (not shown) and intermediate the continuous casting machine and hot working apparatus (not shown). The continuous casting machine produces the bar **12** having the general cross-sectional shape illustrated in FIG. 3 which includes flat top **14**, vertically extending inwardly tapering side walls **16**, base **18** and radius **20** connecting the base **18** with the side walls **16**. The inwardly tapering side walls **16** are sloped, preferably at an angle of about 9 ½°. This slope gives a bar included angle of 80½° as will be more fully explained. Since the bar conditioning machine is disposed in tandem between the continuous casting machine (not shown) and the hot working machine (not shown) and since the temperature of the metal being conditioned is between the hot working temperature and the melting point, the bar is quite plastic and requires close support and guidance. This support and guidance is preferably carried on the framework of the present apparatus. Accordingly, the bar conditioning machine **10** is provided with a framework which includes forward and rear vertical end supports **21** preferably secured to the foundation, a plurality of intermediate vertically extending supports **22**, cross braces **23** disposed between the vertical supports **21** and **22** and horizontal braces **24** disposed between the various vertical supports **21** and **22** both forward and rear. While another scheme of framework will suffice, the above-described has proved adequate for the needs of the present components of the bar conditioning machine.

It will be appreciated that because of the geometry of the cast bar **12** as well as the various differential stresses imparted to the bar **12** during the continuous casting and conveyance to the bar conditioning machine **10** in addition to its plastic nature, the bar **12** will not always assume a perfect pass line orientation. In order to compensate therefor, the framework is also provided with a plurality of guides **25** which preferably assume the configuration of a hollow truncated pyramid. Each of the guides **25** is secured to the framework before each station and functions to minimize deviation from the preferred pass line during threading of the bar. Once the bar is threaded through and into the hot working apparatus, the tension exerted on the bar is usually sufficient to minimize deviations from the pass line consequently the guides **25** perform their most useful function only during threading. While other guide means can be employed the foregoing is illustrative only.

The bar conditioning machine **10** of the present invention prepares the continuously cast bar **12** for hot working. Accordingly, the bar **12** is quite plastic since it is at a temperature between the hot working temperature and the temperature of the molten metal, requiring close support for any conditioning operation. This support is provided by a plurality of roll supports shown generally at **26** disposed along the pass line and secured to the framework by means of frame support **27** secured to cross brace **23**. More particularly, the roll support **26** comprises a yoke **28** secured to the frame support **27**, roll member **29** carried by the yoke **28** and secured for rotational movement by means of axle **30** anchored in the yoke **28**. Also included within the structure is bearing **32** for minimizing slippage due to inertia between roll member **29** and bar **12**. The roll supports **26** are positioned along the frame support **27** so that the thrust line of the various stations passes through the center of axle **30**. In addition thereto, the roll supports **26** also provide the lower limiting gauge for the bar **12** being conditioned as will be described more fully hereinafter.

As previously stated it is desirable to condition the bar **12** prior to any hot working being performed. This results from the fact that during the continuous casting of the bar, imperfect fit and sealing of the flexible steel belt with the casting wheel results in the formation of flash **34** as shown in FIG. 3. In addition since the flat top **14** is the first surface to solidify release agents and other impurities may become entrapped. Moreover,

because of the chilling effect of the exterior surfaces differential thermal stresses may be induced and some corner cracking may occur at the intersection of flat top **14** and side walls **16.** Therefore, it is preferred to remove said defects prior to hot working. Moreover, since the intersection of flat top **14** and vertical walls **16** is quite sharp, there is a pronounced tendency to "fold-over" the edge and unless the surface was exceedingly clean and protected, surface contaminants are worked into the bar destroying the quality of the product thus produced. Such fold-over is produced by hot rolling the initial configuration into the form of an oval first and thereafter rolling into a round and a subsequent series of ovals and interspaced rounds. These discrepancies can be eliminated by providing the corners of the bar **12** with a prescribed radius and surface brushing the bar prior to hot working.

In the embodiment of FIG. **1** the bar **12** is illustrated as moving through the bar conditioning machine **10** in a direction from let to right. Since bar guide **25** carried by the framework leads bar **12** to roll support **26** it engages the chamfering station shown generally at **40.** Chamfering station **40** comprises tool holder shown generally at **42** carried by arm **44** which is supported for pivotal movement within bracket **46,** bottom stop **48** carried by horizontal member **50** secured to the framework, and elevation means **52** connected at one end to arm **44** at a predetermined position between tool holder **42** and bracket **46** and carried at the other end by actuation bracket **54** secured to the framework for selectively raising and lowering the tool holder **42** into and out of engagement with the bar **12.** Preferably, the elevation means **52** is a pneumatically actuated double acting cylinder in which the piston rod **55** terminates in swivel bracket **56** which is pivotally secured to arm **44** by means of pin **57.**

Since the tool holder of first radius station **60** is a mirror image of the tool holder **42** of chamfering station **40,** the tool holder **42** will be described with respect to the first radius station **60.** The tool holder **42** comprises an anchor plate **43** which is secured to arm **44,** for example, by welding, a substantially H-shaped receiver **45** which is mounted for indexing movement on the anchor plate **43** and a plurality of chamfering tools **47** removably secured in the receiver **45.** In the embodiment illustrated, the receiver **45** is indexable at 180° positions apart from one another. It will be appreciated that if the receiver **45** is replaced by a turret any number of indexing positions may be utilized and such is contemplated herein.

The chamfering tools **47** are disposed for seating engagement in the recess (not shown) formed by the flanges and web of the H-shaped receiver **45** and each tool is secured therein in any well known manner, for example, by bolting. Preferably the tool **47** will have a special cutting insert **49** which is also preferably indexable. The aspect of having the cutting insert **49** as well as the receiver **45** indexable permits rapid tool change without interrupting the conditioning operation. Thus, both tools and inserts can be indexed and replaced without stopping the operation. This becomes important when it is realized that tool wear could be excessive since the conditioning is performed at temperatures in excess of 1,600° F. Good life of the cutting insert **49** has been obtained when the cutting insert is made from a high temperature alloy, tool for example, cobalt-chromium-tungsten alloy containing high amounts of carbon together with iron, manganese and tantalum/columbium, such as Tantung "G" manufactured by VR Wesson. This alloy bridges the gap between the high speed tool steels and the cemented carbides. Other equally suitable alloys are well known and can be employed.

It will be appreciated that the chamfer tool **47** may be inclined laterally at any desirable angle to provide the necessary clearance; however, it is preferred not to incline the tool from the direction normal to the direction of bar travel so that the cutting insert **49** at the leading edge thereof coincides with the center of axle **30** of the roll support **26** to thereby establish the proper depth of cut. Moreover, by maintaining a predetermined pressure on the elevation means **52** and rigidly securing the chamfering tools **47** within receiver **45** oscillations from the pass line are minimized.

In addition it is preferred to use regulators (not shown) on each side of a piston (not shown) contained in elevation means **52.** These regulators are preferably of the relieving type which can be adjusted to provide a constant pneumatic pressure and thereby a constant force to the cylinder **52** so that when the bar **12** deviates from the pass line on a vertical axis the tool will follow the bar **12** in said deviation without losing its function. It will of course be appreciated that the roll support **26** limits the downward deviation from the pass line and the lateral movement is limited by each of the tools **47** disposed on each side of the bar **12.** The upward movement along the vertical axis is limited by the stroke of the piston contained in cylinder **52.** Such relieving regulators are well known in the art (see, for example, RO_2 Pressure Regulators manufactured by the Gall Corporation).

In the embodiment illustrated, the elevation means **52** is provided with said regulators in the chamfering station **40** and each of the radiusing stations **60** and **80** are similarly equipped with respect to the elevation means of each of said stations. The horizontal surfacing station **90** and the vertical surfacing station **110** are provided with similar pressure regulators to the top and bottom units and the left and right units, respectively. The actual pressure asserted by each unit can be regulated by controlling the amount of current drawn by the field coils of motors of each unit. Thus the horizontal surfacing station **90** and the vertical surfacing station **110** can accommodate deviations from the pass line without losing their function.

The cutting insert **49** is preferably formed in the conventional manner to provide for a 45° chamfer from the surface of the bar flat top **14.** Referring to FIG. **4** there is illustrated a view in cross-section of the bar **12** as it emerges from the chamferring station **40.** Any flash **34** or cracks at the intersection between bar flat top **14** and side walls **16** are removed and said surfaces are joined by chamfer edge **58** in the manner shown.

Upon emerging from the chamfer station **40,** the bar **12** having the configuration illustrated in FIG. **5** is directed through the second guide **25** to first radius station shown generally at **60.** Since the first radius station is a mirror image of chamfer station **40** its individual components will not be described in detail, except for the radius tool **62** shown in partial view of FIG. **6.** In FIG. **6** there is illustrated tool **62** having radius cutting insert **64** secured thereto by means of clamping member **66.** Preferably a chip breaker **68** is interposed between the clamping member **66** and the insert **64.** In

order to provide the bar **12** with the proper rounded corners, the geometry of the radius cutting edge becomes significant. In FIG. **7** the cutting insert **64** is illustrated with a true radius within the angle α which extends to a predetermined depth from the leading edge of the insert. In practice it has been found that optimum results are obtained when the maximum radius R is between 5/32 and 3/16 inch. Since the overall bar geometry includes a bar included angle of 80 ½° and is between 5/32 and 3/16 inch in radius the included angle α extends 80½°. However, with a bar included angle 60 of 80½° it becomes necessary in order to prevent gouging of the flat top **14** surface and/or the vertical walls **16** to provide a terminal portion **70** on each side of the angle α of the radius cutting insert **64** and such terminal portion **70** is provided with a relief angle of about 0° 45″ so the angle formed by the extension of the relief angle of the terminal portion **70** and a line parallel to the bisector of the angle α will provide an included angle 1/2 βor about 41°. Thus with the total angular relationship of the 1/2 β and 1/2 β providing an angle of about 82°, no gouging occurs. This angle β is referred to herein as the tool included angle. It will be apparent that with the foregoing geometry, the cutting insert **64** will provide a smooth radius to the bar **12** will have sufficient relief angle to prevent gouging yet maintain sufficient proximity to remove chips from the area. Thus, upon emerging from the first radius station **60** the bar **12** will have the configuration shown in FIG. **5** wherein the flat top **14** is joined to the vertical side wall **16** by the smooth radius **70** which resulted from the transformation of chamfered edge **58** of FIG. **4.**

Since the bar **12** must be conditioned and delivered for entry into the hot working apparatus before the temperature drops to about 1,625° F. it will be realized that the bar **12** is in a highly plastic condition. Accordingly, some difficulty may be encountered in chip breaking at chamfering station **40** and first radius station **60.** As a result, the idealized configuration to the cross-section of the bar **12** as illustrated in FIG. **5** may not always be obtained. Furthermore, deviations from the pass line are minimized by the working forces at chamfer station **40** and first radius station **60.** Therefore, in order to approximate the closest approach to the idealized configuration of FIG. **5,** it is preferred to subject the bar **12** to a second radius station **80** which is identical with first radius station **60.** The second radius station **80** has the same components, actuation mechanism, supports and guidance so that its description is unnecessary. As the bar **12** emerges from second radius station it will have the configuration nearest to that illustrated in FIG. **5.**

The reason for conditioning the bar **12** is to prevent the entrapment of material which would adversely affect the chemical, physical, mechanical and electrical properties of the material being produced, in the present embodiment — magnet quality wire. In this respect, perhaps oxide scale or surface contaminants provide the major source of concern. Accordingly, it appears desirable to remove the same from all surfaces prior to hot working. In order to accomplish this the bar **12** with its corners having been provided with a smooth radius is directed through another guide **25** to the horizontal surface station shown generally at **90.** The horizontal surfacing station **90** comprises a top unit **92** and a bottom unit **94** each unit being substantially a mirror image of the other. The top unit **92** comprises a platform **97** having one end pivotally mounted in bracket **98** secured to the cross brace **23** on the vertical intermediate support **22.** The platform **97** is also provided with a pivot bracket **99** to which an actuating cylinder **100** is attached, that is, the actuating cylinder **100** is carried for pivotal movement on anchor bracket **101** and a piston rod **102** of actuating cylinder **100** terminates in eye bracket **103** which is pinned to bracket **99.** The platform **97** also serves as the base to which the motor (not shown with respect to horizontal surfacing station **90** but quite similar to the motor to be described with respect to vertical surface station **110**) is secured in any well known manner. Referring to FIG. **8,** there is illustrated the shaft **107** of the motor (not shown) and keyed thereto is the arbor **106** to which wire wheel **105** is secured for rotating movement thereon. The wire wheel **105** is also provided with a guard **104** that partially encloses wire wheel **105.** The guard **104** is also provided with an opening into which the end plate **108** of the arbor **106** is secured. a coupling **109** is disposed within the end plate **108** and is connected to a source (not shown) of a cutting cooling fluid which is conveyed to the central point of the arbor **106** for metering to the wire wheel **105.** By supplying a fluid coolant in the manner described, the life of the wire brush **105** is enhanced and the coolant aids in removing the surface contaminants. It will be appreciated that the rate of delivery of fluid coolant must be limited so that the surface of the bar **12** is not chilled to below about 1,600° F. for copper when the bar enters the hot working apparatus.

With the top and bottom surfaces of the bar mechanically conditioned, the bar **12** enters guide **25** and is conveyed to vertical surfacing station **110** which is structurally similar to the horizontal surfacing station **90** described hereinbefore. Referring more particularly to FIG. **2** there is illustrated a left unit **112** and a right unit **114** which are substantially mirror images and each unit is carried by the framework **116–118** for movement into and out of engagement with the bar **12.** More particularly, each of the units **112** and **114** comprise a horizontal platform **116** with a downwardly depending, inwardly inclined anchor plate **118** on which is secured a motor **120** similar to that construction described hereinbefore with respect to the horizontal conditioning unit **90.** The horizontal plate **116** is provided at the inward portion thereof with upwardly extending brackets **122** which are secured for pivotal movement by pins **124** in yoke **126** anchored to the framework. The opposite end of the platform **116** provides the point for the attachment of the actuation mechanism which comprises cylinder **128** having one end thereof secured for pivotal movement to the framework by means of anchor bracket **130** and pin **132** and having a piston rod **134** depending from the other end of said cylinder, said piston rod **134** terminating in a fork bracket **136** which is secured to another anchor bracket **138** by means of pin **140.** The motor **120** is provided with a shaft **142** (**107** in FIG. **8**) which is keyed to the arbor **106** in the same manner as the horizontal surfacing station and is in all terms identical with the arbor **106,** wire wheel **105,** guard **104** and the balance of the structure which performs the horizontal surfacing.

Since the vertical side walls **16** of the bar **12** have a taper of about 9½° from the vertical, the downward depending anchor plate is provided with a similar taper so

that when the piston rod **134** is actuated to cause horizontal plate **116** to move downwardly and is pivoted about pin **124,** the outer periphery of wire wheel **105** engages the entire surface of the vertical wall **16** to remove scale and other surface contaminants which would detrimentally affect the quality of the product.

OPERATION

The bar **12** in the form shown in FIG. **3** is conveyed 0to the chamfering station shown generally at **40** by means of guide **25.** The bar **12** is supported for continuous movement along the pass line by means of the upwardly extending roll support means **26** to which the roll member **29** is attached for rotating movement within the yoke **28.** In line with the roll supporting means **26** the cylinder **52** is actuated driving the piston rod **55** in a downward direction a predetermined distance until the chamfering tool **42** engages the upper portion of the vertically extending side wall **16** of the bar **12.** Since the cylinder **52** is designed to operate at a preset pressure any undue bending in the bar will force the tool upwardly and tend to straighten the bar between the tool **42** and the roll support **26.** Since the tool **42** works on a predetermined pressure a predetermined chamfered corner **58** is cut between the flat top **14** and the vertically extending inwardly tapered side wall **16** at the initial chamfering station **40.** The bar next passes through the second guide member **25** to the first radius station **60** and the cylinder **52** of the station **60** is actuated thereby dropping the radiusing tool **42** to a predetermined height for engaging the chamfered surface **58** of the bar **12.** The cutting tool is provided with a geometry to accept the bar included angle of about 80° 30′, so that a smooth radius can be obtained on the chamfered portion **58** of the bar **12.** However, the included angle of the tool provides for an approximate 0° 45′′clearance from the angle α so that the overall tool included angle β will be 82° as is evident from FIG. **7.** Since the copper bar material of the continuous casting process is at an elevated temperature and does not cool to an average of below 1,600° F. during the entire conditioning thereof it will be appreciated that the bar is in a plastic condition. As a result it is preferred to have two radiusing stations in tandem with one another, the first station providing for a partial radiusing and the second station providing for a finish radiusing. In addition thereto, any chips that may be remaining from the chamfering operation must also be effectively removed from the bar prior to the commencement of the hot working operation. Accordingly, the bar from the first radiusing station is conducted through guide **25** to the second radius station **80** where the finish radiusing by a tool having the same geometry is applied to each side of the bar. Following the completion of the formation of a radius between the flat top **12** and the vertically extending inwardly depending side walls **16** as shown more clearly in FIG. **5** the bar is guided by means **25** to the horizontal surfacing station shown more clearly at **90.** The wire brushes **105** are rotated by means of motors and the cylinder **100** is actuated to bring and maintain the periphery of the wire brushes in contact with the flat top and the bottom surface of the bar **12.** Each of the cylinders **100** can be regulated so that a predetermined amperage is monitored on the motors driving the brushes and as such optimum mechanical conditioning to the top and bottom surfaces can be applied to the bar without unduly removing the same from the pass line through the apparatus. Upon the completion of the mechanical conditioning, the top and bottom surface the bar is conveyed through guide **25** to the vertical surfacing station **110** where cylinders **128** are actuated to drive wire brushes **105** into contact with the vertically extending side walls **16** of the bar **12.** The motors **120** are actuated and the pressure in cylinder **128** is regulated so that a predetermined amperage is maintained in the field coils of the motor thus obtaining optimum surface conditionoing. Since the wire brushes **105** are provided with a fluid coolant which is dispensed through flexible coupling **109** and arbor **106** to the perhipery of the wire brush **105,** the fluid coolant also acts to improve the efficiency of the conditioning operation and prolongs the brush life. Upon emerging from the vertical conditioning station the bar may be delivered directly to the hot working apparatus to produce a circular rod of an indeterminant length.

In the embodiment described, the bar which was continuously cast was provided with vertically extending inwardly tapering side walls which were described as having about a 9° 30′′ taper thereto. It will be appreciated that a different degree of taper can be provided to the bar and the overall apparatus of the present invention can be utilized with the proper change in cutting insert geometry to accommodate the different bar geometry. It is preferred however for copper bars to maintain the taper between 9° and 10°, although large deviations therefrom are also contemplated. Moreover, the cutting insert has been described as having 0° 45′′ relief angle and it will be appreciated that such relief angle can vary between 0° 30′′ to 1° 30′′ and greater, although it is preferred to maintain the same within the range stated.

For other metals such as aluminum, or copper base alloys, suitable changes in the apparatus and the processing conditions can be readily made.

It will be appreciated that various changes and modifications may be made in the foregoing apparatus without departing from the spirit of the present invention and as many changes may be made in the embodiments herein set forth it being understood that all matter described herein are to be interpreted as illustrative and not in a limiting sense.

We claim as our invention:

1. In bar conditioning apparatus, the combination comprising a first station including means for supporting a moving bar having a flat top surface, a relatively flat bottom surface and generally vertically extending side walls, the flat top surface and side walls meeting to form edges, and means for chamfering the edges of the moving bar, a second station in tandem with the first station and including means for supporting the moving bar and means for partially forming a predetermined radius on each chamfered edge of the bar, a third station in tandem with the second station and including bar supporting means and means for finish forming the radius and means in tandem with the third station for mechanically cleaning the surfaces of the bar before hot working the same.

2. The apparatus of claim **1** in which the mechanical cleaning of the surfaces of the bar is accomplished by means of a horizontal surfacing station and a vertical surfacing station, said horizontal surfacing station comprising a pair of opposed wire wheels each of which engages the flat top surface and the bottom surface of the

bar and the vertical surfacing station comprises a pair of opposed wire wheels each of which engages the vertical side walls of the bar.

3. The apparatus of claim **2** in which each of said wire wheels is fluid cooled.

4. The apparatus of claim **1** in which each radius is formed with a cutting insert which is provided with a tool included angle of between 81° and 83° 30'' and a bar included angle of about 80½°.

5. In bar conditioning apparatus disposed intermediate a continuous casting machine of the wheel and belt type to produce a bar and hot working apparatus for hot working the bar, said bar having a flat top surface, a relatively flat bottom surface and generally vertically extending side walls, the flat top surface and side walls meeting to form edges, the combination comprising, first means for supporting a hot continuously cast moving bar produced by the casting machine while chamfering the edges thereof, second means in tandem for supporting the chamferred bar while forming a radius on the chamfered edges, and third means in tandem for mechanically cleaning the surfaces of the moving bar before hot working the same.

6. The apparatus of claim **5** in which the radius on the chamfered edges is formed in two operations in tandem, the first operation comprising means for supporting the moving bar and means for partially forming a radius on the chamfered corners and the second operation comprising means for supporting said moving bar and means for finish forming said radius.

7. The apparatus of claim **5** in which the mechanical cleaning of the surfaces of the bar is accomplished by means of a horizontal surfacing station and a vertical surfacing station, said horizontal surfacing station comprising a pair of opposed wire brushes one of which engages the flat top surface and one of which engages the bottom surface of the bar, and the vertical surfacing station comprises a pair of opposed wire brushes disposed for movement toward one another on opposite sides of the vertical side walls of the bar.

8. The apparatus of claim **7** in which each wire brush is fluid cooled.

9. The apparatus of claim **5** in which the radius is formed by means of a tool having a tool included angle of about 82° and a bar included angle of about 80° 30''.

10. The apparatus of claim **7** in which the wire brushes of the vertical surfacing station are carried at an angle corresponding to the degree of inward taper of the vertical side walls of the bar for tangentially engaging said vertical side walls of the moving bar.

11. The apparatus of claim **5** in which the chamfering radiusing and cleaning means are adjustably mounted for the application of a substantially constant force thereto with respect to the moving bar to provide for bar deviation from a bar pass line while maintaining effective operative functioning.

12. The apparatus of claim **5** in which the cutting insert for forming the radius is provided with a tool included angle within the range between 81° and 83° 30'' and a bar included angle of about 80° 30''.

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