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METHOD OF STRAIGHTENING METAL MEMBERS

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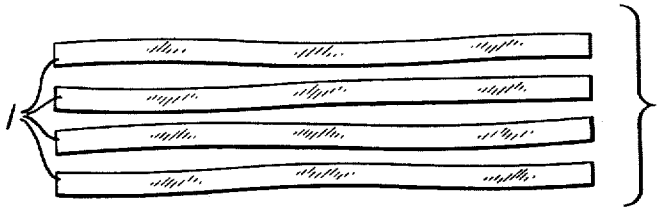


Fig. 1.

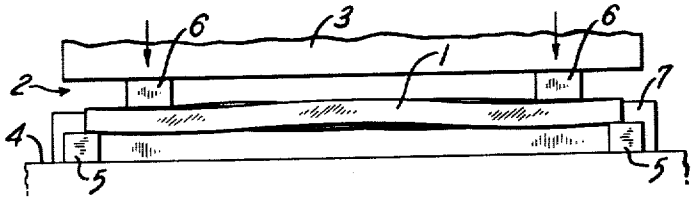


Fig. 2.

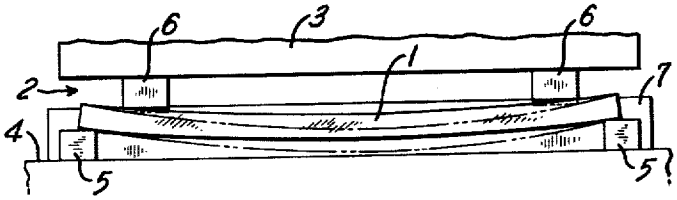


Fig. 3.

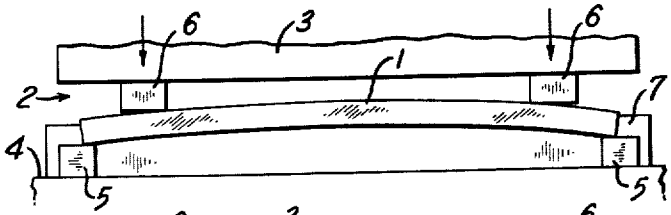


Fig. 4.

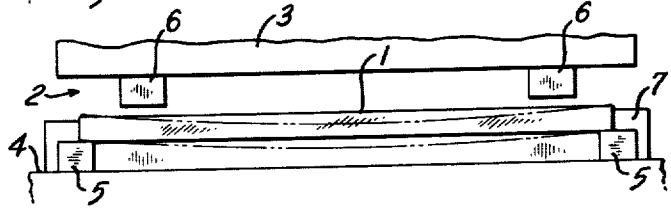


Fig. 5.

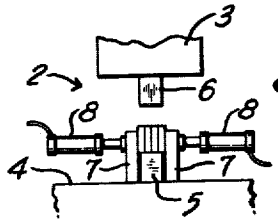


Fig. 6.

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METHOD OF STRAIGHTENING METAL MEMBERS

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The present invention relates to a method of straightening metal members and particularly to a method of straightening blanks, bars, rods and other shapes which are cambered or twisted in varying degrees and in both simple and complex curves.

In many situations, preliminary straightening operations are required to be performed on metal members such as blanks, bars and/or rods which have become warped, to render the members suitable for use, or for subsequent forming operations, such as drawing, to be performed thereon. The distorted condition of the members frequently arises from hot rolling performed on the members wherein, due to non-uniform cooling, internal stresses are set up in the member causing the same to set in various degrees of camber.

Present straightening techniques generally are limited to hand straightening methods which, although conducive to extreme precision, are slow and commercially unattractive, and to the punch and press straightening method which is semi-mechanical and more adapted to assembly line production. In this latter method, the high spots or points of convesities of the warped members are successively located beneath the ram of the straightening press and sufficient pressure is applied to remove the high spot and permit the member to spring back to a straightened condition when the load is released. This method of straightening requires considerable know-how on the part of the press operator and where the object being straightened has a complex camber, great difficulty is experienced in obtaining a straight member with a minimum of ram strokes.

Further, since the members in a given production run ordinarily warp or distort in a different manner and degree even though subjected to identical hot rolling treatments, each member must be individually straightened. Thus, even with the punch and press straightening method, it is difficult to attain economical production rates.

In the method of the present invention, the shortcomings of the prior art are substantially reduced by subjecting one or more cambered members to a preliminary bending or shaping operation designed to stress the members to their yield point and to bend the members to an extent sufficient to remove all vestige of their original camber and to provide each member in lieu thereof with an identical, permanent camber of arcuate contour. The members are then subjected to a second pressure load directed oppositely of the direction of camber and of a magnitude to again stress the blanks to their yield point and to bend the members an extent such that upon load release, the members "spring back" to a straight condition.

During each stage of the straightening operation, the members are supported at the ends and along the sides thereof to permit controlled deformation of the members. The invention contemplates load application immediately inwardly of the ends of the members to establish a uniform bending moment at each and every portion of the members between the loaded points to thereby insure the impartation of an arcuate contour to the members.

The invention greatly simplifies the straightening operation and provides substantially decreased production

costs since only two strokes of the press are required to simultaneously straighten a plurality of differently and complexly warped members. The extent of bending required in the initial and final straightening operations may be determined experimentally and will remain substantially constant for any given run of members. The invention eliminates the hit-or-miss bending heretofore utilized in the straightening art.

The accompanying drawing illustrates the best mode presently contemplated of carrying out the invention.

In the drawing:

FIG. 1 represents a diagrammatic view of a plurality of blanks having varying amounts and types of camber;

FIG. 2 is a diagrammatic view of a group of blanks such as illustrated in FIG. 1 in the initial stages of the straightening operation;

FIG. 3 is a view similar to FIG. 2 illustrating the progressive bending of the blanks with the phantom lines indicating the position of the blanks just prior to load release and with the solid lines indicating the initial "set" of the blanks;

FIG. 4 is a view similar to FIG. 2 illustrating diagrammatically the initial phase of the final step of the straightening operation;

FIG. 5 illustrates successive positions of the blanks during the application of the pressure load in the final step of the operation with the phantom lines indicating the position of the blanks prior to "spring back" and the solid lines indicating the position of the blanks after "spring back" and in their final straightened condition; and

FIG. 6 is a fragmentary transverse section of the straightening apparatus with the blanks positioned therein.

For purposes of explanation only, the method of the present invention is described and illustrated in connection with a plurality of elongated metal blanks **1** having varying degrees of camber in the plane or direction of width of the blanks and having both complex and simple contours. The blanks illustrated in FIG. 1 are representative of the type of warping or distortion (in greatly exaggerated form) which may take place as the blanks cool subsequent to hot rolling. For purposes of the present invention, the blanks are of any metal having resilient properties and which is capable of cold deformation and strain hardening.

According to the general method of the invention, the blanks **1** are transformed from a cambered to a straightened condition in a two step operation by means of a bending load applied through a predetermined distance and in a manner to impart a uniform bending moment along the length of the blanks. In the first phase of the straightening operation, the blanks are simultaneously bent generally from their initial complexly and differently curved condition to an identical arcuate contour. Subsequently, in the final phase of the operation, the blanks are simultaneously bent in a direction reversely of the camber, to and beyond a straight condition by an amount such that they will spring back to a straight condition upon load release.

It is contemplated to conduct the straightening operation in a press **2** comprising generally a movable ram **3** and a stationary bed **4**. The blanks are adapted to be supported in bed **4** on a pair of support blocks **5** spaced generally in accordance with the length of the blanks to be straightened and slightly outwardly of the spaced pressure bars **6** appendant to the ram. The bed is further provided with a pair of parallel dies **7** extending lengthwise of the bed **4** and operably connected to the hydraulic cylinders **8** for movement relatively of one another.

Prior to straightening the blanks, it is preferred to orient them according to the location of the point of maximum bow as determined either by visual inspection or by suitable mechanical means.

The blanks are then placed edgewise on blocks **5** with the bow of the blanks disposed upwardly relative to the ram, although the reverse position is equally permissible, and the cylinders **8** actuated to move the dies **7** against the outermost blanks in the manner shown in FIG. 6 to prevent lateral movement of the blanks during the straightening operation.

Ram **3** is then lowered towards the blanks to move pressure bars **6** into engagement with the blanks **1** and to apply equal loads to the blank ends. The applied load is increased during the downstroke of the ram until it reaches a value sufficient to stress the blanks to their yield point. As the ram proceeds downwardly, the camber of blanks **1** generally diminishes in degree and eventually, as ram movement is continued sufficiently far, the camber reverses in direction relative to the horizontal. Concurrently therewith, the camber changes from a complex or simple curve to an arcuate contour as each and every point on the blanks between the loaded positions is subjected to an equal bending moment due to the manner of load application.

Downward movement of ram **3** is continued to bend the blanks sufficiently below the horizontal such that upon load release the blanks "set" in a camber such as shown in the solid lines in FIG. 3.

After completion of the preliminary straightening operation, dies **7** are opened and the blanks turned through 180° to position the high spot towards the ram whereupon dies **7** are closed to fix the blanks in position for the succeeding or final straightening step. Sufficient pressure is again applied to the blanks by lowering ram **3** to again exceed the yield point of the blank material and to force the blanks into the general position indicated in the lower phantom lines of FIG. 5.

In this operation, however, the lower limit to which the ram is moved is slightly above the comparable position of the ram during the initial bending operation to enable the blanks to "spring back" to a straight, horizontal position upon load release.

In the invention, the ram stroke required to produce the desired amount of bending or deformation of the load of blanks in both the initial and final straightening operations will be a readily determinable value and will remain substantially a constant from one load to the next in any given production run of blanks. The press operator thus need only properly orient the blanks relative to each other and position the blanks in the press, move the ram to the first predetermined position, re-position the blanks in the press, and finally move the ram to the second predetermined position. The method of the invention enables even unskilled operators to straighten the blanks accurately and precisely and, as opposed to the prior art methods, provides substantially increased production rates.

While described in connection with blanks which are cambered in the direction of their width, the method of the invention may be practiced on blanks cambered transversely to their width as well. Bars, rods, and other shapes may also be straightened by the method of the invention.

Various methods of carrying out the present invention are contemplated as being within the scope of the following claims particularly pointed out and distinctly claiming the subject matter regarded as the nature of the invention.

I claim:

1. A method of straightening metal beam-like means cambered in varying degrees and in both simple and complex contours relative the longitudinal axis thereof, comprising applying a first bending load to the metal means adjacent the ends thereof to stress the same to the yield point, continuing the application of said load to bend the metal means an amount sufficient to remove substantially all vestige of original camber and to provide the metal means in lieu thereof with an arcuate camber, applying a second bending load to said metal means adjacent the ends thereof and directed oppositely of said first bending load to again stress the same to the yield point, and continuing the application of said second bending load to bend the metal means to and beyond a straight condition by an amount sufficient to permit the metal members to spring back to a straight condition upon load release.

2. A method of straightening a plurality of metal members cambered in varying degrees and in both simple and complex contours in the direction of width thereof, comprising supporting said members at each end only, applying a first pair of equal forces to the members adjacent and inwardly of the supported ends thereof, said forces being applied in the direction of width of said members and having a value to stress the members to approximately the yield point thereof, continuing the application of said first pair of forces to bend said members sufficiently to remove all trace of the original camber and to provide said members with an arcuate camber upon release of said forces, releasing said first pair of forces, applying a second pair of forces to said members at or near the point of application of said first pair of forces with said second pair of forces being applied in the direction of width of said members and opposite in direction to the direction of said first pair of forces, said second pair of forces being of a magnitude to stress the blanks to approximately the yield point thereof, continuing the application of said second pair of forces to bend the members an amount such that upon load release said members spring back to a straight condition, and releasing said second pair of forces.

3. A method of simultaneously straightening a plurality of elongated and elastic metal members cambered in varying degrees and in simple and complex curves in the plane of width of said members and with said camber being limited to one plane only, comprising subjecting said members to a first pair of forces near and inwardly the ends thereof with said forces being applied in the plane of width of said members, said first pair of forces being of a magnitude to stress said members to the yield point, continuing the application of said first pair of forces to remove all trace of original camber and to provide the members with an identical, arcuate camber, releasing said first pair of forces, applying a second pair of forces near and inwardly the ends of said members with said forces being applied in the plane of width of said members and opposite to the direction of said first pair of forces, said second pair of forces being of a magnitude to exceed the yield point of said members, continuing the application of said second pair of forces to bend said members to a camber of reverse contour to that resulting from said first pair of forces with said reverse camber being of an extent such that upon load release said members spring back to a straight condition, and releasing said second pair of forces.

4. A method of straightening a plurality of elongated metal members cambered in the plane of width thereof and in one plane only, comprising fixedly supporting said members at the ends only; holding the end portions of the members to support said members against lateral displacement, applying a first load to said members by applying a pair of equal forces near and inwardly the supported ends of said members with said forces being applied in the plane of width of said members, said load being of a value to stress said members to their yield point, continuing the application of said first load to remove substantially all of the original camber of said members and to establish an arcuate, identical camber in each of said members, releasing said first load, applying a second load to said members by applying a pair of equal forces near and inwardly the supported ends of said member with said forces

being applied in the plane of width of said members and opposite to the direction of said first load, said second load being of a value to stress the members to their yield point, continuing the application of said second load to establish an identical and arcuate camber of reverse direction to that resulting from said first load with said reverse camber being of a magnitude to permit said members to spring back to a straight condition upon release of said second load, and releasing said second load.

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