Jan. 10, 1928. 1,656,003

G. F. JOHNSTON

BENDING APPARATUS AND METHOD OF PRODUCING BENT STRIP MATERIAL

Filed Jan. 14, 1924 2 Sheets-Sheet 1

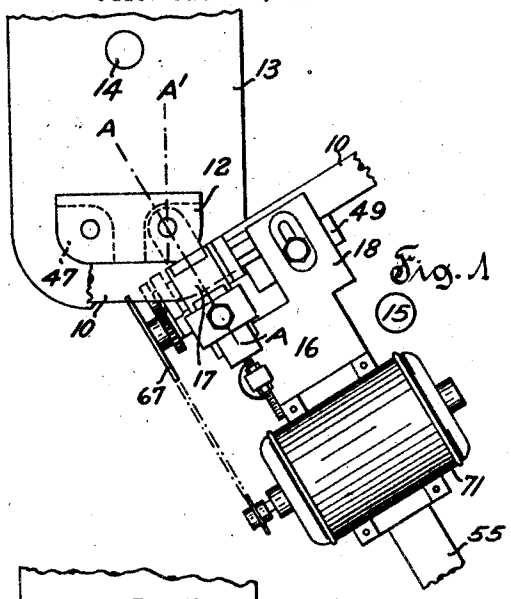


Fig. 1

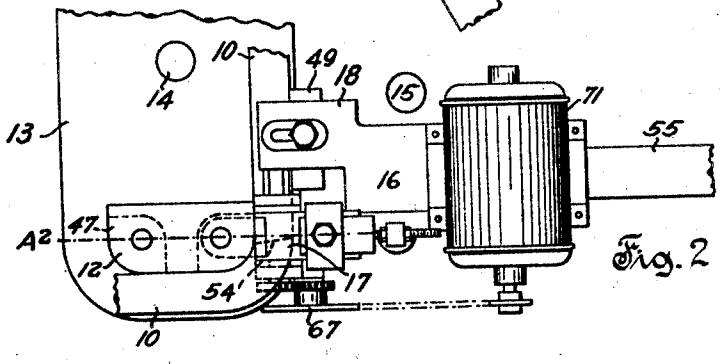


Fig. 2

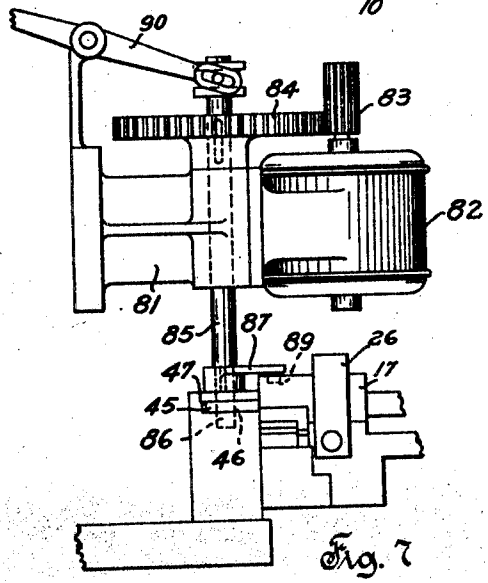


Fig. 7

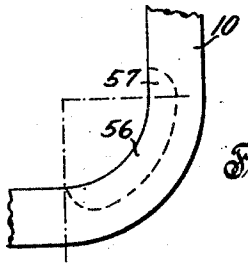


Fig. 3

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BENDING APPARATUS AND METHOD OF PRODUCING BENT STRIP MATERIAL

Filed Jan. 14, 1924 2 Sheets-Sheet 2

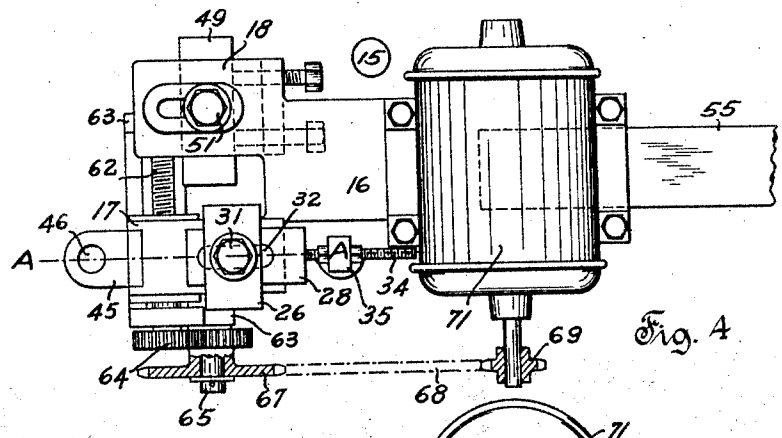


Fig. 4

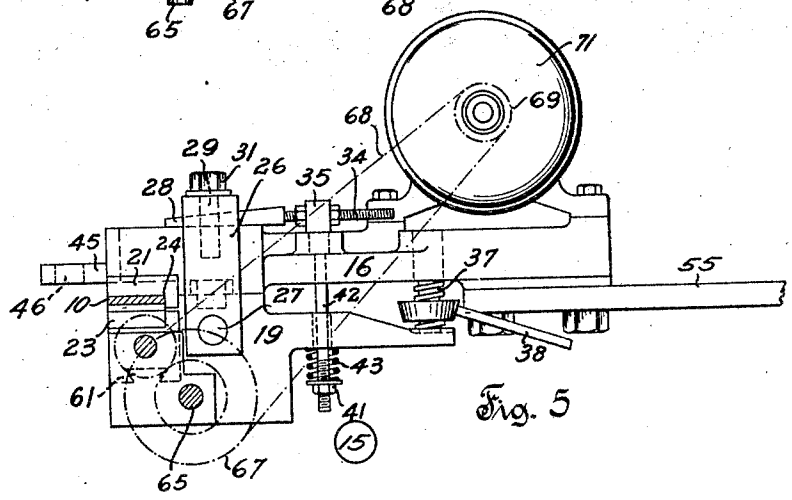


Fig. 5

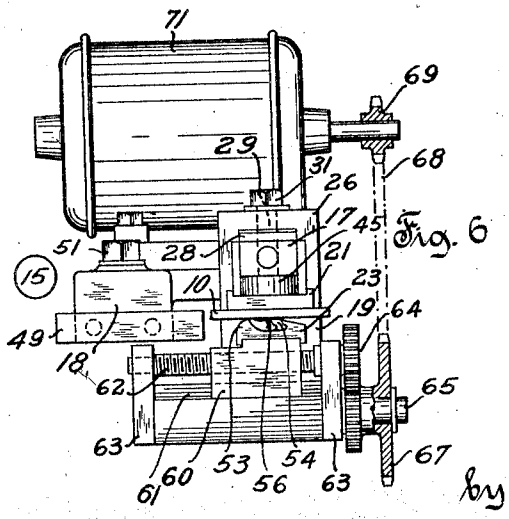


Fig. 6

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Patented Jan. 10, 1928. 1,656,003

UNITED STATES PATENT OFFICE.

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BENDING APPARATUS AND METHOD OF PRODUCING BENT STRIP MATERIAL.

Application filed January 14, 1924. Serial No. 685,946.

This invention relates in general to metal bending, and it has particular relation to apparatus and methods of special utility in the production of strip material bent in edgewise fashion.

In bending strip material, especially material of large size, in an edgewise manner, there is a crowding over or enlargement of the material adjacent the inner edge of the bend and a tendency toward stretching or reduction of the cross section of the material adjacent the outer edge of the bend. Where it is necessary or desirable to preserve the same thickness of the material throughout, as in the case of wound coils for electromagnets of dynamo-electric machines, etc., this enlargement of the material at the inner side of the bend is a decided disadvantage, for it requires a subsequent expensive operation to reduce or re-form the enlarged wedge-shaped section, usually through cutting, grinding or swaging.

The present invention contemplates or includes the production of articles formed from distortible strip material, especially of relatively large size or width, bent edgewise at one or more points, and wherein excess thickness of material produced at the inner edge of bend during the bending operation, is removed by an operation directly associated with the bending operation; and, likewise, the invention contemplates the performance of the combined operations of bending and reducing the bent material to desired final shape at a considerably reduced cost and in considerably less time than is required for the several operations of bending and trimming the material at the bend, as practiced in the past.

An object of the present invention is to provide an improved method and apparatus especially adapted for producing bent strip material wherein excess thickness formed at the inner side of the bend is reduced to desired dimensions.

A further object of the present invention is to provide an improved method and apparatus especially adapted for producing objects formed from bent strip material, and in accordance with which the material may be bent and a portion of the excess thickness formed at the inner side of the bend may be reduced during the bending operation or a continuation thereof.

These and other objects and advantages are attained by the present invention, various novel features of which will be apparent from the description and drawings herein, disclosing embodiments and features of the invention, and will be more particularly pointed out in the claims.

In the accompanying drawings:—

Figs. 1 and 2 are plan views of apparatus through which advantages of the invention may be realized, the apparatus being shown in several positions assumed during the operation of bending a section of strip material;

Fig. 3 is a detailed plan view of a section of material subjected to the bending operation;

Fig. 4 is an enlarged plan view of the apparatus shown in Figs. 1 and 2;

Fig. 5 is a front elevation of the device shown in Fig. 4;

Fig. 6 is an end view of the device shown in Figs. 4 and 5; and

Fig. 7 is a view in elevation of a modification, showing an arrrangement for permitting power operation of the bending device.

As shown in the drawings, 10 indicates a section of strip material whose width is considerably greater than its thickness, and which is to be subjected to an edgewise bending operation. 12 indicates a form or forming block having its outer wall formed along an arc of 90 degrees and a radius required to produce the desired bending arc at the inner side of the bent strip material. The form 12 may be shaped to provide a single 90 degree bend or, as shown, a plurality of such bends, which arrangement would be an ordinary one for use in the formation of the turns of a coil. The form 12 is mounted upon a support or table 13, preferably rotatable about an axis 14 which, in the case of a form for producing turns of a coil, is located at the center of such coil.

15 indicates generally a device or apparatus for effecting the operation of bending the strip material about the form 12 and, at the same time, producing the desired uniform thickness of the bent strip, this uniformity being secured by trimming or shaving the excess material from the inner edge of the bend. The device 15 includes a body portion 16, in the form of an upper jaw hav-

ing at its forward end two spaced extensions or arms 17, 18. A member is disposed at the lower side of the body portion 16, being pivotally carried by the body portion or member 16 and constituting, in effect, a lower jaw cooperative with the upper jaw 16. Bearing or wearing plates 21, 23 of relatively hard metal, are secured in opposed relation upon the opposed faces of arm 17 of the upper stationary jaw 16 and the lower jaw 19, respectively. As indicated, the upper jaw plate 21 is provided with a recess having a right angle shoulder at its inner side, as indicated at 24. During operation of the bending device 15 to impart the desired shape to the strip material 10, the latter is disposed in the recess 24 of the upper jaw plate and is held in position therein through the forcible bearing of the lower jaw plate 23 against the under side of the strip material, as indicated generally in Figs. 5 and 6.

Through the arrangement provided for insuring pivotal adjustment of the lower jaw with respect to the upper jaw, it is possible to handle strip material of different thicknesses. As indicated, a saddle-shaped block 26 is mounted upon the upper side of the extension 17 of the upper jaw 16, the depending side arms of the saddle being apertured and carrying a pivot pin 27 on which the lower jaw 19 is pivotally mounted. The saddle 26 may be mounted in any one of several fixed positions upon the upper block, the adjusting and securing means comprising a wedge 28 which is slidable beneath the cross arm of the saddle on the upper side of the extension 17 to permit bodily separation of the pivot pin 27 and the lower jaw 19 carried thereby from the upper jaw. A bolt 29 has its head 31 bearing upon the upper side of the saddle 26 and passes through an elongated slot 32 in the wedge 28, the bolt being adjustably threaded in an aperture in the extension 17. The wedge 28 may be adjusted through a screw 34 carried thereby and threaded through an aperture in an abutment 35 mounted upon a portion of the upper jaw 16. As will be apparent, the screw 34 may be adjusted through the abutment 35, permitting the wedge to be forced to and from its position beneath the cross arm of the saddle, and the saddle and lower jaw 19 will then assume new positions in which they may be secured by tightening of the bolt 29.

The lower jaw 19 may be adjusted on its pivot 27 to cause the lower jaw plate 23 to forcibly cooperate with the under side of the strip material 10, by means of an adjusting screw 37 whose lower end abuts upon an end portion of the lower jaw 19 and which is threaded into the upper jaw 16, an operating handle 38 being secured to the screw 37 for rotating the latter. Operation of the handle 38 causes the plate 23 to forcibly grip or to release the strip material 10. An adjustable abutment 41 is carried by a rod 42 which in turn is carried by the upper jaw 16, and is preferably integral with or secured to the abutment 35, a spring 43 being positioned between the abutment 41 and the under side of the lower jaw 19, this spring being normally compressed and thus serving to bias the lower jaw to a position wherein the lower plate 23 is retracted from its operative position against the lower side of the strip material 10. With this arrangement, it will be apparent that when the operating handle of the adjusting screw 37 is shifted to draw the lower end of the screw upward, the spring 43 is effective to cause the lower jaw plate 23 to be retracted from the upper jaw plate.

The forward end of the arm 17 of the upper jaw plate is provided with an extension 45 having an aperture 46, the extension 45 being of such thickness as to be readily insertible within an undercut recess or slot 47 in the outer wall of the form 12. As indicated, the arrangement is such that this extension 45 is preferably integral with the upper jaw plate 21, thus insuring that for handling strip material of different widths or different arcs of curvature, all that is necessary is the substitution of an upper jaw plate of the required shape as to thickness and radius of bend. As indicated, with the device in operative position to bend a section of strip material, the axis of the aperture 46 coincides with the axis of curvature of the 90 degree arc along which the form is shaped, a pin being inserted through the aperture in the form 12 and the aperture 46 to secure the bending device in operating relation.

A bending or forcing knee or plate 49 is adjustably positioned on the under side of the extension 18 of the upper jaw 16, being held in operative position by means of a bolt or screw 51 adjustable through an elongated aperture in the extension 18. The outer side of the bent knee or plate 49 is preferably formed as a straight edge, as indicated, which is in line with the inner wall of the recess 24 in the upper jaw plate 21, thus insuring that the outer edge of the strip material to be bent is in full contact with the bending knee and the inner wall of the recess 24 in the upper jaw plate during the bending operation.

The lower bearing surface of the upper jaw plate 21 is plain or shaped to fully engage throughout with the upper side of the strip material to be bent; while the opposed upper face of the lower jaw plate 23 is formed at its leading edge with a more or less rounded bead 53 extending across the face of the plate and which bears forcibly against the under side of the strip material.

In the operation of the bending device, this bead serves to straighten or draw out or smoothen any irregularities in the strip material as it enters the active portion of the bending device. The upper face of the lower jaw plate 23 is also provided with a cutting tool or edge which is located at the rear side of the center line of the bending device, retreating from such line. As indicated in Figs. 1, 2, 4 and 6, the radially outer point of the cutting edge, considered with respect to the axis of rotation of the bending device about the form, may practically coincide with the axis of the bending device which passes through the axis of rotation of the device. The cutting edge 54 projects upwardly to substantially the same extent as, or preferably to a slightly greater extent than, the bead 53.

Assuming that the lower jaw plate 23 is not provided with the cutting edge 53, as described hereinabove, the device 15 may be used for the purpose of merely effecting the desired bending of the strip material.

With the strip material 10 lying with its inner edge along the near side of the form 12, Figs. 1 and 2, the extension 45 of the device 15 is inserted to and pinned in operative position, the lower jaw 19 being retracted at this time, the tool being thus permitted to rotate about an axis through the center of the 90 degree arc through which the strip material is to be bent. At this time, the bending device occupies a position wherein the center line A—A thereof occupies the position A^1 in Fig. 1. By applying the required pressure to the operating handle 55 of the device, the latter is swung in an anti-clockwise direction about the center of the bending arc, during which operation the bending knee or plate 49 exerts the required pressure on the outer edge of the strip material to cause the latter to be bent along the outer surface of the form. When the tool 15 has reached the position wherein the center line A—A thereof occupies the position A^2, the desired 90 degree curvature has been imparted to the strip material. However, assuming for the moment that the cutting tool 54 is not present, the thickness of the strip material has been increased at the inner edge of the bend, so that the material is now of a more or less wedge-shape which is thicker at the inner edge, the extent of the enlarged portion being as indicated at 56 within the dotted line area, Fig. 3.

With a lower jaw plate 23 having a cutting tool 54, as described hereinabove and shown in the drawings, and with the plate 23 drawn up to operative position wherein it is in forcible engagement with the lower side of the strip material to be bent, the device 15 may readily be operated from the position A^1, to the position A^2, during which operation the excess thickness of the material produced during the rotation of the device is formed just in front of the center line A—A of the device, that is, substantially in the space between the drawing or smoothing bead 53 and the cutting edge 54. Hence, during the progress of the tool 15, the bead 53 draws or straightens the bending strip and holds it firmly against the upper jaw plate, and immediately behind this bead an enlargement is formed as the actual bending of the strip occurs along the center line A—A. However, as fast as this excess material is produced, the cutting tool 54, which is fixed in position in so far as its approach and retraction from the upper jaw plate 21 is concerned, cuts or shaves this excess material from the under side of the strip material; and because the strip material is forcibly held against the plain surface of the upper jaw plate 21, all the increase in thickness appears at the lower side of the strip. The result is a strip bent to the desired shape with excess material, normally formed at the inner edge thereof, removed so as to leave the strip of substantially uniform thickness throughout the bent portion.

However, in certain cases, as in the present case, it is desirable that the bent strip be in the form of a plurality of straight sections connected by a curved section, the desired movement of the cutting tool in an anti-clockwise direction may not be sufficient to insure the removal of the final portion of the entire excess material, indicated at 57, Fig. 3, the latter portion being that beyond the line corresponding to the position A^2. Accordingly, when the bend is completed, that is, when the tool has reached the position shown in Fig. 2, it may then be returned in a clockwise direction so as to release the cutting tool from the chip, corresponding to the excess thickness being removed from the strip material. The remaining portion 57 of excess thickness may then be removed in any suitable manner, as by means of a hand or power-operated chipping or milling tool.

As an additional feature of the present invention, the device 15 may be provided with improved means for removing not only the main portion of the excess material 56 formed during the bending operation, but also the additional portion 57 of such excess material. As indicated, the lower jaw plate 23, with its straightening or drawing bead 53 and its cutting tool 54, are carried by a traveling element or block 60 which is shiftable upon the lower jaw plate transversely of the center line A—A of the tool, a guiding arrangement, indicated at 61, being provided to insure straight line movement of the block 60 as the latter is forced to travel along the lower jaw plate, by means of an operating screw 62 threaded through the traveling block, and rotatably mounted in end plates 63 secured to the lower jaw plate.

A gear drive 64 is provided for the operating screw 62, the spindle 65 of this gear drive being arranged for operation by means of a crank handle or, as shown, through a sprocket 67, chain 68 and pinion 69 on the shaft of a motor 71 carried by the upper jaw plate 16.

In the operation of the apparatus last described, the traveling block 60 is adjusted to the position wherein the radially outer portion of the cutting edge of the tool 54 lies approximately in the center line A—A of the device, as previously described. The device may then be rotated in an anti-clockwise direction, with the lower jaw plate drawn up to bring the straightening bead 53 and the cutting edge 54 into operative position relative to the strip material, until the device is brought to the position shown in Fig. 2, wherein the 90 degree bend has been imparted to the strip material and the cutting tool 54 has removed the major portion of the excess material 56, the portion 57 of such excess material, however, remaining to be trimmed by a subsequent operation. With the device 15 in this position, the traveling block 60, with its straightening bead 53 and cutting tool 54, are reciprocated in such direction as to remove the excess material 57, power being applied to reciprocate the tool, by means of the motor 71. When the traveling block 60 has been reciprocated to a sufficient extent to enable the cutting tool 54 to remove all of the excess material 57, the traveling block with its tools are again withdrawn to normal position wherein the forward edge of the cutting tool is in line with the center line A—A of the device.

With the bending and shaving operation thus completed, the device may be removed from the strip material by retracting the lower jaw, and removing the pin which connects the extension 45 to the former block. The bent strip material may then be removed; or, in case it is desired that such strip be provided with a plurality of such 90 degree bends as in the case of forming a coil, a tool is removed to the adjacent former block about which the strip material is to be bent, and the operation described repeated. It will be apparent that by rotating the support 13 for the form 12 about its axis 14, any number of arc-shaped forms may be brought into operative position with respect to the bending device.

Where the labor of the combined bending and shaving operation is relatively great, this operation may be accomplished by means of a motor drive. As shown in Fig. 7, a support 81 may be mounted in fixed position relative to the form 12 or its supporting table 13, this support 81 carrying a motor 82 whose pinion 83 drives a gear 84 mounted upon a vartical reciprocating shaft 85. The lower end of the shaft 85 is provided with an extension 86 of such size as to fit within the alined aperture 46 of the extension 45 of the bending tool 15 and the corresponding aperture in the form 12, under which conditions the tool 15 is held in operative position, with an operating arm or crank 87 on the shaft 85 having a driving pin 89 engaged in a recess in the upper side of the extension 17 of the upper jaw plate. With the parts in the position shown, it will be apparent that when power is supplied to the motor 82, the crank arm 87, through its driving pin 89, supplies the power required to shift the device 15 to the extent required to produce the desired 90 degree bend with an accompanying shaving operation on the strip material. When the operation is completed, the shaft 85 and its crank arm 87 may be removed from operative position with respect to the form 12 and the bending tool 15, by means of the lever 90. The table 13 may then be rotated to bring an adjacent form into position wherein its axis is alined with that of the shaft 85 and the parts arranged to effect the next bending operation. If desired, the table 13 may be stationary and the support 81 for the motor drive may be shiftable to bring the shaft 85 in line with any desired form.

Instead of the use of an additional motor 82 for producing the power operation of the bending tool, the latter may be operated to effect the bending and the shaving operations, from the motor 71 which has been described as the source of power for producing the final shaving of the portion 57 of the excess material at the bend. To effect this operation through the motor 71, a train of gears connected to the motor pinion may be mounted upon the upper jaw plate 16, the final gear of the train, preferably provided with means for releasably clutching it to its shaft, being in such position as to mesh with a circular gear of gear section formed on and having its axis coinciding with the form 12. With the gears meshed and the drive operatively clutched to the motor pinion, it will be apparent that the tool will be driven by the motor 71 from the position A^1 to the position A^2, indicated in Fig. 2, after the effect of a planetary gear drive. When the bending operation is completed the drive connection between the gear train and the fixed gear segment on the form 12 may be released, and power may be supplied by hand or from the same motor 71 to drive the reciprocating cutting tool 54 to complete the removal of the excess material 57 on the under side of the bent strip material.

While a 90 degree arc has been described as the extent of a single bend accomplished with the apparatus herein described, obviously any less or greater bend may be

formed; and the bends may constitute parts of one or more complete turns of a coil. It will be obvious that by the improved process and apparatus herein described, bent strip material may be produced by a relatively simple operation and at a greatly reduced cost in the matters of apparatus, time and labor.

It should be understood that the invention claimed herein is not limited to the details of construction and operation shown and described, for obvious modifications will be apparent to persons skilled in the art.

It is claimed and desired to secure by Letters Patent:—

1. In apparatus for bending material about a form, a device adapted to move relatively to the form and operative during said relative movement to bend said material and to remove therefrom excess thickness thereof produced during the bending operation.

2. In apparatus for bending strip material, the combination of means for determining the shape to which said material is to be bent, and instrumentalities for bending said material to said desired shape while permitting increase in thickness of said material at the inner edge of the bent portions and for reducing the thickness of bent portions of said material at the inner edge thereof simultaneously with the bending of adjacent portions of said material.

3. In apparatus for bending strip material, the combination of a form and a combined bending and thickness-reducing device, said device and form being relatively movable and operative to produce the desired bending of said material and to reduce excess thickness produced on a portion of said material bent during said relative movement.

4. In apparatus for bending strip material, the combination of a form, and means for accomplishing a combined bending and thickness-reducing operation on said material, said means and said form being relatively movable and said means being operative to form the desired bend and to reduce a portion of the excess thickness of said material during the bending thereof and to remove another portion of the excess thickness subsequently to the completion of the bending operation.

5. In apparatus for bending strip material, the combination of a movable bending device, said bending device being cooperative with the material to cause said material to be bent to desired shape, and means operative with said bending device and cooperative with bent portions of said material for reducing excess thickness of said material produced during the bending thereof.

6. In apparatus for bending strip material, the combination of a form, and instrumentalities movable relative to said form and having a bending device and a cutting tool, said bending device and said cutting tool being adapted during said relative movement to bend said material and to reduce excess thickness thereof produced during the bending operation.

7. In apparatus for bending strip material, the combination of a form, and a movable element carrying a bending device and a cutting tool, said bending device and said cutting tool being movable about said form and adapted to cooperate with and bend said material against said form and to reduce excess thickness of said material produced during the bending operation.

8. In apparatus for bending strip material, the combination of a form, and means movable about said form and comprising instrumentalities operative to bend the strip material about said form and to simultaneously shave from said material excess thickness at the inner side of the bent portion.

9. In apparatus for bending strip material, the combination of a form, an element provided with a bending device and a cutting tool, said form and said element being relatively movable, said bending device being adapted during said relative movement to bend said material about said form, and said cutting tool being adapted to remove a portion of the excess thickness formed at the inner side of the portion of said material bent during said relative movement, and said cutting tool being movable relatively to said bending device and adapted during said latter movement to remove from said material a further portion of excess thickness thereof.

10. In apparatus for bending strip material, the combination of a form of curved outline, en element movable about said form, and provided with bending and cutting devices adapted to bend strip material about said form and to remove a portion of the excess thickness formed at the inner side of the bent portion of said material, and means for imparting to said cutting tool a further movement in a substantially straight line to cause said tool to remove a further portion of said excess thickness.

11. In apparatus for bending strip material, the combination of a form, a carrier movable about said form, bending and cutting tools mounted on said carrier, said bending tool being cooperative with said form and adapted to bend strip material about said form, said cutting tool being movable simultaneously with said bending tool and operative to remove from said material a portion of the excess thickness thereof formed during the bending operation, and said cutting tool having a movement relative to said bending tool and adapted therethrough to remove an additional portion of excess thickness of said material after the completion of the bending operation.

12. In apparatus for bending strip material, the combination of a form, an element movable about said form and adapted to bend a section of the strip material about said form, said element comprising relatively movable members, an abutment on one member, a cutting tool on another member, and means for holding the strip material against said abutment and said cutting tool in proximity to the opposite side of said strip material whereby said cutting tool is adapted to remove excess thickness of said material during the movement of said element.

13. In apparatus for bending strip material, the combination of a form, an element movable about said form and adapted to bend a section of said strip material about said form and to remove excess thickness produced at the inner edge of the bent portion of the material, an abutment on one member, a cutting tool on the other member, a smoothing element on said latter member in advance of said cutting tool, and adjustable means for holding said strip material against said abutment and said cutting tool in operative proximity to the opposite side of said strip material.

14. In apparatus for bending strip material, the combination of a form, an element movable about said form and adapted to remove excess thickness produced at the inner edge of a bent section of the material during the bending thereof, said element comprising relatively movable members, one of said members being pivotally mounted with respect to the other member, means for adjusting the position of the pivotal axis of said pivoted member, a cutting tool on said pivoted member, and means for holding said cutting tool in operative position relative to said strip material.

15. In apparatus for bending strip material, the combination of a form, an element movable about said form and adapted to bend a section of said strip material about said form, a cutting tool carried by said element, means for holding said cutting tool in cutting proximity to said strip material, means for operating said cutting tool relatively to its carrying element whereby said cutting tool is caused to remove excess thickness from said strip.

16. In apparatus for bending strip material, the combination of a form, an element movable about said form and adapted to bend a section of said strip material about said form, said element comprising relatively movable members, an abutment on one member, a cutting tool carried by the other member, and means for holding the strip material against said abutment and said cutting tool in cutting proximity to the opposite side of said strip material whereby said cutting tool is effective to remove excess thickness from a bent section of the material during the movement of said element, and means for shifting said cutting tool with respect to its carrying member to cause removal of a further portion of excess material from said strip.

17. In apparatus for bending strip material, the combination of a form, an element movable about said form and adapted to bend a section of strip material about said form, said element comprising relatively movable members, an abutment on one member, a cutting tool carried by the other member, and means for holding said strip material against said abutment and said cutting tool in cutting proximity to the opposite side of said strip material whereby said cutting tool removes a portion of the excess thickness of said material during movement of said element about said form, and means for shifting said cutting tool relatively to its carrying member to cause said tool to remove a further portion of excess material from said strip subsequent to the formation of a bent section of the material.

18. In apparatus for bending strip material, the combination of a form, an element movable about said form and adapted to bend a section of strip material about said form, a cutting tool carried by said element and operative during movement of said element about said form to remove from said material a portion of the excess thickness at the inner edge thereof, and means for causing operation of said cutting tool with respect to its carrying element to cause removal of a further portion of excess thickness of said strip subsequent to the formation of said bent section, said means comprising a motor carried by said element and drivingly connectible to said tool.

19. In apparatus for bending strip material, the combination of a form, an element having bending and cutting devices, said element being movable into and out of operative relation with respect to said form and the strip material thereof and being further movable with respect to said form and said strip material when said element is in operative relation therewith, and power-applying means detachably connectible in driving relation to said form and said element and adapted to effect the relative rotation thereof when said element is moved into operative relation to said form and cause said material to be bent about said form and the removal of excess thickness thereof at the bent section.

20. In apparatus for bending strip material, the combination of a plurality of forms, an element adapted for operative association with and movement about each of said forms and adapted to bend the strip material about said forms and to remove excess thickness produced at the inner edge

of the bent sections, a driving motor, and means connectible in driving relation with said element and the several forms interchangeably and adapted to move said element about each of said forms to cause bending of said material and removal of excess thickness thereof at the bent portions.

21. An improvement in the art of producing bent material subject to increase in thickness during the bending operation, which comprises bending said material to desired shape while permitting increase in thickness thereof at the inner edge of the bent portion and removing during said bending operation a portion of the excess thickness of said bent portion produced during said bending operation.

22. An improvement in the art of producing bent strip material subject to increase in thickness during the bending operation, which comprises removing during the operation of bending said material a portion of the excess thickness formed at the bend, and removing another portion of the excess thickness subsequent to the completion of the bend.

23. An improvement in the art of producing bent strip material subject to increase in thickness during the bending operation, which comprises bending said strip material while one face thereof is held against a relatively fixed abutment, and removing a portion of the excess thickness of the material from the opposite face of said strip material during the operation of bending the same.

24. An improvement in the art of producing bent strip material subject to increase in thickness during the bending operation, which comprises bending said material while one face thereof is forcibly held against a relatively fixed abutment, removing a portion of the excess thickness of the material from the opposite face thereof during the operation of bending the same, and removing the remaining portion of said excess material by an operation subsequent to the completion of the bend.

25. In apparatus for bending strip material, the combination of means for bending said material to desired shape, and means operatively associated with said bending means and operative upon portions of said material subsequent to bending thereof for reducing the thickness of said bent portions at the inner edge thereof.

26. In apparatus for bending strip material, the combination of means for bending said material to desired shape while permitting natural enlargement thereof at the inner edge of the bent portion, and a device operative during the bending of said material for removing excess thickness of enlarged portions thereof formed during bending.

In testimony whereof, the signature of the inventor is affixed hereto.

GEORGE F. JOHNSTON.

CERTIFICATE OF CORRECTION

Patent No. 1,656,003. Granted January 10, 1928, to

GEORGE F. JOHNSTON.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 5, line 105, claim 10, for the misspelled word "en" read "an"; page 7, line 14, claim 21, after the word "portion" insert a comma; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 14th day of February, A. D. 1928.

Seal.

M. J. Moore,
Acting Commissioner of Patents.