Feb. 6, 1934. W. THOMA 1,945,579

EDGE CURLING MACHINE

Filed July 22, 1932 3 Sheets-Sheet 1

Fig. 1.

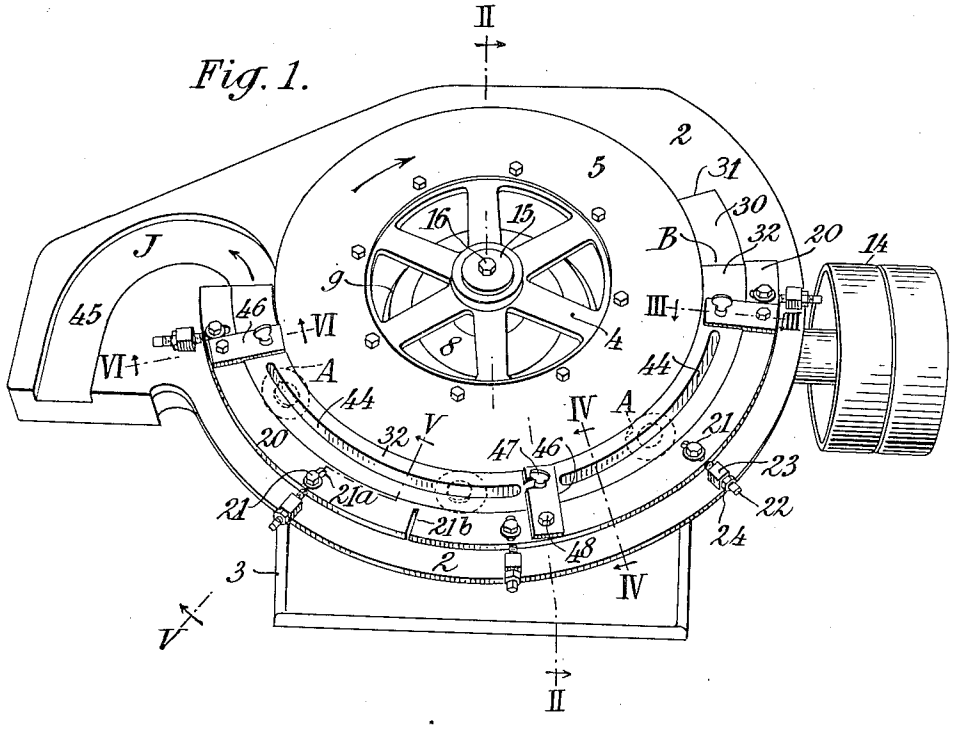
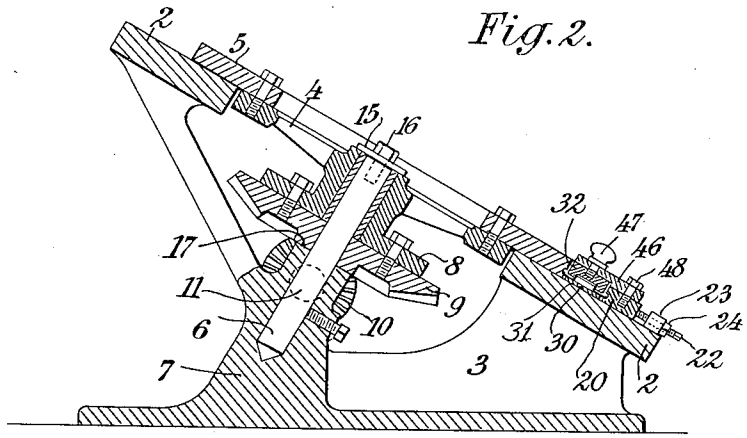


Fig. 2.



INVENTOR
Walter Thoma,
BY
Fraser Myers & Manley
ATTORNEYS.

Feb. 6, 1934. W. THOMA 1,945,579

EDGE CURLING MACHINE

Filed July 22, 1932 3 Sheets-Sheet 2

Fig. 3.

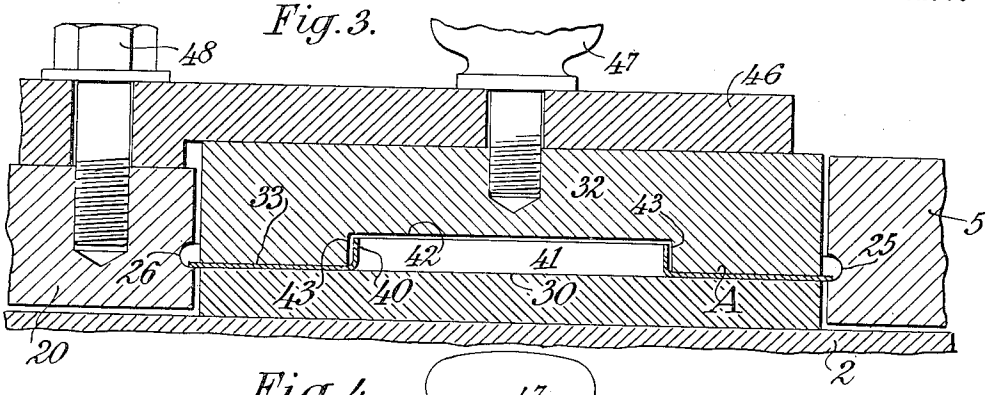


Fig. 4

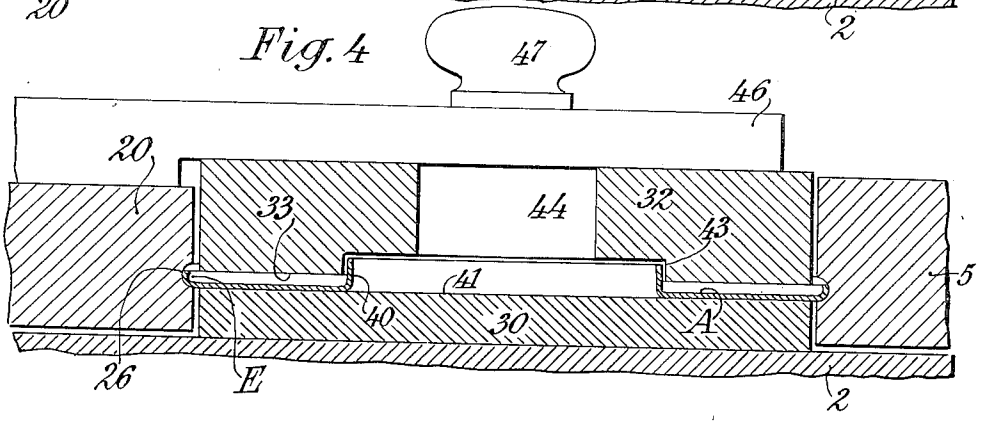


Fig. 5.

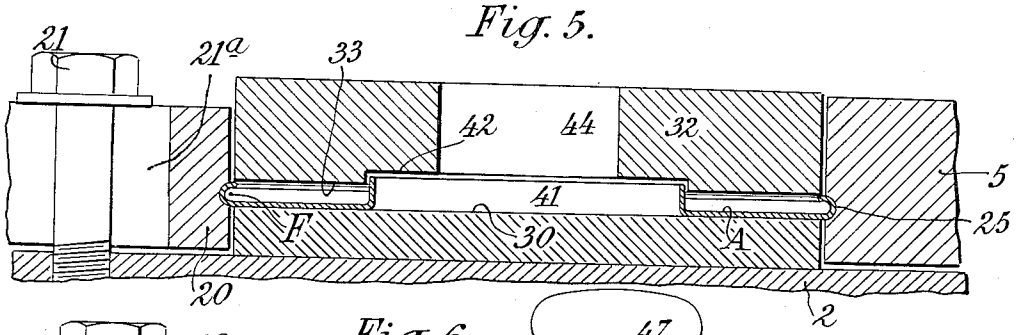
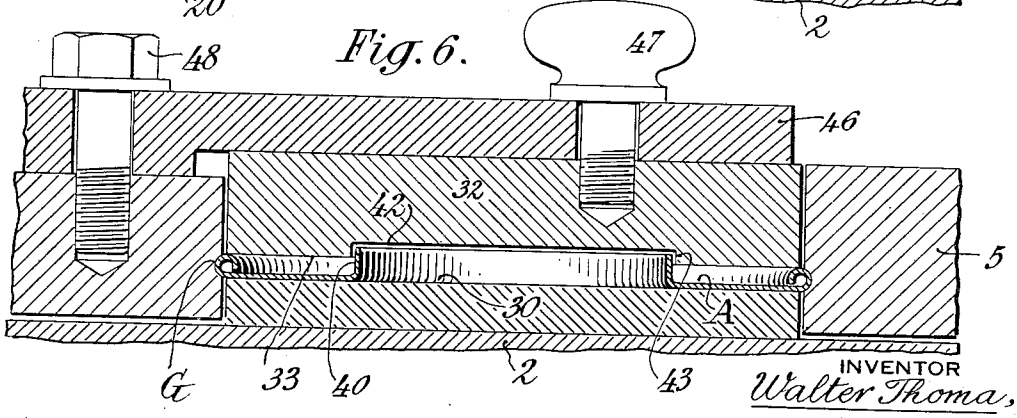


Fig. 6.



INVENTOR
Walter Thoma,
BY
Fraser Myers & Manley
ATTORNEYS.

Feb. 6, 1934. W. THOMA 1,945,579

EDGE CURLING MACHINE

Filed July 22, 1932 3 Sheets-Sheet 3

Fig. 7.

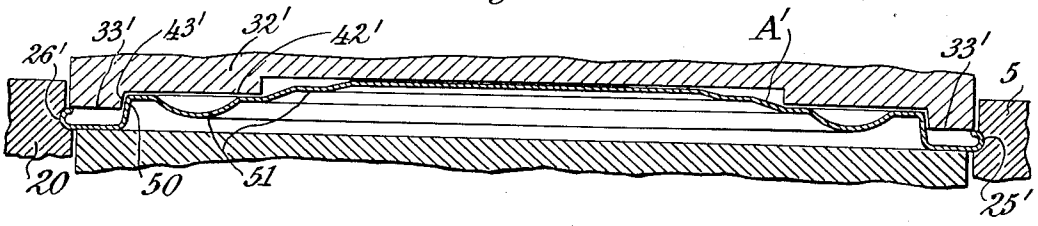


Fig. 8.



Fig. 9.



Fig. 11.

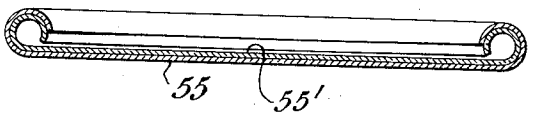


Fig. 12.

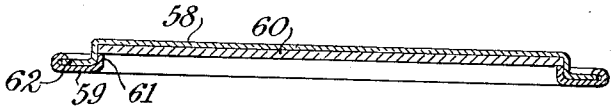
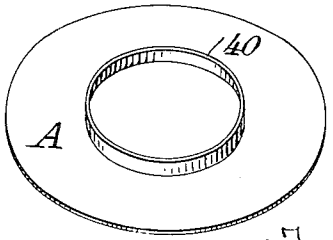


Fig. 10.



INVENTOR
Walter Thoma,
BY
Fraser Myers & Manley
ATTORNEYS.

Patented Feb. 6, 1934 1,945,579

UNITED STATES PATENT OFFICE

1,945,579

EDGE CURLING MACHINE

Walter Thoma, Hasbrouck Heights, N. J., assignor to E. W. Bliss Company, Brooklyn, N. Y., a corporation of Delaware

Application July 22, 1932. Serial No. 623,975

16 Claims. (Cl. 153—59)

This invention relates to mechanism for performing a curling or rolling operation on the edge of disks.

The invention aims to provide improved apparatus for performing various curling operations on the edges of disks. Such operations may include a wide range of edge-forming work from very slight curling of the edge, to provide what is known in the art as a "started" edge,—to an edge-curling operation that will result in a complete rolling of the edge in upon itself to provide a peripheral bead of substantially circular cross-section. The device is applicable to a variety of commercial uses, as, for example, the various edge-turning or curling operations required in the formation of the disk ends for metal cans, or for curling or rolling in the edges of sheet metal disks whereby to produce a peripheral reinforcing roll or bead, sometimes described as a "wired edge". The latter operation is advantageously employed to eliminate the sharp edges of disks stamped from thin sheet metal, the rolled edge thus obtained being perfectly smooth and materially improving the appearance of the finished article.

The present invention more particularly provides novel blank-supporting, confining or guiding means adapted to accurately position the edge of the work relative to the curling tools or dies. As applied to machines employing the conventional "wheel and ring" curling tools, the invention greatly extends the utility of such machines, adapting them to the accurate performance of various curling operations hitherto requiring more complicated mechanism. Such adaptation of the present invention provides a very simple curling apparatus of general utility, which will rapidly turn or curl the edges of blanks fed thereto in continuous succession, the apparatus being capable of immediately acting upon a blank without any regard to timing, so that it may be combined with various automatic machines supplying a succession of blanks without any necessity for synchronizing the operation of the two mechanisms.

The invention is further adapted for curling the edges of disks having central or interior portions which do not lie in the plane of the disk edge, special guiding means being provided to engage said interior portions whereby to prevent any buckling or warping of the central disk area, even when very thin disks are employed. Such guiding means may also be used to positively center the disk between the curling tools, although such centering function will ordinarily be performed with sufficient accuracy by the self-centering tendency of the disk when advanced between the opposed working faces of the curling tools.

The invention further aims to provide curling apparatus which may be readily adjusted to handle disks of various sizes and to perform various curling operations upon the edges thereof. While the invention is particularly applicable to the conventional "wheel and ring" curling apparatus, certain of its features may be advantageously employed with other forms of curling mechanism.

Further objects of the invention will be apparent from the following description in which reference is had to the accompanying drawings, and wherein,—

Figure 1 is a front elevation of the preferred form of curling apparatus according to the present invention.

Fig. 2 is a vertical axial section taken along the line II—II of Fig. 1.

Figs. 3 to 6 inclusive are fragmentary radial cross-sections taken, respectively, along the lines III—III to VI—VI inclusive of Fig. 1, showing the typical relationship of the disk blank to the working faces of the tools and guides at three different points along the path of travel when the apparatus is adjusted to produce a full roll or curl of the disk edge. In the particular embodiment illustrated, the guideway is adapted to receive a blank having an upstanding internal flange.

Fig. 7 is a cross-section through somewhat modified tools and guides, according to the present invention, adapted to form the conventional curled edge upon a can end, the curled edge being that required as a step in the formation of the usual seam by which the end is attached to the can body.

Fig. 8 is an enlarged cross-section of a form of "started" edge heretofore provided in blanks before they could be successfully used in the conventional arrangement of ring and wheel curling dies.

Fig. 9 shows the same blank after it has been acted upon by the said dies as conventionally employed.

Fig. 10 shows one form of blank that may be used in the apparatus according to Figs. 1 to 6.

Fig. 11 shows the edge-curling operation applied to a laminated blank.

Fig. 12 shows how the curling operation may be applied to secure or seam together the disk edges of two differently formed blanks or articles.

Referring to the drawings, the embodiment

illustrated comprises a rigid table or bed, 2, which is supported preferably at an angle upon a rigid box-frame 3. The slope of the table is such as to permit the blanks which are fed thereto, to slide under their own weight into engagement with the tools, as will hereinafter appear. The table 2 is centrally apertured to receive a rotatable frame or spider 4, upon the upper face of which is rigidly secured an annular curling wheel 5. The spider 4 which carries the curling wheel is mounted upon, and freely revolves about, a shaft 6, the lower end of said shaft being rigidly secured in a suitable bracket 7 forming a part of the framework of the machine. The lower hub portion of the curling wheel spider carries an integral flange 8, upon which is secured a bevel gear 9. A driving pinion 10 meshing therewith is secured at the inner end of a horizontal shaft 11, suitably journaled in the side wall of the box-frame 3. This shaft may be driven in any desired manner, as, for example, by means of a pulley 14.

The curling wheel assembly is retained on the shaft 6 by means of a hold-down disk 15 secured to the end of said shaft by a screw 16. At the lower end the hub of bevel gear 9 bears against the upper face 17 of bracket 7. In this manner the curling wheel assembly, while freely rotatable about the shaft 6, is held against axial displacement relative thereto, the wheel 5 accurately revolving in a plane parallel to the face of table 2.

A cooperating arcuate curling tool or ring-die 20, spaced apart from the curling wheel 5 and embracing an arc of approximately 180° thereabout, is rigidly secured upon the face of table 2 by a plurality of screws 21. These screws pass through radial slots 21*a* in said ring-die, thus permitting its radial adjustment relative to curling wheel 5. Such adjustment is rigidly maintained by a plurality of radially-disposed set screws 22, which are threaded into lugs 23, rigidly secured to table 2, lock nuts 24 being provided to hold said screws in a desired adjustment. The curling ring 20 is conveniently formed as a segment of a circular annulus, the inner or working face of which has a radius of curvature substantially equal to its own radial distance from the axis of the curling wheel at the point where the blank enters between the curling ring and wheel (as at B in Fig. 1). As mounted upon the table, the curling ring 20 is not, however, concentric with the curling wheel 5, but from the point B very gradually approaches the working face of said wheel. This convergence of the cooperating working faces of the wheel and slightly eccentric ring results in their progressive curling action upon the blank as the latter rollingly advances therebetween. If desired, the ring may be radially slotted, as shown at 21*b*, to permit a freer relative adjustment of its parts. Such slotting is equivalent to sectionalizing the ring inasmuch as it permits the segments to be readily set to different degrees of convergence relative to the cooperating curling wheel should such adjustment be required.

The working faces of the curling wheel 5 and curling ring 20 are provided with opposed curling grooves 25, 26, which may be of any desired contour, depending upon the character of curl or roll that is required to be imparted to the edge of the blank. These grooves are preferably of uniform depth throughout their entire length and both lie in the same plane. At the point where the blank enters, the wheel and ring are preferably spaced apart a sufficient distance, so that the edges of the blank do not initially project into the grooves far enough to receive any appreciable curling action. Due to the slight friction of the revolving curling wheel 25 against the edge of the blank, and also due to the weight of the blank (when an inclined table is provided) the blank advances along the circular path between the converging surfaces of the tools, i. e., between the rotatable curling wheel 5 and the fixed curling ring 20. As the blank progresses, the convergence of the tool surfaces results in a progressively deeper penetration of the edges of the blank within the curling grooves, the increasing frictional engagement of the edge of the blank with the curling wheel groove 25 forcing said blank to revolve, the latter rolling along the stationary tool surface 26, being thus rollingly propelled by its wedging engagement within groove 25 of rotating curling wheel 5.

The general method of rollingly advancing a disk blank between a curling wheel and ring is well understood in the art, and has been employed for many years. Hitherto, the use of such method has been limited to operations which involved nothing more than merely increasing the degree of curl or roll that had been initially imparted to the edge of the blank in another machine. For example, the method has been employed to slightly turn in the "started" edge of a can end, the edge of the blank having been previously turned upwardly as far as practicable in a reciprocating die press, the edge initially having a curvature or curl resembling that illustrated in Fig. 8, wherein the so-called "started" edge is shown at C. Such blanks, after being operated upon by the usual curling ring and wheel arrangement, have the slightly increased curl, as indicated at D in Fig. 9, this being the form of curled edge that is ordinarily required in preparing a can end to be seamed to a can body. As far as I am aware, it has not heretofore been possible to accurately produce a curled edge on an initially flat blank directly in a curling machine embodying the conventional principle of the curling ring and wheel, and although apparatus of this nature is ideally simple in construction, rapid in operation, and possesses the further advantage of having but a single moving element which rotates at a uniform speed, its use has been practically restricted to the one operation of increasing the curl at the edge of a blank which has already been "started".

The improvement according to the present invention makes possible the utilization of ring and wheel curling dies for "starting" the edge of an initially flat disk and progressively curling such edge to any desired degree, even to the point of rolling the edge completely in upon itself to form a perfectly rounded peripheral bead on the blank. In order to start the curling operation, it is obviously necessary to subject the initially flat edge of the blank to very considerable rolling pressure, and the same is true when, in the further progress of the blank between the tools, it is desired to turn the edge in upon itself to form a round bead. The unsupported blank is often incapable of withstanding any such pressures without buckling. Furthermore, it is essential to support the edge of the blank, as it is progressively curled, very close to the working faces of the curling dies, in order to insure the proper and accurate positioning of the blank edge relative to the grooved working faces of the dies. As far as I am aware, this has not hitherto been accomplished.

According to the present invention, novel

means are provided for closely confining the edge of the blank and holding the latter in a predetermined position relative to the curling grooves, such confining action being continuously operative to positively guide the blank and position its edge while said edge is being curled away from the plane of the blank. In spite of the fact that the edge of the blank is progressively varying in height during at least a substantial part of the curling operation, it is possible, according to the present invention, to so effectively support the blank at all times that it is incapable of buckling and its edges will be presented to the curling tools in an accurately predetermined relationship. In the preferred construction, this is accomplished in the following manner: The lower face of the blank A moves along a flat guiding surface 30 which lies between the curling ring 20 and curling wheel 5. This surface is parallel to, and at the level of, the lower edges of the curling grooves 25, 26. If desired, the surface may be machined on the face of the table 2, or a ring 31 of suitable form may be secured on the face of said table, as indicated in Fig. 2; such ring practically filling the gap between the working surfaces of the wheel and ring dies, so as to support the blank very close to the working faces thereof.

An upper guide member 32 is supported in the gap between the curling wheel and ring, this guide member being so formed as to present guiding surfaces 33 which are slightly inclined along the path of travel of the blank, the inclination of said guiding surfaces relative to the lower guiding surface 30 being such as to provide a gap therebetween which closely approximates the increasing height of the curled edge of the blank as the latter advances along the guides and between the curling dies. The initial relationship of the upper and lower guiding surfaces at the commencement of the curling operation is shown in Fig. 3. It will be seen that the flat edge of the blank A is closely confined between said guiding surfaces, although being free to slidingly advance therebetween. As hereinbefore set forth, the blank is rolled forward, due to the engagement of its edge with the revolving curling wheel, and as the blank advances its edge is progressively curled away from the plane of the blank. When the blank has reached the position IV, in Fig. 1, for example, the edge will have been curled as indicated at E, in Fig. 4. During this curling operation the upper guiding surfaces 33 of the guide member or hold-down plate 32 have been diverging from the lower guide 30 so that the gap between the upper and lower guiding surfaces continues to be substantially equal in height to the progressively increasing elevation of the curled edge. In this manner, such edge is continuously supported throughout the aforesaid travel of the blank. This condition is clearly apparent in Fig. 4. The further progress of the blank brings it to the line V—V (Fig. 1) where the relationship of the guiding surfaces to the curled edge is as indicated in Fig. 5. Although after the edge has been well "started" and curled somewhat less than as represented at F in Fig. 5, it has a certain tendency to center itself in the curling grooves 25, 26, the curl will be more accurately formed and with less likelihood of buckling the blank if the positive guiding function of the upper and lower guides is maintained. This is mentioned merely to indicate that it is not absolutely essential to make use of the divergent guiding surfaces according to the present invention after the blank has reached the point where the curl is well "started", although it is preferable to employ such guiding surfaces throughout the entire edge-curling operation. After the edge has been curled to the form indicated at F in Fig. 5, it may be further rolled in upon itself to produce a circular bead, as shown at G in Fig. 6. Such further curling of the edge does not involve any increase in height of the curl, and consequently the upper guiding surfaces 33 from line V—V to line VI—VI in Fig. 1 are maintained parallel to the lower guiding surface 30 throughout this range, their mutual guiding action continuing to support the edge of the blank and preventing any buckling along such edge that would otherwise result from the relatively heavy pressure required to produce the fully rounded bead.

The foregoing description applies to the edge-curling and edge-guiding operation, applicable alike to all forms of blanks. When blanks having centrally elevated portions are employed, such portions may cooperate with additional guiding surfaces to insure against any buckling of the blank at its interior. This additional guiding is only required when very thin material is used, or when the blanks are of relatively large diameter so as to be very flexible. It will be apparent that, as applied to the conventional "wheel and ring" method of curling, such interior guiding can only be accomplished so long as the height of the centrally elevated portion of the disk blank exceeds the height of the curled edge, as otherwise the interior guiding surfaces would interfere with the further curling of such edge. It will be understood that such guiding of an interior portion of the blank is in no sense a substitute for the guiding or supporting function of the edge-guiding rails or surfaces 33, as hereinbefore set forth, whereby the edge of the blank is securely maintained in an accurately predetermined relationship to the working grooves of the curling tool.

If a blank such as shown in Fig. 10 is to be used, the guiding surfaces are appropriately formed to accommodate the raised central portion of the disk which, in the example shown, consists of an internal flange 40. This flange is concentric with the circular margin of the disk A. This particular blank is used for forming the ends of bobbins or spools. As shown in Fig. 3, the guide or hold-down plate 32 is centrally channeled on its under surface to provide a guide-way 41, into which the internal flange 40 projects, the upper edge of such flange bearing against the smooth guiding surface 42 in said guide-way. Since the height of flange 40 remains constant, guiding surface 42 lies in a plane parallel to the bottom guide 30 throughout its entire length. On the other hand, the edge-guiding surfaces or rails 33 extend on a gentle incline throughout a substantial part of their length, as hereinbefore described, in order to accommodate the progressively-increasing height of the curled edge of the blank. It will therefore be apparent that in forming the hold-down plate 32, the depth of channel 41 throughout at least a substantial portion of its length, will gradually decrease. This is seen in the progressive diminution in the vertical depth of channel walls 43, as viewed in the successive cross-sections (Figs. 3, 4 and 5).

If desired, the vertical walls of channel 41 may be so related to the internal flange 40 of the blank as to positively center the latter between the working grooves 25, 26 of the curling tools, as seen, for example, in Fig. 3. If this action is desired, the channel 41 should be machined

to a nice sliding fit, providing adequate width to permit the free rotation and linear advance of the flanged disk while holding it at the required radial distance from the center of curling wheel 5. The channel will therefore be of slightly spiral contour, in order to move the blank inwardly as the edge thereof is progressively curled, the center of the blank always remaining equidistant from the convergent working surfaces of the curling tools. As hereinbefore noted, such radial guiding of the blank is not necessary except when working on very thin material, or when it is desired to form a curled edge of unusually accurate contour, inasmuch as the tools automatically tend to center the blank between their working surfaces.

It may be here noted that the hold-down plate 32 may be conveniently provided with central slots or apertures 44 through which the blank may be inspected as it travels between the tools. After being curled, the blanks are normally ejected at the point J, and are conveyed along a suitable guide-way 45 to any desired point. Should it be necessary to extract a defective blank from between the tools, this may readily be accomplished by removing the hold-down plate 32. Said plate is attached to its rigid supporting cleats or brackets 46 by wing screws 47 which when removed permit the arcuate hold-down plate to be slipped endwise from between the curling wheel and ring. Because of the convergence of the tool surfaces and the corresponding tapering width of the plate, the latter must be withdrawn in a counter-clockwise direction, as viewed in Fig. 1. If desired, the screws 48 which secure the cleats 46 upon ring 20 may be loosened, thus permitting said cleats to be turned out of the way, so that the hold-down plate may be lifted directly from between the tools.

It may also here be noted that the described mounting of the hold-down plate permits the latter to be adjusted vertically at one or more points by placing shims of the required thickness either between the plate and cleats or between said cleats and the ring 20 upon which they are mounted. Ordinarily such adjustment is not required, inasmuch as the hold-down plate and its supporting cleats are preferably accurately formed to provide the required divergence and clearance between the upper and lower guiding surfaces 30, 33, as hereinbefore set forth. If blanks of different thickness are to be operated upon, or various types of curling operations performed, such capacity for adjustment will, within certain limits, adapt one hold-down plate to various work.

In Fig. 7 there is shown in cross-section a somewhat modified set of tools and guides adapted to curl the edge of an annularly corrugated can end. The blank A' is initially stamped out with either a flat or "started" edge, as desired, its central portion being embossed with concentric corrugations 50, 51, as shown. The internal and external curling grooves are shown, respectively, at 25' and 26'. The inclined edge-guiding rails 33' are similar to the guiding elements 33 hereinbefore described, their inclination being designedly such as to maintain their guiding surfaces in contact with the edge of the blank throughout a substantial part of the travel of the blank between the curling dies.

The hold-down plate 32' is centrally channelled out to receive the embossed or elevated central portion of the blank A', the guiding surface 42' of said channel being parallel to the lower guiding surface 30', the said surfaces closely confining the central portions of the blank while permitting the free advance thereof between the curling tools. If desired, the wall surfaces 43' of the guide-way in the hold-down plate may be so formed as to positively center the disk in the manner hereinbefore described, said walls bearing against the concentric annulus 50 initially formed in the blank and thus positively guiding the blank in a predetermined path relative to the curling tools.

In the foregoing description the relationship between the guiding surfaces and curling grooves has been considered as applied to blanks having upstanding internal portions and where the edge of the blank is curled upwardly. Obviously, the relationship of the upper and lower guiding surfaces may be reversed and the edge may be curled downwardly if desired.

It is believed that any further detailed description of the operation of the apparatus according to the present invention is unnecessary, inasmuch as such operation has already been full explained. Briefly summarized, the operation is as follows. Circular blanks are successively fed in any desired manner to the entrance B between the ring and wheel curling tools 5, 20. The rotation of wheel 5 causes the rolling advance of the blank therebetween, the convergence of the working surfaces of the tools resulting in a progressive curling of the edge of said blank. During at least the initial portion of the travel of the blank, its edges are accurately guided between divergent guiding surfaces 30, 33, the divergence of said surfaces being such as to closely accommodate the height of the edge as the latter is progressively curled away from the plane of the blank. The said guiding surfaces thus maintain the edge of the blank in accurately predetermined relationship to the curling grooves of the wheel and ring, their edge-supporting effect occurring immediately adjacent to the said grooves. If the blank is provided with interior portions which extend above the height of the curled edge, the central area of the blank may be supported against buckling by the provision of upper and lower parallel guiding surfaces, as hereinbefore described, and the blank may also be positively guided in such manner as to insure its being accurately centered between the working faces of the tools. The curling tools may obviously be formed and adjusted to provide any desired form of curl, from that known as a "started" edge to a fully rounded peripheral bead, as shown in Fig. 6; the size and curvature of the curl depending upon the particular form of the curling grooves; and the extent to which the curling operation is carried, depending upon the convergence of the working surfaces of the tools throughout the length of travel of the blank.

The apparatus according to the present invention is applicable to edge-curling operations upon laminated or assembled articles, as well as upon single disks, and the articles may be flat or have integral or separate central portions which do not lie in the plane of the disk edge. Such curling operations may include any desired form or degree of curling, from a slight turning of the edge, to an operation which involves turning the edge inwardly into contact with a surface of the article which is being curled. In Fig. 11, for example, there is shown how the edge-curling effect may be applied to a laminated blank. Obviously, the disks 55, 55' must be initially secured together so that they will advance as a unit through

the curling mechanism. This does not require that they be very securely held together, inasmuch as there is practically no strain tending to separate them during the initial phases of the curling operation, and once the curl is well started, they are effectively bound together by the engagement of their curled edges. The initial attachment of the disks may be made by any good cementitious material, or they may be soldered or otherwise connected, as desired.

In Fig. 12 there is shown a further example of how the edge-curling operation may be utilized to securely connect the edges of circular articles. In this instance the upper part of the article consists of a shallow circular receptacle 58, while the lower part consists of a ring or frame 59 adapted to retain a flat, disk-like object 60 within said receptacle. The ring is formed with an internal flange 61 which fits snugly within the receptacle 58 and bears against the retained article 60, thus holding the latter in place. If with the parts thus assembled, the edge of ring 59 is curled in the manner hereinbefore described, such edge will be bent around and confine the edge 62 of the receptacle so that the parts are securely locked together.

From the foregoing examples, it will be seen that the curling apparatus according to the present invention is applicable to edge-curling operations on a wide variety of simple or composite articles having circular edges like those of a simple disk. In the appended claims the term "disk" is therefore not limited to flat circular articles, but is applicable generally to any blank or article having an annular marginal portion which is susceptible of being curled in the described manner.

The invention is not limited to the specific constructions hereinbefore described and illustrated, but may be otherwise variously modified and embodied without departing from the spirit thereof, as set forth in the following claims.

What I claim is:

1. Apparatus for curling the edges of disks, comprising curling dies between which a disk is engaged, means adapted to effect a relative rolling movement between said dies and the edge of said disk, the working surfaces of said dies approaching one another whereby to progressively increase their curling action on the disk edge, and opposed guiding elements adapted to confine the progressively curled edge of said disk in a predetermined operative relationship with respect to said dies, said guiding elements being adapted to afford progressively increasing space between their confining surfaces, so that while effectively supporting the disk, said surfaces progressively accommodate the increasing height of the disk edge as the latter is curled by the action of said dies.

2. Apparatus for curling the edges of disks, comprising internal and external curling dies between which a disk is rollingly engaged, means for effecting relative rotation of said dies, whereby to curl the edge of said disk, the working surfaces of the said dies approaching one another whereby to progressively increase their curling action, and the opposed guiding surfaces adapted to engage the progressively curled edge of said disk at points adjacent to the said curling dies and thus closely confine the disk edge within a predetermined path relative to said dies, said guiding surfaces progressively separating along said path so that, while effectively guiding said disk, said surfaces progressively accommodate the increasing height of the disk edge as the latter is curled by the action of said dies.

3. Apparatus for curling the edges of disks, comprising a central curling die, an arcuate curling die cooperating therewith, driving means to rotate one of said dies, the cooperating die surfaces converging so as to progressively curl the edge of the disk advancing therebetween, a guideway adapted to confine the disk within a predetermined path as the latter rolls between said dies, said guideway having divergent guiding surfaces which, while continuously guiding the disk, progressively afford the requisite separation to accommodate the increasing height of the disk edge as the latter is curled by the action of said dies.

4. Apparatus for curling the edges of disks, comprising a rotatable circular curling die, a fixed arcuate curling die cooperating therewith, said dies receiving a disk between their working faces, the rotation of said circular die effecting a rolling advance of the disk and subjecting the edge thereof to the curling action of said dies, the surface of the arcuate die gradually approaching that of the circular die whereby to progressively curl the edge of the disk as the latter is rolled therebetween, and disk guiding means comprising a guiding surface parallel to the plane of rotation of said circular die, and an opposed divergent guiding surface, the divergence of the latter surface being such as to accommodate the increasing height of the disk edge as the latter is progressively curled by the action of said dies.

5. Apparatus for curling the edges of disks, comprising a rotatable circular curling die, a fixed arcuate curling die cooperating therewith, said dies being adapted to receive a disk between their working faces and to rollingly advance said disk and progressively curl the edge thereof, and guiding means adapted to closely guide said disk in a predetermined path relative to the plane of said dies, said guiding means comprising divergent guiding surfaces engaging opposite sides of the disk, the divergence of said surfaces being such as to permit the edge of the disk to be progressively curled away from the plane of said disk as the latter advances between the dies, said disk being effectively guided by the continued engagement of its curled edge with one of the said guiding surfaces while the opposite side of the disk is supported by the other of said guiding surfaces.

6. The apparatus according to claim 5 further characterized in that the said arcuate curling die is radially adjustable at a plurality of points whereby to regulate the distance between the working faces of said dies and thus determine the rate at which the curl is formed in the disk as it rolls therebetween.

7. The apparatus according to claim 5, further characterized in that adjusting means are provided to regulate the divergence of the said guiding surfaces whereby to adapt them to different rates of curling which result from various die settings.

8. Apparatus for curling the edges of disks, comprising cooperating grooved curling dies adapted to rollingly engage and progressively curl the edge of a disk, a flat guide plate lying between said dies and parallel to the grooves thereof, and an inclined guide rail adjacent to each of said dies, the space between said guide rails and said guide plate varying in accordance with the progressive change in elevation of the disk edge caused by the curling action of said dies.

9. The apparatus according to claim 8, further

characterized in that for curling the edges of disks having elevated interior parts, a secondary guiding surface is provided between the said guide rails, said secondary guiding surface being parallel to the said guide plate and at such distance therefrom as to engage the said elevated interior part of the disk.

10. The apparatus according to claim 3, further characterized in that the said divergent guiding surfaces occupy the marginal portions of the said guideway extending along the die surfaces whereby to confine and guide the progressively curled edge of the disk at points adjacent to the working faces of said dies, the portion of said guideway lying between said marginal portions being adapted to provide non-divergent surfaces between which an initially elevated interior portion of the disk may be effectively guided whereby such disk may be simultaneously guided both interiorly and adjacent to the working faces of said dies.

11. Apparatus for curling the edges of disks, comprising a circular curling die, an arcuate curling die cooperating therewith, said dies having grooved working faces, a guide surface between said dies, said surface lying in a plane substantially coincident with one edge of said grooves, and an opposed guiding surface which at the entrance between said dies is separated from said first mentioned guiding surface by the thickness of the disk that is to be curled, the said opposed guiding surface extending on a gradual slope until it is substantially at the level of the other edge of said die grooves.

12. The apparatus according to claim 11, further characterized in that the said opposed guiding surface has an extension beyond its sloping portion, said extension being substantially parallel to the die grooves whereby the gap between the said guiding surfaces remains uniform throughout the travel of the disk during which the continued curling action of the dies produces no further increase in the height of the curled edge.

13. Apparatus for curling the edges of disks, comprising cooperating grooved curling dies adapted to operatively engage the edge of a substantially flat marginal border of a blank disk and progressively curl the said edge as the disk is rolled between said dies, and disk-confining means adapted to hold said disk in the required attitude while it receives the curling action of said dies, said confining means on one side continuously engaging points on the curling edge of the disk, the height of which is being progressively increased and said confining means on the opposite side engaging the uncurled surface of said disk.

14. Apparatus for curling the edges of disks, comprising a central curling die, an arcuate curling die cooperating therewith, driving means to rotate one of said dies, the cooperating die surfaces converging so as to progressively curl the edge of the disk advancing therebetween, and a guideway adapted to confine the partially curled edge of said disk at points adjacent to the working faces of said dies whereby to maintain said edge in the required plane to receive a further curling operation as the disk advances between said dies.

15. Apparatus for curling the edges of disks which have a central portion at a different elevation from the plane of the disk edge, said apparatus comprising a circular curling die, an arcuate curling die cooperating therewith, driving means to rotate said circular die, and upper and lower guiding surfaces parallel to the plane of rotation of said circular curling die, said surfaces closely confining the said central portion of the disk at points remote from the disk edge and thus guiding said central portion within a fixed path whereby to centrally support the disk as the disk rolls between and marginally receives the pressure of the curling dies.

16. Apparatus for curling the edges of circular disks which have a concentric central portion at a different elevation from the plane of the disk edge, said apparatus comprising a circular curling die, an arcuate curling die cooperating therewith, driving means to rotate said circular die, and an arcuate guideway disposed between said dies, said guideway being adapted to receive and radially guide the said central portion of the disk relative to the curling dies whereby to positively center the disk between said dies.

WALTER THOMA.

CERTIFICATE OF CORRECTION.

Patent No. 1,945,579. February 6, 1934.

WALTER THOMA.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, line 98, for "full" read fully; page 6, line 81, claim 13, for "curling" read curled; and line 108, claim 15, after "disk" first occurrence insert the words against buckling; 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 20th day of March, A. D. 1934.

F. M. Hopkins

(Seal) Acting Commissioner of Patents.