United States Patent

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[54] METHOD FOR COLD-ROLLING GRATING WORKSTOCK

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[51] Int. Cl. B21h 8/00

[58] Field of Search 72/184, 196, 197, 198, 190, 72/194; 29/160

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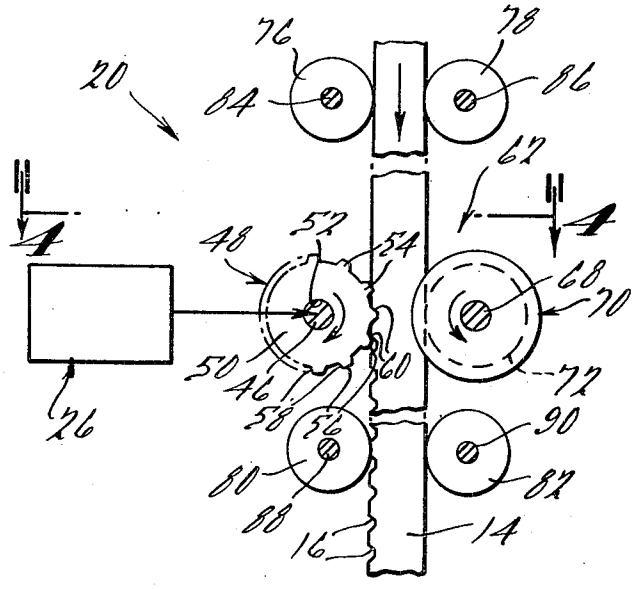
[57] ABSTRACT

A method of forming grating material from elongated, generally flat workstock, comprising the steps of cold-forming a series of adjacently oriented notches or recessed portions along at least one edge of the workstock by peripherally engaging a rotatable externally ribbed or toothed roller element with the workstock, and thereafter passing the workstock between a plurality of spaced rollers and thereby straightening and flattening the workstock, and finally cutting the workstock into preselected lengths preparatory to assembling the same into a unitized grate structure.

9 Claims, 8 Drawing Figures



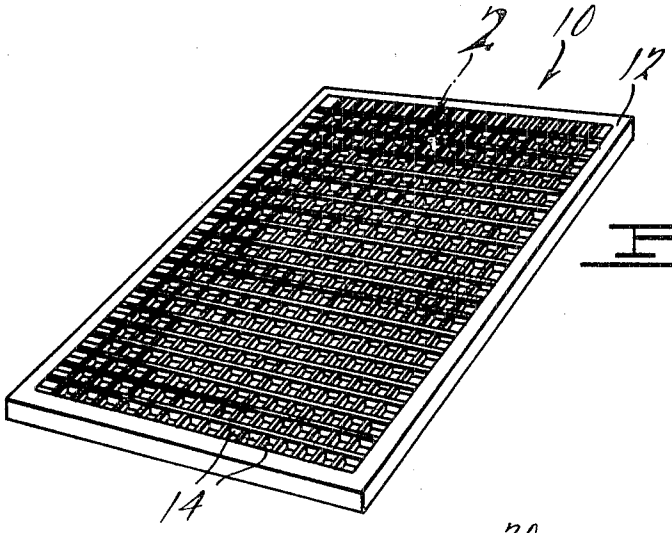


FIG. 1.

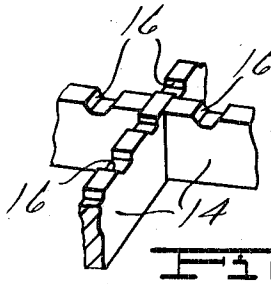


FIG. 2.

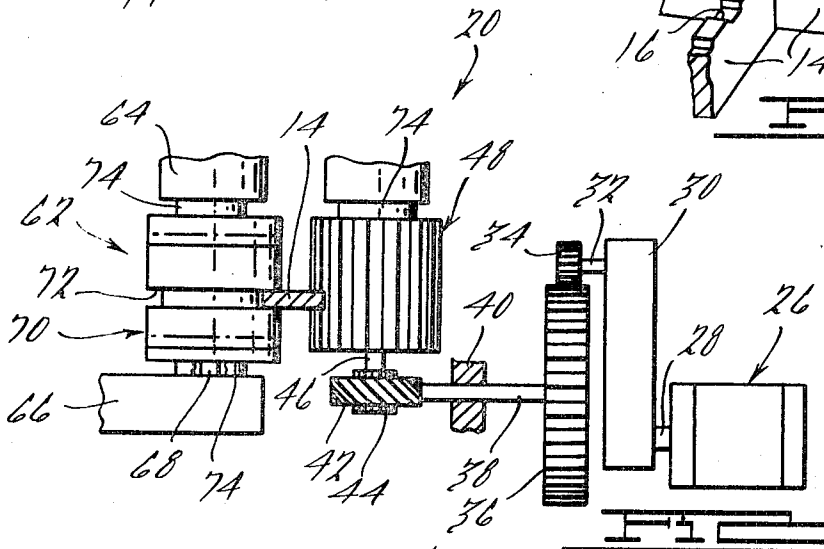


FIG. 3.

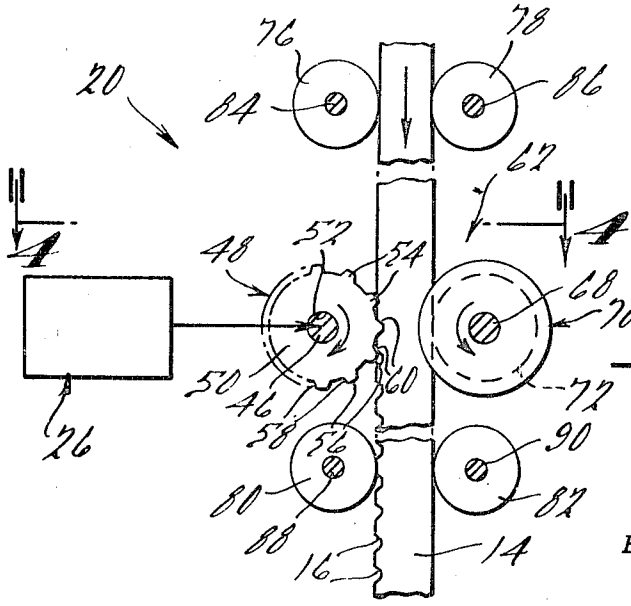


FIG. 4.

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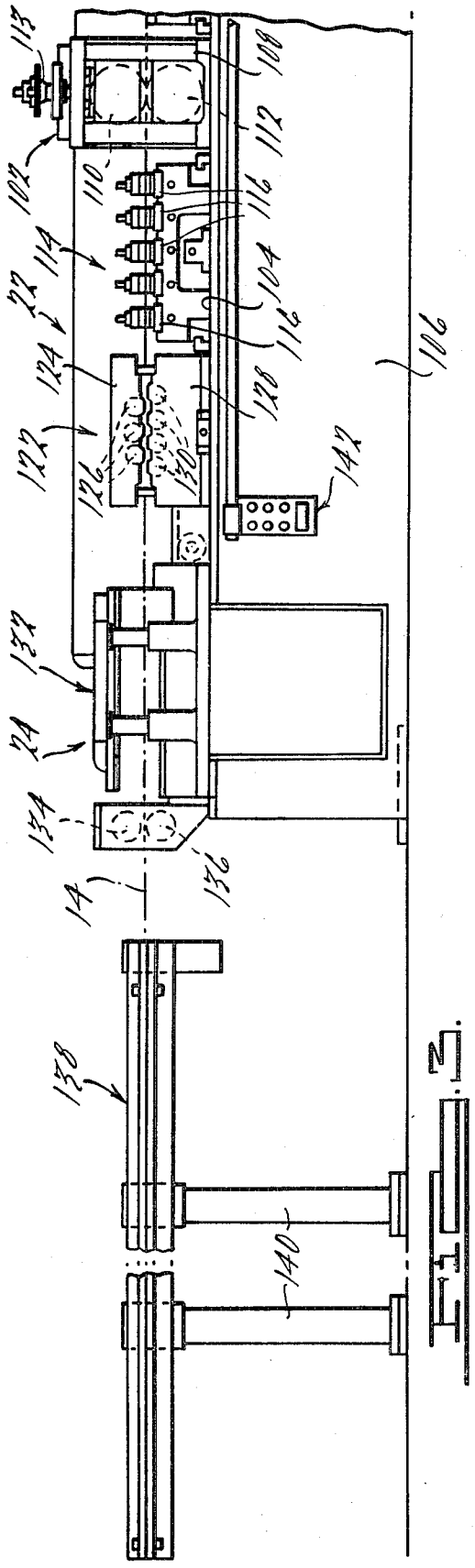

FIG. 2.

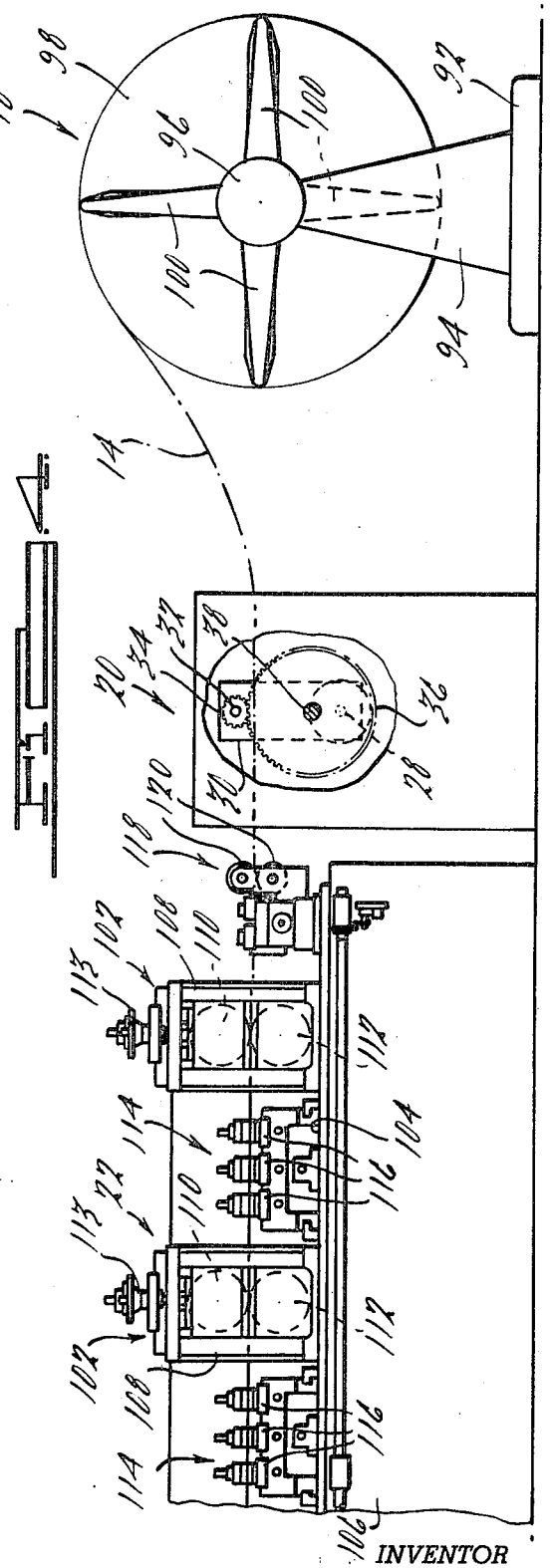

FIG. 1.

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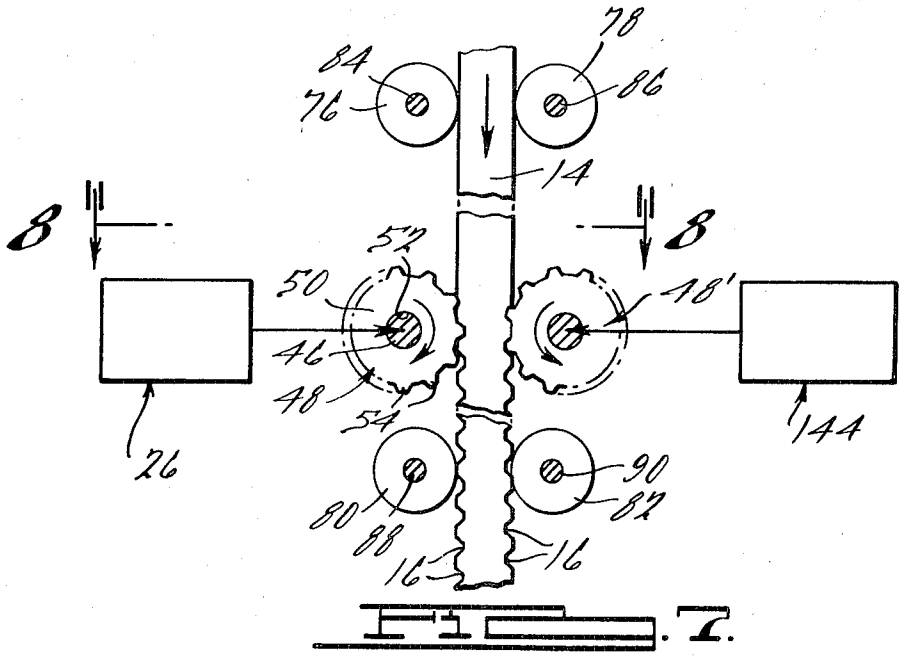

FIG. 7.

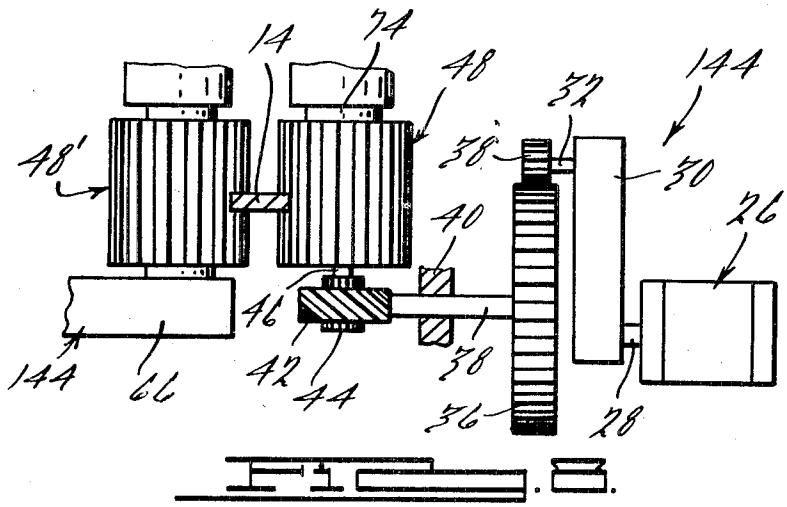

FIG. 8.

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METHOD FOR COLD-ROLLING GRATING WORKSTOCK

BACKGROUND OF THE INVENTION

Grating structures, such as are commonly utilized in fire escapes, sidewalk, and sewer grates, and the like, consist of a grid of spaced parallel metal strips arranged on edge and oriented such that a certain number of the strips are disposed at approximately right angles to others thereof, with any suitable joint being provided at the intersection of the series of strips. While such grating constructions have been found extremely useful for many applications, it has been found desirable to provide the upper sides thereof with a nonskid surface to minimize the possibility of a person inadvertently slipping or sliding thereon in the event water, ice, snow, or the like accumulates on the upper side of the grates. While a number of so-called nonskid surface designs have been heretofore proposed to obviate such slipping and/or sliding problems, it has been found that one of the most effective nonskid surfaces can be achieved by forming a series of notches or recessed portions along the upper edges of the strips making up a grating structure, which notches provide or define a plurality of biting edges arranged transversely of the strips and adapted to increase the frictional characteristics between the upper side of the structure and, for example, the sole of the shoe, boot or the like of a person walking thereon.

In order to provide the aforesaid notches or recessed portions in the striplike grating workstock which constitute the majority of grating structures, it has heretofore been the practice to pass preheated strips of workstock through or adjacent a reciprocating cutter or die which function to cut a series of longitudinally spaced notches or recesses in the material. While this procedure has been found to be the best available technique for forming the nonskid notches in the workstock, such a technique has been objectionable for a number of reasons. First of all, such a procedure produces vast quantities of metal chips which, for most purposes, are waste material that cause considerable problems in handling and disposition, to say nothing of the expenses involved in the wasted material itself. Another objectionable feature of the above described method of forming the notches or recesses in the grating workstock resides in the expenses involved in heating the workstock preparatory to subjecting the same to the reciprocating notch-forming die or cutting tool.

In accordance with the principles of the present invention, a new and improved apparatus is provided for forming grating material which is provided with the aforesaid nonskid notches or recessed portions along either one or both edges thereof. More particularly, the present invention utilizes a cold-rolling operation consisting of passing the strip grating material adjacent a rotatable tool having a plurality of circumferentially spaced, outwardly projecting portions adapted to be forced inwardly into the workstock and thereby form the notches or recessed portions therein, the workstock thereafter passing through an associated straightening and flattening means to remove any eccentricities or curvatures in the workstock that may be produced upon forming the notches therein. Such a cold-forming operation has been found to be a considerable advance over the above described practice of forming the notches by means of initially preheating the workstock and thereafter subjecting the same to the action of a reciprocating cutting tool or die, since the cold-forming technique entirely obviates the production of any metal chips, the ancillary problems of disposing of such chips, as well as the need for heating the workstock prior to forming the notches therein.

Certain additional advantages of the present invention reside in the fact that the notched or recessed grating workstock produced in accordance therewith will be found to be substantially stronger as a result of the cold-rolling operation, as compared with similar workstock that has heretofore been produced by initially heating the workstock and thereafter cutting the notches therein with a reciprocating tool. It is estimated that the structural integrity of the workstock is increased as much as 10–20 percent as a result of the cold-rolling operation, which permits the use of a smaller number of strips of grating material to support a given load per unit of area. Moreover, as a result of the cold-forming operation, the workstock has been found to be elongated as much as approximately 1 inch per foot, with the result that a given length of strip workstock will produce an even greater length of grating workstock as a result of the notches or recesses being formed therein pursuant to the teachings of the present invention. Additionally, the actual formation of the nonskid notches can be performed at a considerably fast rate than has been possible with heretofore known and used methods, thereby substantially increasing the production rate of such grating workstock.

SUMMARY OF THE INVENTION

This invention relates generally to a new and improved method of fabricating metal workstock, and more particularly, to a new and improved method of fabricating metal grating material.

It is accordingly a general object of the present invention to provide a new and improved method of forming grating workstock.

It is a more particular object of the present invention to provide a method of cold-rolling nonskid notches or recessed portions in grating workstock.

It is another object of the present invention to provide a method of the above character which includes the steps of forming the notches or recessed portions in the grating workstock by passing the workstock adjacent a rotatable element having outwardly extending projections adapted to be forced into the workstock and thereby form the nonskid notches or recesses therein.

It is a further object of the present invention to provide a method of the above character which includes the steps of forming the series of nonskid notches or recessed portions simultaneously along the opposite edges of the workstock.

It is yet another object of the present invention to provide a new and improved method of cold forming grating workstock which includes the steps of flattening, straightening, and automatically cutting off preselected lengths of the workstock subsequent to the nonskid notches or recessed portions being formed therein.

Other objects and advantages of the present invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevated perspective view of a typical grating structure adapted to be manufactured in accordance with the method of the present invention;

FIG. 2 is an enlarged fragmentary elevated perspective view of a portion of the grating structure shown in FIG. 1;

FIG. 3 is an elevated perspective view of a portion of the apparatus utilized in practicing the method of the present invention;

FIG. 4 is a side elevational view of the portion of the apparatus of the present invention located at the right end of the structure shown in FIG. 3;

FIG. 5 is a side elevational view of a notch-forming roller and associated drive means incorporated in practicing the present invention;

FIG. 6 is a top elevational view, partially schematic, of the roller and associated backup rollers incorporated in the present invention;

FIG. 7 is a view similar to FIG. 6 and illustrates an alternate embodiment of the present invention, and

FIG. 8 is a transverse cross-sectional view taken substantially along the line 8—8 of FIG. 7.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now in detail to the drawings, FIGS. 1 and 2 illustrate a typical grate structure 10 which may be provided with an external frame or the like 12 and comprises a series of spaced parallel strips of grating workstock, generally designated 14, which strips 14 are arranged in perpendicularly oriented transverse and longitudinally arranged rows which intersect, via lap joints or the like, as best seen in FIG. 2.

The strips of grating workstock 14, in a typical construction of the grate structure 10, are fabricated of cold-rolled steel or the like and are provided with a series of adjacently oriented inwardly projecting notches or recessed portions, generally designated 16 that function to enhance the frictional characteristics of the upper surface of the structure 10 whereby to provide a nonskid surface upon which people may traverse without slipping, falling, or otherwise endangering themselves. The present invention deals particularly with a new and improved method for forming the nonskid notches, as will hereinafter be described in detail.

Generally speaking, the apparatus of the present invention consists of a feeding station 18 which provides a source of the grating workstock 14 to be notched, a notch forming station 20 into which the workstock 14 is fed and which performs the notch-forming operations hereinafter to be described, a workstock straightening and flattening station, generally designated 22, adapted to receive the workstock 14 from the station 20, and finally a workstock cutoff station 24 which takes the workstock 14 after it has been straightened and flattened via the station 22 and cuts it off into preselected segmental lengths preparatory to assembly thereof into a suitable grate structure such as the structure 10.

Referring now in detail to the workstock-notching station 20, as illustrated in FIGS. 5 and 6, the station 20 is provided with a suitable drive motor or the like 26, that may be energized by any suitable source of electrical or hydraulic power, and has an output shaft 28 that is drivingly connected through a suitable gearbox or transmission 30 and shaft 32 to a pinion gear 34. The gear 34 is meshingly engaged with a primary drive gear 36 which is mounted at one end of a drive shaft 38 that is rotatably supported by a suitable antifriction means (not shown) in an appropriate support structure, representatively designated by the numeral 40. The end of the shaft 38 opposite that which is connected to the gear 36 is provided with a suitable worm gear 42 that is drivingly engaged to an associated drive gear 44 which is mounted on the lower end of a generally vertically disposed shaft 46. The support structure 40 may be of any suitable construction adapted to support the various gears 34, 36, 42, and 44, as well as the shafts 28, 32, 38, and 46 in an efficient, compact, and operative configuration.

The shaft 46 is adapted to rotatably support a generally cylindrically shaped notch forming element 48 which is adapted to perform a cold rolling or working operation upon the grating workstock 14 and thereby form the series of nonskid notches 16 therein. More particularly, the element 48 comprises a generally cylindrically shaped body section 50 defining a central vertically extending bore 52 within which the upper end of the shaft 46 is received and drivingly connected to the element 48. The outer periphery of the element 48 is formed with a plurality of equally circumferentially spaced, vertically or axially extending outwardly directed notched forming projections or riblike teeth 54 which preferably extend along the entire length of the element 48. Preferably, the axial length (height) of the element 48 is several times the thickness of the workstock 14, for purposes later to be described. As best seen in FIG. 6, the notch-forming teeth 54, in transverse section, are generally trapezoid shaped and have a generally axially extending outer surface portion 56 and inwardly diverging face portions 58 and 60. As will be described in detail, in operation of the notch-forming station 20, the teeth 54 are adapted to peripherally engage one edge of the grating workstock 14 and thereby cold-form the notches 16 therein.

As best illustrated in FIG. 5, disposed adjacent the notch forming element 48 is a backup roller assembly, generally designated 62, which comprises a suitable support structure having upper and lower sections 64 and 66 adapted to support a suitable rotatable shaft 68 in generally spaced parallel relation with respect to the shaft 46. The shaft 68 is provided with a backup roller member 70 which is generally cylindrically shaped and defines an annular, radially inwardly extending guide recess 72 around an intermediate portion thereof. The axial width of the recess 72 is adapted to be slightly greater than the thickness of the workstock 14, whereby one edge of the workstock 14 may be received therein and thereby guided in peripheral relation with respect to the notch-forming element 48, as shown in FIG. 6. It will be seen that the shaft 68 is spaced radially away from the shaft 46 a preselected distance such that the space between the radially innermost portion of the recess 72 and the outer periphery of the body section 50 of the element 48 is approximately equal to the width of the workstock 14, so as to assure that the workstock 14 will be positively peripherally engaged with the element 48 as the notches 16 are formed therein by the teeth 54.

A particular feature of the above invention resides in the fact that means may be provided on either one or both of the shafts 46, 68 for moving the roller assembly 62 and/or element 48 axially of its respective supporting shaft. Such means may be provided by one or more large washers or spacing disks 74 disposed between the upper and lower ends of the assembly 62 and element 48 and the adjacent support structure rotatably supporting the shafts 46, 68. The purpose of such a design is to permit the workstock 14 to selectively peripherally engage the element 48 at different axial positions thereon, whereby to equalize tool wear after continued use of the apparatus of the present invention. More particularly, it will be seen that if one or more spacers are provided beneath the lower side of the assembly 62 and/or above the element 48, the annular guide recess 72 will be located relatively closer to the upper end of the element 48, whereby when the workstock 14 is passed interjacent the recess 72 and element 48, it will peripherally engage the element 48 adjacent the upper end thereof. Similarly, if one or more of the spacing disks 74 are provided adjacent the upper end of the roller member 70 and/or at the lower end of the element 48, the annular guide recess 72 will be axially disposed relatively closer to the lower end of the element 48 so that as the workstock 14 is guided thereby, it will be engaged with the lower end of the element 48. Thus, by properly incrementally axially adjusting or positioning the assembly 62 and/or element 48 along the shafts 68, 46 through proper selection and periodic changing of the spacing disks 74, the workstock 14 can be made to engage the element 48 at different axial locations thereon so that relatively uniform wear of the element 48 may be achieved, thus maximizing tool life. It will be apparent, of course, that various alternate means may be used for selectively adjusting the axial relationship or relative axial positioning of the annular guide recess 72 with respect to the element 48, such as by providing some type of axial adjustment means on the shafts 46, 68, as will be apparent to those skilled in the art.

In a preferred construction of the present invention, two pairs of guide rollers 76, 78 and 80, 82 are provided adjacent the forward and rearward sides of the element 48 and roller assembly 62, which guide rollers are provided upon suitable vertically extending shafts 84, 86 and 88, 90, respectively, whereby to assure proper orientation of the workstock 14 as it passes toward and away from engagement with the notch-forming element 48. If desired, one or more of the pairs of rollers 76, 78 or 80, 82 may be rotatably driven whereby to push or pull the workstock 14 through the notch-forming station 20. Also, such rollers 76–82 may be formed with radially inwardly extending recesses such as the guide recess 72 to assist in axially aligning the workstock 14 with respect to the element 48, provided, however, that such guide recesses do not

impair relative axial positioning of either the element **48** or backup roller assembly **62** pursuant to the above-described feature minimizing tool wear on the element **48**. If desired, horizontally disposed rollers (not shown) may be provided adjacent the guide rollers **76, 78** and **80, 82** for positioning the workstock **14** axially of the element **48**.

Referring now to the construction of the workstock feeding station **18**, as best seen in FIG. **4**, the station **18** comprises a base or support structure **92** adapted to support an upwardly extending pedestal **94** upon which a suitable horizontally disposed support shaft **96** is mounted. The shaft **96** is adapted to support a suitable reel or coil of the workstock **14**, representatively designated by the numeral **98**, and be provided with suitable radially outwardly projecting coil-supporting arms **100** adapted to operatively support the workstock roll or coil **98**, for example, in the manner disclosed in U.S. Pat. No. 3,022,024, issued Feb. 20, 1962 to the applicant. Suitable braking or clutching means may be provided in the feeding station **18** for preventing rotational momentum of the workstock coil **98** from building up upon rotation thereof, and thereby control selective feeding of the workstock **14** into the notch-forming station **20**.

After the workstock **14** has been conveyed from the feeding station **18** into the station **20**, wherein the series of notches or recessed portions **16** are formed therein, the workstock **14** progresses or is conveyed to the straightening and flattening station **22** which may be of any suitable conventional construction and preferably comprises one or more longitudinally spaced workstock flattening assemblies, generally designated **102**, that are supported on a generally horizontally extending support surface **104** defined by a suitable support or base structure **106**. Each of the assemblies **102** comprises suitable roller support means, generally designated **108**, adapted to operatively support upper and lower cooperative pairs of rollers **110** and **112**, respectively, for rotation about vertically spaced, horizontally extending support shafts or the like (not shown). Suitable means, representatively designated **113**, is preferably provided for selectively adjusting the relative proximate positions of the upper rollers **110** with respect to the lower rollers **112** of each of the assemblies **102**, whereby to selectively control and adjust the applied pressure exerted by the rollers **110, 112** upon the workstock **14** which passes therebetween in order to effect flattening of the workstock **14**, as is well known in the art.

Disposed adjacent the "outlet" sides of the flattening assemblies **102** are a plurality of workstock-edging assemblies **114** which may be of any suitable construction and are preferably provided with laterally spaced pairs of rollers **116** rotatable upon vertical extending axes and adapted to have the workstock **14** pass therebetween so as to apply laterally inwardly directed forces thereon to control the conformation or shape of the laterally opposite edges thereof, as is well known in the roll-forming art. The need for such edging assemblies **114** results primarily from the fact that the original coil **98** of workstock **14** is frequently considerably wider than the strips that are subjected to the notch forming operations, and that the edges of the strips of workstock become out of "square" when they are cut from the original coils **98**, thereby necessitating the assemblies **114** for cold-forming the workstock **14** into the desired symmetrical or rectangular configuration.

In a preferred construction of the present invention, the end of the support structure **106** adjacent the notch-forming station **20** is provided with suitable guide roller assembly **118** comprising a pair of horizontally extending, vertically spaced rollers **120** adapted to guide the workstock **14** as it passes from the station **20** into the adjacent flattening assembly **102**. Disposed at the opposite end of the support structure **106** from the assembly **118** is a workstock-straightening assembly **122** comprising an elevated support structure **124** adapted to operatively support a plurality of horizontally extending upper rollers **126**. The assembly **122** also comprises a lower roller support structure **128** which supports a plurality of lower rollers **130** that are spaced below and in staggered relation with respect to the upper rollers **126**, as is illustrated in FIG. **3**. The construction and operation of the workstock-straightening assembly **122** is well known in the art and a detailed description thereof will be omitted for purposes of simplicity of disclosure, it being apparent that the workstock **14** is designed to pass between the upper rollers **126** and lower rollers **130** and thereby be accurately straightened as a result of the interaction of the rollers **126, 130** thereon.

Disposed adjacent the assembly **122** is a workstock cutoff assembly, generally designated **132**, which is adapted to have the workstock **14** pass therethrough and be cut into segmental sections of predetermined length. The assembly **132** may be of any suitable construction, such as the construction described in U.S. Pat. No. 3,111,054, issued Nov. 19, 1963 to the applicant, although various alternate constructions will be apparent to the skilled artisan. After the workstock passes through the assembly **132**, it passes between a pair of extraction rollers **134** and **136** which may be suitably powered so as to pull the segmental sections of the workstock **14** away from the cutoff assembly **132** at a relatively faster rate than the workstock **14** is conveyed thereto, whereby to prevent any interference between successive workpieces being cut off by the assembly **132**. From the extraction rollers **134, 136**, the segments of workstock **14** are adapted to pass onto a runoff table, generally designated **138**, which is supported adjacent the end of the support structure **106** by suitable support pedestals **140**. The runoff table **138** may be provided with suitable means for periodically dumping or otherwise transferring a plurality of workstock sections thereon onto an appropriate conveyor assembly, pallet, or other workstock transferring medium after a preselected number of sections have accumulated on the table **138**, as is well known in the art.

In operation, assuming the initial condition that the drive motor **26** is energized and that the straightening and flattening station **22** is properly energized, for example through suitable manually actuatable controls **142**, workstock **14** is initially unreeled from the coil **98** and is passed between the guide rollers **76, 78**. Thereafter, the workstock **14** passes between the notch forming element **48** and the backup roller assembly **62**, whereby the series of longitudinally spaced notches **16** are cold formed in the workstock **14** as the projections **54** are successively forced inwardly into the adjacent lateral edge of the workstock **14**. As the projections **54** thus produce the notches **16**, a certain amount of metal adjacent each of the notches **16** cold-flows or is displaced above and below the workstock **14** at each of the notches **16**, with the result that there is a certain increase in the overall thickness of the workstock **14** around the edge of each of the notches **16**. Moreover, as a result of forming the notches **16** along one lateral side of the workstock **14**, the workstock **14** tends to assume a somewhat curvilinear configuration.

After the workstock **14** passes between the element **48** and backup roller assembly **62**, it passes between the guide rollers **80, 82** and thereafter between the rollers **120** and through the straightening and flattening station **22**. As the workstock **14** passes through the station **22**, it alternately passes through the flattening assemblies **102** and the edging assemblies **114**, whereby the aforesaid curvilinear shape is removed and the enlarged thickness portions of the workstock **14** at the notches **16** are flattened or removed. Finally, the workstock **14** passes between the straightening rollers **126, 130** which function to straighten the workstock along the plane of the major width thereof, at which time the workstock **14** passes through the cutoff assembly **132** and extraction rollers **134, 136**, whereby the workstock **14** is cut into segmental sections that are transferred to the runoff table **138**. After a certain number of sections of the workstock **14** have accumulated on the table **138**, the same will be actuated to dispose the workstock sections onto suitable conveyor, pallet truck, or the like.

FIGS. **7** and **8** illustrate an alternate embodiment of the present invention wherein a series of the notches **16** are adapted to be formed along both lateral side edges of the workstock **14** instead of along only one side thereof, as was

the case with the workstock **14** processed by the apparatus shown in FIGS. **5** and **6**. In order to accomplish forming the notches **16** along both edges of the workstock **14**, the backup roller assembly **62** is replaced with a notch-forming element **48'** which may be identical in construction and operation to the hereinabove described element **48** and may be suitably driven by a suitable drive means, representatively designated by the numeral **144**, which may be identical in construction and operation to the drive means provided by the drive motor **26**, transmission **30**, and gears **34**, **36**, **42**, and **44**, or any other suitable drive mechanism. The notch forming elements **48**, **48'** may be rotatably positioned so as to form the notches **16** along each side of the workstock **14** so that the notches **16** are laterally aligned, or alternatively, staggered or alternated, as is shown in FIG. **7**, depending upon the particular type of grating structure desired. A particular feature resulting from the simultaneous forming of the notches **16** along both sides of the workstock **14**, as compared with forming the notches **16** along only one side thereof, resides in the elimination of the curved configuration that the workstock **14** assumes when the notches **16** are formed on one side thereof, thereby obviating the need for subsequently laterally straightening the workstock **14**.

It will be seen from the above described construction of the present invention that a new and improved method and apparatus is provided for cold-rolling nonskid notches within elongated or strip grating workstock. A particular feature of the present invention resides in the elimination of the formation and subsequent handling of metallic chips which were abundantly produced in the production of grating material on conventional reciprocal cutting machines. Additionally, the present invention eliminates the need for preheating the workstock preparatory to cutting the nonskid notches therein. Also of importance is the fact that cold-rolling the notches **16** in the workstock **14**, as well as the cold-working of the workstock **14** as the same is subjected to the straightening, flattening and edging operations, has been found to considerably strengthen the workstock and effect a certain amount of elongation thereof. Accordingly, the grating workstock produced in accordance with the present invention will be capable of supporting a greater load than has heretofore been possible with conventionally manufactured grating material, and a greater amount of grating workstock will be produced for a given amount of workstock utilized. Another feature of the present invention resides in the fact that the notch forming element **48** (**48'**) and associated backup roller assembly **62** may be selectively axially positioned relative to one another, whereby to reduce wear of the element **48** to a minimum. Moreover, by designing the element **48** such that it is of a relatively massive (thick) construction, said element will be extremely strong and not be subjected to chipping or other attrition. Additionally, the relative shape and spacing between the notches **16** on the workstock **14** may be varied considerably by changing the configuration of the notch forming element **48**, and said notches **16** may be provided along both sides of the grating workstock **14** by merely substituting an additional element **48'** for the backup roller assembly **62**, as above described, whereby to provide for universality of application.

While it will be apparent that the preferred embodiment illustrated herein is well calculated to fulfill the objects above stated, it will be appreciated that the present invention is susceptible to modification, variation and change without departing from the scope of the invention.

I claim:

1. In the method of manufacturing elongated strips of grating material from generally flat, rectangular cross section workstock, the steps which include,

successively engaging a plurality of irregular notch forming elements on the periphery of a rotating member with the workstock and thereby forming a series of adjacently oriented notch portions along one lateral edge of the workstock and simultaneously cold working the workstock to strengthen the same and effecting preselected elongation of the workstock, whereby workstock of preselected length produces a recessed grating workpiece of predeterminately greater length.

2. The method as set forth in claim **1** which includes the step of straightening and flattening the workstock both longitudinally and laterally by passing the workstock between spaced rollers.

3. The method as set forth in claim **2** which includes the step of successively cutting off preselected segmental sections of the workstock after the same has been straightened and flattened.

4. The method as set forth in claim **1** which includes the step of alternatively flattening and straightening the workstock subsequent to forming the notched portions therein.

5. The method as set forth in claim **1** which includes the step of simultaneously forming a series of adjacently oriented notched portions along the laterally opposite edges of the workstock.

6. The method as set forth in claim **1** which includes the step of guiding the workstock into peripheral engagement with the rotating member by passing the workstock in part through an annular recessed portion formed in a backup roller assembly, which includes the step of straightening the workstock both longitudinally and laterally by passing the workstock between spaced rollers, and which includes the step of successively cutting off preselected segmental sections of the workstock after the same has been straightened and flattened subsequent to forming the notched portions therein.

7. The method as set forth in claim **6** which includes the step of simultaneously forming a series of adjacently oriented notched portions along the laterally opposite edges of the workstock.

8. The method as set forth in claim **6** which includes the step of adjusting the relative axial positions of the backup roller assembly and rotatable member, whereby to guide the workstock into peripheral engagement with the rotatable member at different axial locations thereon.

9. The method as set forth in claim **1** which includes the step of flattening the grating material subsequent to forming said notch portions therein, whereby the thickness of the notched grating material is substantially the same as the original workstock.

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