April 19, 1932. C. L. LEE ET AL 1,854,944

MEANS AND METHOD FOR MAKING METALLIC BELLOWS

Filed March 9, 1929 3 Sheets-Sheet 1

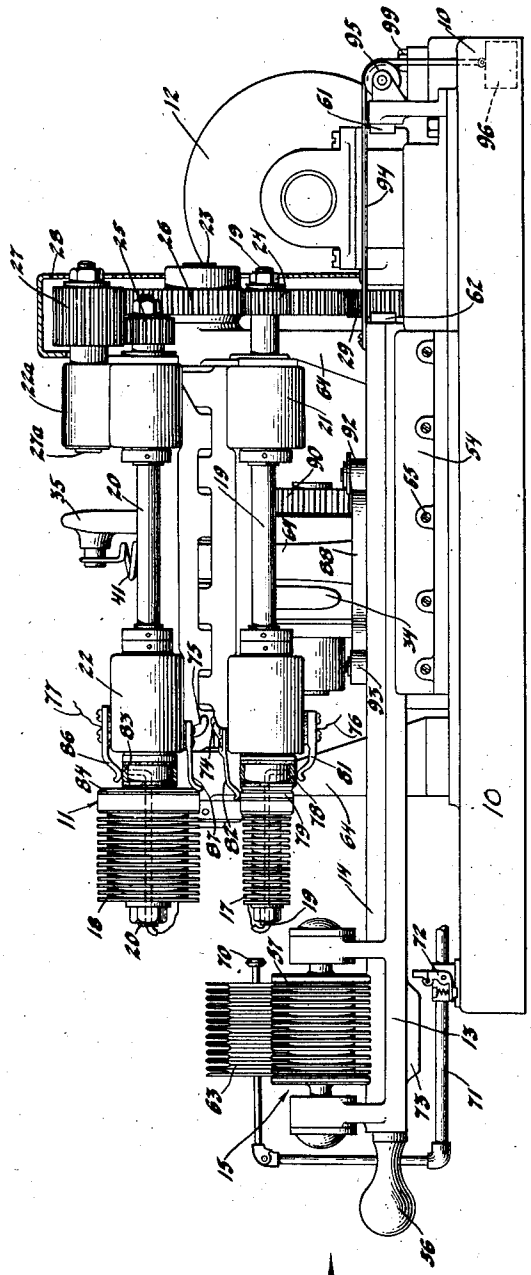

Fig. 1.

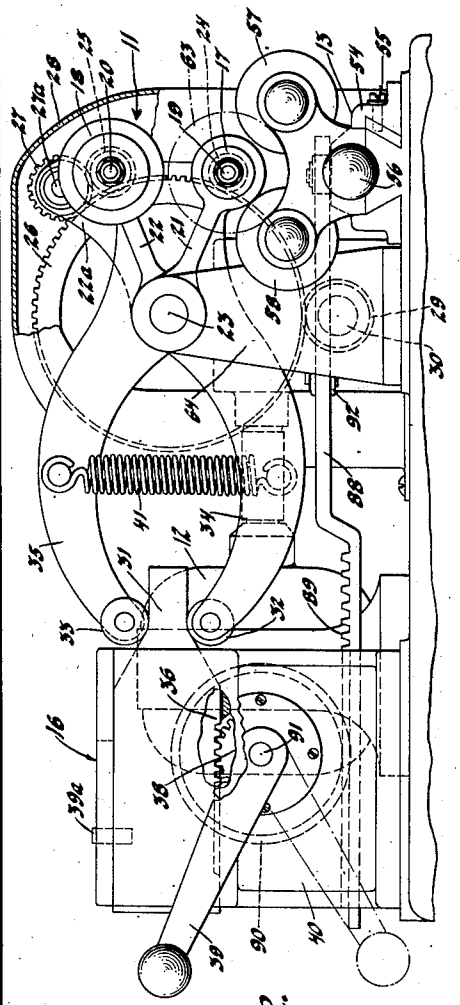

Fig. 2.

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Filed March 9, 1929 3 Sheets-Sheet 2

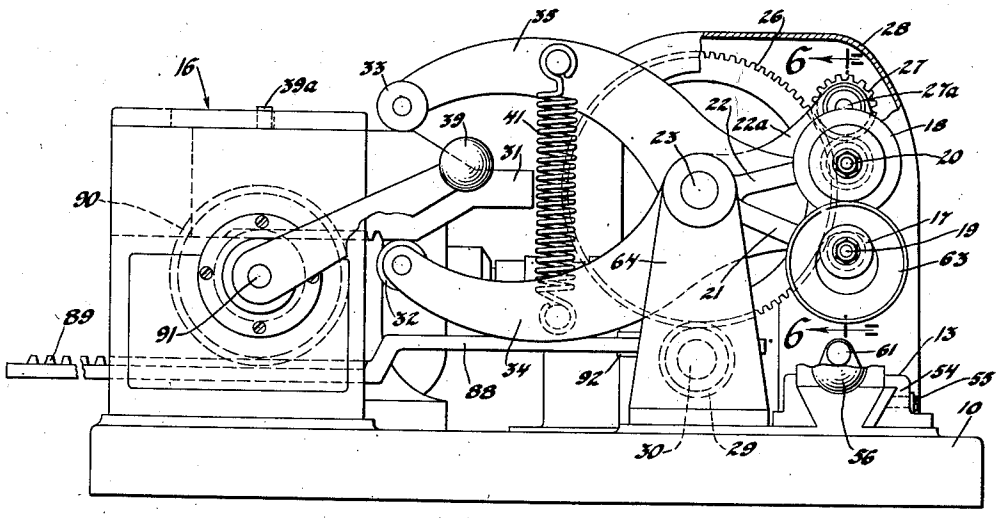

Fig. 3.

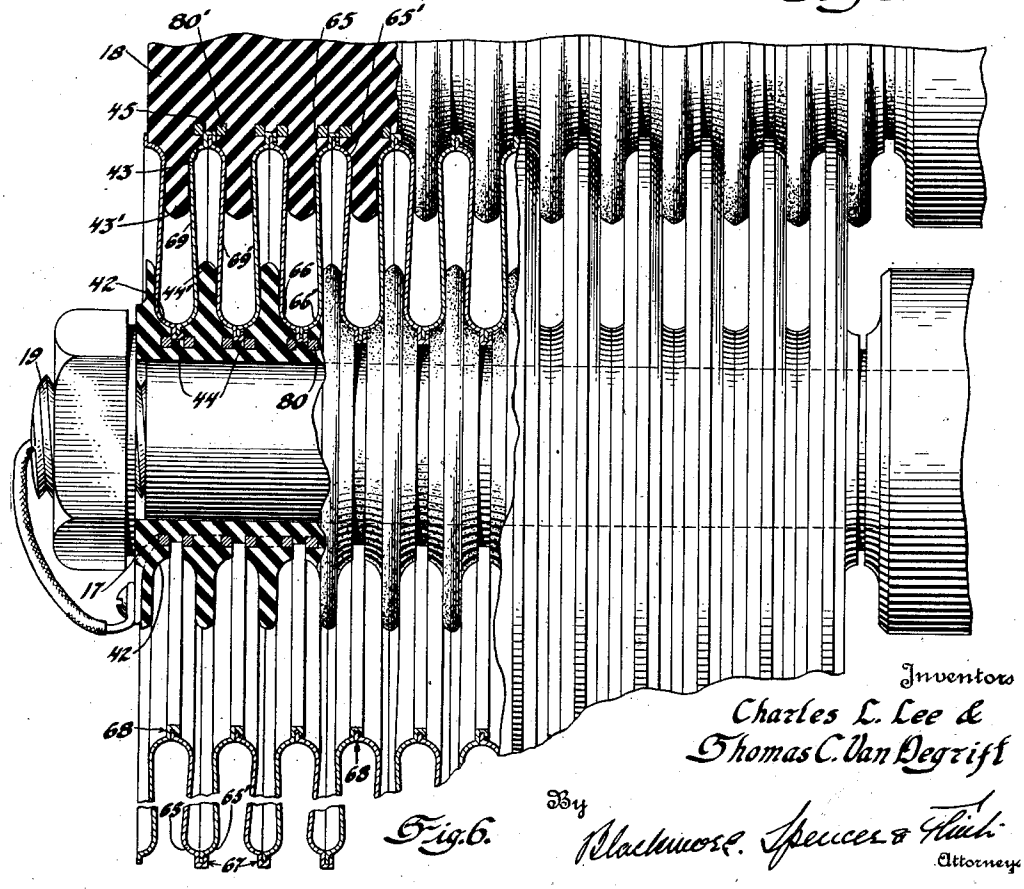

Fig. 6.

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MEANS AND METHOD FOR MAKING METALLIC BELLOWS

Filed March 9, 1929 3 Sheets-Sheet 3

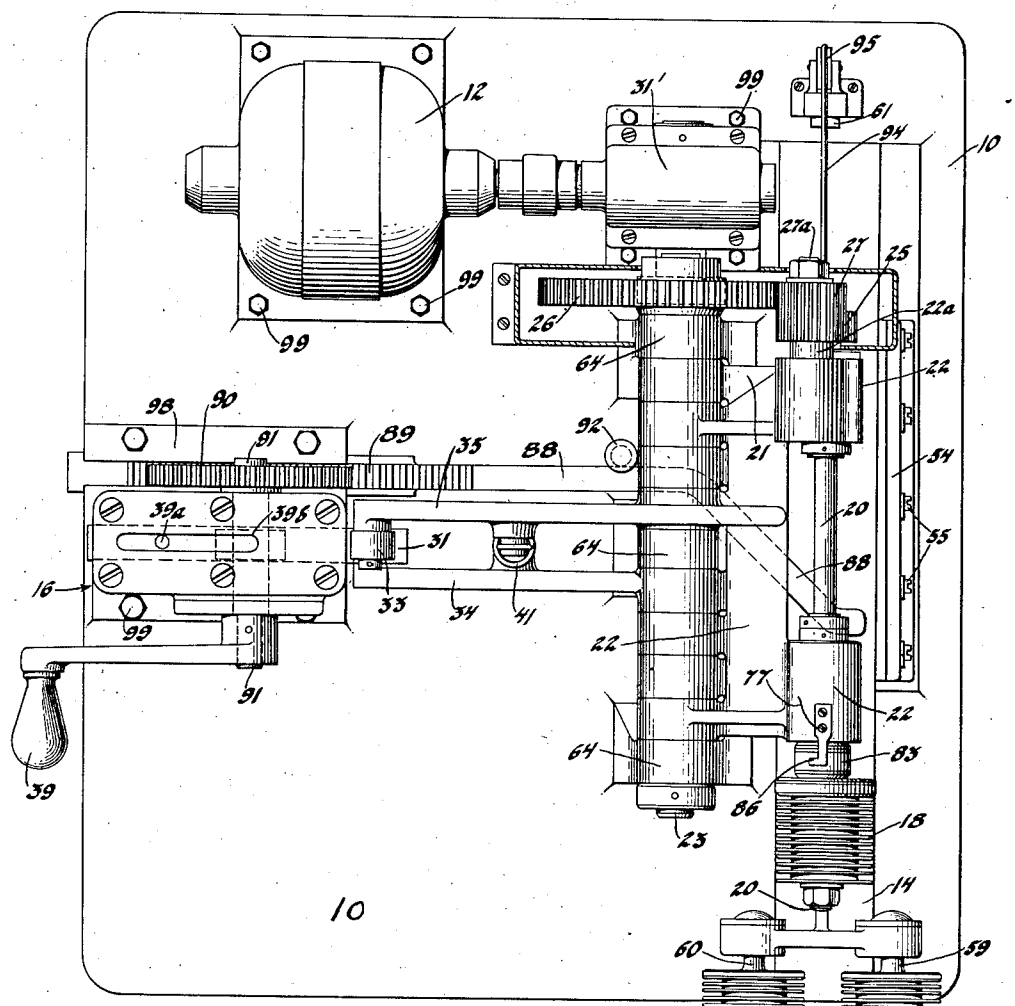

Fig. 4.

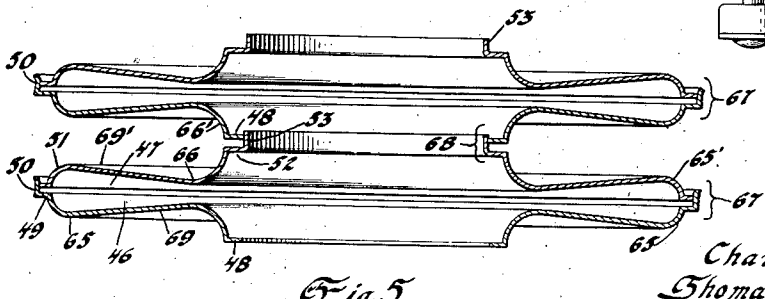

Fig. 5.

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UNITED STATES PATENT OFFICE

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MEANS AND METHOD FOR MAKING METALLIC BELLOWS

Application filed March 9, 1929. Serial No. 345,774.

This invention relates to the production of bellows from so-called "wafer" assemblies,—said bellows having annular corrugations which render the same suitable for use in thermostats, pumps, dashpots, etc.; and it is an especial object of this invention to provide means and methods whereby suitable oppositely rotating and annularly corrugated and/or grooved crimping rolls, or equivalent elements provided with means for effecting a movement of approach during rapid rotation of a bellows assembly therebetween, may be utilized for effecting a deformation of flanges upon said wafers,—so crimping the same as permanently to unite the edges thereof.

It is a further object of this invention to provide a technique initially relying upon a frictional engagement which may be partly due to gravity, to effect both an acceleration and a rapid rotation of wafer assemblies and a crimping of inwardly extending flanges through engagement thereof with an inner crimping roll; and, in preferred embodiments of said invention, an outer crimping element, such as a suitably grooved complemental roll, movable relatively to but always spaced from the first mentioned roll, may cooperate with the latter in the mentioned rotative effect and may also serve, by an opposed radial pressure, to deform outwardly extending flanges incidentally or subsequently to the mentioned deformation of the inwardly extending flanges,—arches of which are formed by mating parts being interiorly unsupported and said crimping elements being preferably rotated in opposite directions and at different peripheral speeds during a cam-control movement of approach therebetween.

It is a further object of this inventon to provide means for advantageously positioning wafer assemblies for engagement by said rolls; and said rolls may be provided with staggered or grooved depressions which are shaped to receive mating parts providing corrugations that are arched in two planes; and the rotation thereby effected may advantageously be such as to produce not only the indicated "spinning" effects, due to friction, but a centrifugal action which is favorable to an enhancement of the radial rigidity of the mentioned wafer assemblies,—disposing and supporting said flanges suitably to the desired gentle but reliable crimping effect by or during entrance thereof into said grooves.

Other objects of this invention, which includes various optional features for thermal and other effects and various details of mechanical interconnection hereinafter mentioned, and which may employ wafers similar to those disclosed in Patent No. 1,607,200, granted November 16 1926 to Kettering and Lee, said wafers being separately claimed in Patent #1,756,911 dated April 29, 1930 on an application filed by Charles L. Lee, may be best appreciated from the following description of an illustrative embodiment thereof taken in connection with the appended claims and accompanying drawings.

Fig. 1 is a side elevational view, some parts pertaining thereto being broken away and various optional features being included.

Figs. 2 and 3 are respectively end elevational views taken substantially as indicated by the arrow 2 in Fig. 1,—parts being broken away or omitted and different steps in a cycle of operation being shown, as hereinafter explained.

Fig. 4 is a top plan view generally consistent with Fig. 2 but assuming a cam-operating handle to occupy such a position as is therein shown in dotted lines.

Fig. 5 is a diagrammatic sectional view, on a larger scale, showing the preferred general manner in which pairs of flanged wafers may be interfitted in preparation for the uniting operations for which this machine is designed, some details of an optional piling means being shown.

Fig. 6 is an enlarged but fragmentary view, taken in substantially the plane indicated by the line 6—6 of Fig. 3.

Referring to details of that specific embodiment from the invention which has been taken as an illustration, a base plate 10 may directly or indirectly support a bellows-spinning organization 11, a motor 12, a bellows handling carriage 13 (including a slider 14 carrying a loading rack 15) and also a crank-

operated mechanical advantage cam organization 16,—manipulable to effect a movement of approach between an inner crimping roll 17 serving as a mandrel roll and an outer crimping roll 18 of larger diameter than roll 17 included in the mentioned bellows-spinning organization.

The crimping rolls 17 and 18 are shown as terminally mounted upon shafts 19 and 20; and these shafts are not only mounted upon and relatively movable with so-called spinner arms 21 and 22, pivoted upon a main shaft 23, but driven, preferably from said main shaft, by means of separate pinions 24 and 25. In order oppositely to rotate said pinions, and thereby the crimping rolls 17 and 18, assuming the pinion 24 to be directly engaged by a master gear 26 upon the shaft 23, the pinion 25 may be driven from said master gear by means such as an intermediate gear 27. All of said gears are shown as protected by a housing 28; and the master gear, or its equivalent, may be driven from the motor 12 by means including a drive pinion 29,—shown as mounted upon a shaft 30 and as adapted to be given a suitable rate of rotation through a multiplying or reducing gear train housed within gear box 31'.

Regardless of the means, if any, employed to position successive wafer assemblies between the crimping rolls 17 and 18, means such as a horizontally movable cam 31, comprised in the mentioned cam organization 16 and shown as engaging rolls 32, 33 upon horizontally extending cam arms 34, 35, respectively integral with the mentioned spinner arms 21, 22, may be employed to effect a suitably timed movement of approach between the crimping rolls 17 and 18, after a wafer assembly has been disposed therebetween or while said assembly is dependently supported by one of said rolls.

Horizontal movement may be imparted to the cam 31, or its equivalent, by means such as a rack 36 and a pinion 38. The latter is shown as rotatable by a suitable crank 39; and parts here referred to are shown as suitably supported and protected by means of a housing 40.

Means such as a tension spring 41, shown as interposed between the cam-actuated arms 34 and 35, may be employed to bias the spinner arms 21 and 22, and thereby the rolls 17 and 18, toward the "open" relative position illustrated in Figs. 1 and 2; and it will be obvious that the specific configuration of said rolls will depend upon the configuration given mentioned parts and upon the shape, the dimensions and the number of wafers employed in each assembly, to constitute a bellows. In the form shown, the roll 17 being intended to be received within, and the roll 18 being intended externally to engage, a wafer assembly, annular depressions 42 provided in the exterior in the roll 17, are shown as staggered relatively to similar but narrower annular depressions 43, provided in the roll 18; and, in order that the spinning of a wafer assembly upon the roller 17, or between rollers 17 and 18, shall effect the desired crimping deformations of inwardly extending and outwardly extending flanges upon the mentioned wafers, the respective annular depressions 42 and 43 are shown as provided with special grooves 44 and 45 in the bottoms thereof,—said depressions being respectively adapted to receive mating arcuate parts which provide inwardly extending corrugations and outwardly extending corrugations of the bellows produced from said wafer assemblies.

Assuming the mentioned assemblies to be built up from pairs of interfitting wafers such as are separately shown at 46 and 47, Fig. 5, it will be seen that the wafers 46 are each provided with an inwardly extending flat flange 48, an outwardly extending flat flange 49, and a substantially cylindrical flange 50; and that the wafers 47 each comprise an outer flat flange 51, an inner flat flange 52 and an inner cylindrical flange 53,—the flanges 51 being adapted to so interfit within the flanges 50 as to engage the flanges 49, and the flanges 48 being adapted to so interfit within the flanges 53 as to engage the flanges 52. If desired, the opposed surfaces of the mentioned flat flanges, or any of said surfaces, may be tinned in advance of assembly, and/or a suitable soldering paste may be interposed in advance of or during assembly; and the fit between the mentioned cooperating flanges may be such, even though said wafers are formed of a very thin material, as to permit a careful manual or other loading manipulation of the resultant organizations without danger of accidental disassembly; but it is nevertheless deemed preferable to provide mechanical means for initially positioning and finally withdrawing successive assemblies relatively to the mentioned crimping rolls.

For the purposes last referred to, the slider 14 being shown as having a dovetailed connection with the base plate 10 (by means which may include a removable side element 54, shown as retained by means of screws 55) the loading rack 15 (carried by said slider and completing a carriage which is manipulable by means such as the handle 56) may include one or more channeled handling elements such as rollers 57, 58 freely rotatable upon shafts 59 and 60,—said rollers being shown as provided with annular corrugations adapted to assure correct positioning and to prevent accidental disassembly of wafers by receiving outwardly extending corrugations, as provided by mating pairs of oppositely depressed wafers when the latter are assembled in the described manner.

A suitable wafer assembly being disposed

upon the rolls 57, 58, upon the completion of an inward movement thereof, as effected by such as the handle 56 (said movement being preferably limited by engagement between a fixed stop 61 carried by the base plate 10, and a terminal stop 62 carried by the slider 14) it will be seen that a movement of approach between the crimping rolls 17 and 18 (assumed to be constantly and oppositely rotated through means of the general character described) may serve to lift a wafer assembly 63 from the rolls 57 and 58, or the like, and incidentally to impart rapid rotation thereto and also partially or completely to crimp the flanges 53, during their proportionate descent into the grooves 44; and a further movement of approach between the rolls 17 and 18 (these being preferably driven, as indicated, in opposite directions, and at slightly different speeds) is effective to produce a similar crimping of the flanges 50, during a proportionate entrance thereof into the grooves 45 in the roll 18.

Loading and unloading position of the rack 15 is shown in Fig. 1 and "open" position of the rolls 17 and 18 is shown also in Fig. 2, a "closed" position thereof being shown in Figs. 3 and 6. Said rolls should be understood to remain, in the illustrated embodiment, at all times spaced apart by a distance greatly exceeding the thickness of the metal of which the respective "wafers" are formed; and it will be noted that the very considerable length of the relatively movable shafts 19 and 20, as also the length of the main shaft 23 (shown as rigidly supported by three separate bearing posts 64) assures an invariable parallelism of the said shafts. A bearing for a shaft 27*a*, carrying the gear 27, is shown as provided upon an extension 22*a* of arm 22; and the described construction (the shafts 19, 20, and 27*a* of gears 25, 26 and 27 being movable by and concentrically with arms 21 and 22) will be seen to permit the indicated "opening" and "closing" movements to be executed during continuous rotation of rolls 17 and 18.

Although the principles of this invention may be applicable to the production of bellows from assemblies of various sorts of "wafers", such as may be stamped from an impervious and pliable metal stock having a uniform thickness or regionally varying in thickness, it will be noted that, in the illustrated "wafers", outer pairs of concavities 65, 65′ (received within annular depressions 43 in roll 18 and cooperating to form corrugations or "arches" 67 by union of outer flanges 49, 50 and 51) and inner pairs of concavities 66, 66′ (forming inward corrugations or arches 68 by union of inner flanges 48, 52, 53) are respectively spaced apart by relatively flat but slightly conical intermediate zones or webs 69, 69′; and also the peripheral or annular depressions 42, 43 provided in the respective crimping rolls may be spaced apart by compartively thick beads 43′ and by thinner beads 44′ of any appropriate type. It is important to note that the beads 43′ are not shown as exteriorly contacting with the bottoms of the mentioned inward corrugations or arches 68 as received in annular depressions 42 of roll 17; and that the beads 44′ are not shown as interiorly contacting with the outwardly-extending corrugations or arches 67 received in the analogous depressions 43 of roll 18,—the mentioned arches being shown as unprovided with interior support during crimping in that the beads upon one roll do not enter the depression in the other roll.

The point just referred to will be seen to emphasize a reliance that may be herein placed upon wafer design, lateral support of "arches" curved in two planes and/or rotational effects in contributing to the radial rigidity of wafers while the latter undergo the described crimping of flanges. For example, as a wafer assembly is lifted from the described loading rack 15 or its equivalent, by the elevation of roll 17, the combined effects of rotation and gravity, and a friction due thereto, may promptly cause a partial or complete crimping of the flanges 53, at the same time so flattening or drawing together (by centrifugal effect) the slightly conical webs 69, 69′ as to permit free entrance of the outward corrugations 67 between the beads 43′ of roll 18,—the bottoms of whose grooves 43 may have a pheripheral speed not far different from that acquired by the flanges 50 by the time that the latter closely approach the grooves 45. The comparative rigidity that has in the meantime been acquired through the action of centrifugal force upon the webs 69, 69′ may then be sufficient (especially in view of the design of the wafers and the lateral support rendered available by beads 43′, 44′, and in view of the frictional engagements which may result from slight difference in peripheral speed) to transmit a lateral thrust that is entirely adequate gently but reliably to complete the desired crimping, as shown, of both the flanges 50 and the flanges 53.

A return of crank 39 or its equivalent (whose movements may be limited by means such as the engagement of a pin 39*a* with the ends of a slot 39*b*) from a position such as that shown in Fig. 2 to positions such as those shown in Figs. 2 and 4 may then replace the crimped bellows upon the loading rack 15. Said rack being outwardly withdrawn, a new wafer assembly may then be substituted thereon in readiness for a repetition of the described steps. The described construction and mode of operation are adapted to the crimping of thinner wafers than could be united by ordinary rolling operations or by

use of a lower roller or rollers 57, 58 whether idle or driven, as a platen element.

As to additional and optional features, it is suggested in Fig. 1 that nozzles or burners 70, shown as communicating with certain pipes 71, may be so positioned as to deliver a suitable soldering mixture and/or to heat or cool a bellows assembly incidentally to the advance or retraction of the loading rack 15,—a knuckle-containing valve lever 72 being shown as effectively engageable by a cam 73 during movement of the carriage 13 in one direction only; and Figs. 1 and 6 suggest that electrical means may, if desired, be so associated with the rolls 17, 18 (as, by partially embedding the same therein) that, after a desired approach between the spinner arms 21, 22 (shown as carrying opposable contact 74, 75) and/or after such a crimping of the flanges as enables the same to enter the grooves 44, 45, a resistance heating system, shown as comprising wires 76, 77, may be automatically completed, for a flange-softening effect or for a soldering or for other effect. Collector rings 78, 79, with which embedded heating elements 80, 80′ (see Fig. 6) are connected, are shown as constantly engaged by brushes 81, 82; and collector rings 83, 84, with which heating elements 80 are connected, are shown as being constantly engaged by brushes 86, 87.

If desired, in order completely to free one hand of an operative, using this machine, for the positioning of successive bellows assemblies upon the loading rack 15, or its equivalent, means such as are best shown in Figs. 2 and 3 may be employed,—rendering initial and final movements of the crank 39, or its equivalent, effective to manipulate the carriage 13. To this end, a cam 88, rigidly connected with a rack 89, is shown as horizontally movable by a second pinion 90, mounting upon the same shaft 91 which carries the roll-positioning pinion 38,—the cams 31 and 88 being, when used in the manner referred to, so proportioned as to be successive in their effects. The cam 88 is shown as steadied by a guide roller 92 and as contacting a cam roller 93, mounted upon the slider 14; this slider is shown as biased toward its inner position by means comprising a flexible element 94, carried over a pulley 95 and connected with constantly-acting means such as a spring or weight 96,—diagrammatically suggested in Fig. 1. The rack 89 is shown as slidably retained by a removable guide plate 98; and the various units referred to are shown as secured to the base 10 by bolts or screws 99; but it will be obvious that these optional features and details are here referred to primarily for the sake of completeness, being relatively immaterial to the main invention claims.

Although the foregoing description has included but one complete embodiment of the present invention, it should be understood not only that various features thereof might be independently employed but also that numerous modifications might easily be devised,—without involving departure from the spirit or scope of the invention.

We claim:

1. A method of crimping flanges to form bellows from assemblies of metallic wafers which comprises: rapidly rotating wafer assemblies, applying external pressure only to said flanges, during such rotation, for crimping them, and developing by said rotation sufficient centrifugal force substantially to prevent deformation of the wafers except at the zones where crimping pressure is applied.

2. A method of crimping sets of flanges projecting from an assembly of wafers which comprises: rapidly rotating said assembly, applying substantially opposite deforming pressures externally only to said flanges during rotation and developing by said rotation sufficient centrifugal force substantially to prevent deformation of the wafers except at the zones where deforming pressure is applied.

3. A method of crimping sets of flanges projecting from an assembly of wafers which comprises: rapidly rotating said assembly applying substantially opposite rolling pressures to said flanges during rotation, and developing by said rotation sufficient centrifugal force substantially to prevent deformation of the wafers except at the zones where rolling pressure is applied.

4. A method of producing bellows which comprises: forming wafers with opposable flanges respectively near inner edges and outer edges thereof, which flanges form parts of arches having curvatures in two planes; assembling said wafers to form inner and outer corrugations which complete said arches; and crimping said flanges by applying pressure thereto while so rotating the assembly that said arches remain substantially rigid under said pressure, said arches being interiorly unsupported.

5. A method of producing bellows which comprises: forming wafers with opposable flanges respectively near inner edges and outer edges thereof, which flanges form parts of arches having curvatures in two planes; assembling said wafers to form inner and outer corrugations which complete said arches; and crimping said flanges by applying pressure thereto while so supporting the assembly that said arches remain rigid under said pressure,—an outer set of flanges being crimped by an inward pressure applied during continued rotation.

6. A method of producing bellows which comprises: forming wafers with opposable flanges respectively near inner edges and outer edges thereof, which flanges form parts

of arches having curvatures in two planes; assembling said wafers to form inner and outer corrugations which complete said arches; and crimping the flanges of said inner corrugations by applying pressure thereto while rotating and holding the same so assembled that said arches continued to be rigid under said pressure,—and the outer set of flanges being crimped by an inward pressure applied during continued rotation and by rotating means.

7. In means for producing bellows from assemblies of sheet metal wafers having inner and outer flanges adapted to be crimped and interlocked; the combination of a mandrel roll having longitudinally spaced circumferential grooves, a companion roll substantially parallel thereto having spaced circumferential grooves staggered in position with respect to the grooves of the mandrel roll; means for rotating a bellows assembly with the convex zones of its external and internal corrugations only, engaged by said rolls, and means for causing approach of said rolls to crimp the flanges of said wafers.

8. A combination as defined in claim 7 in which the means for rotating the bellows assembly comprises a high speed transmission arranged to rotate said grooved rolls.

9. In means for producing bellows from assembled sheet metal wafers, the combination of spaced apart circumferentially grooved rolls of different diameters, means for rotating said rolls in opposite directions at high speed comprising a master gear, a shaft for each roll, a pinion on each shaft arranged to be driven by the master gear, levers fulcrumed about an axis in line with the axis of the master gear, bearings for said shafts on said levers and a mechanical advantage device for operating said levers.

10. In means for producing bellows assemblies from assembled sheet metal wafers, the combination of spaced apart substantially parallel circumferentially grooved crimping rolls, a loading rack movable toward and from the crimping rolls, means for rotating the crimping rolls, means for causing one roll to approach the other to produce crimping pressure, and for separating them to release the crimped assemblies, and means, separated by the means for causing the approaching and separating movements of the rolls for imparting appropriate movements of the rack toward and from the rolls.

In testimony whereof we affix our signatures.

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