March 9, 1937. J. D. BOLESKY 2,072,847

METHOD OF MANUFACTURING RADIALLY CORRUGATED DISKS

Filed Nov. 22, 1935 2 Sheets-Sheet 1

FIG. 1.

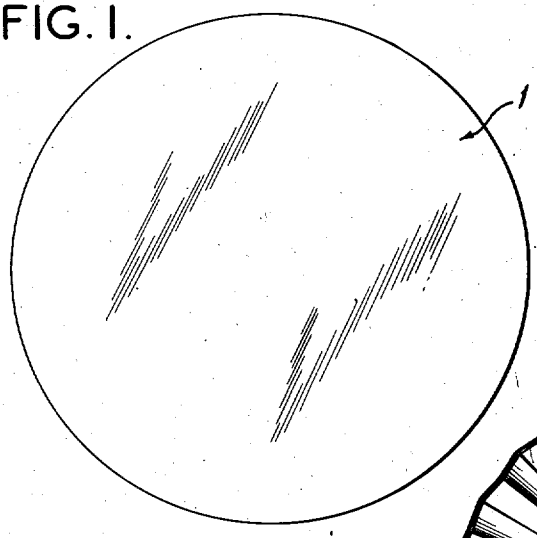



FIG. 3.

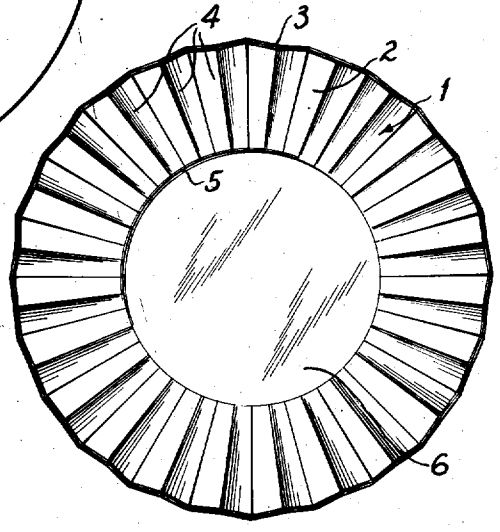



FIG. 2.

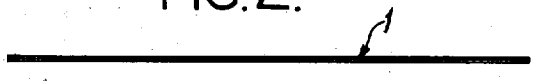



FIG. 4.

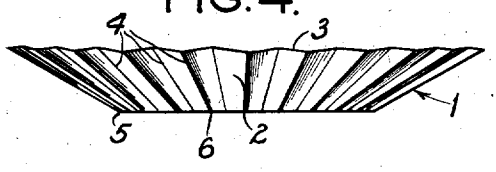
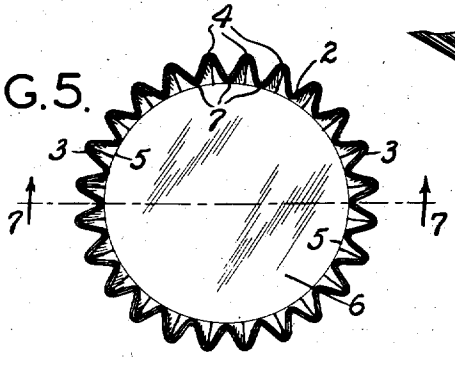



FIG. 5.




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METHOD OF MANUFACTURING RADIALLY CORRUGATED DISKS

Filed Nov. 22, 1935 2 Sheets-Sheet 2

FIG.6.

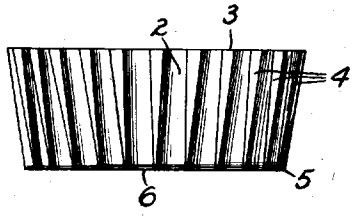



FIG.7.

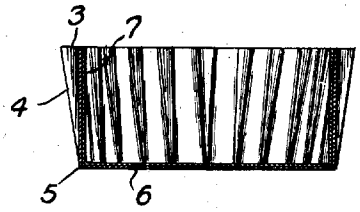



FIG.9.

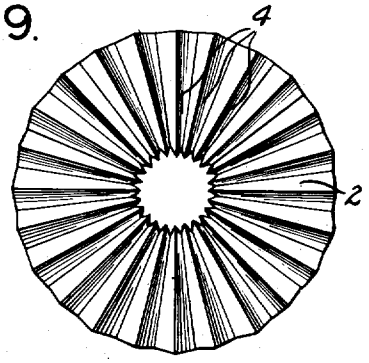



FIG.8.

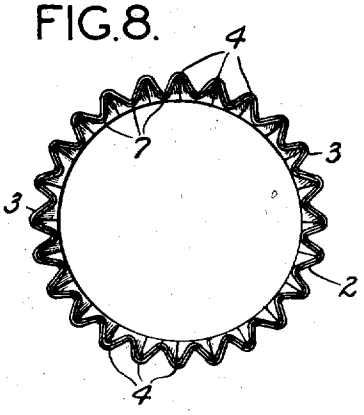



FIG. 10.

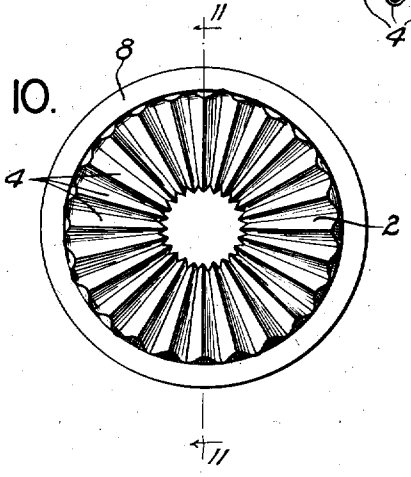
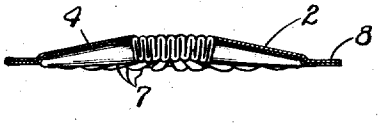



FIG.11.




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Patented Mar. 9, 1937 2,072,847

# UNITED STATES PATENT OFFICE

2,072,847

## METHOD OF MANUFACTURING RADIALLY CORRUGATED DISKS

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Application November 22, 1935, Serial No. 51,035

5 Claims. (Cl. 153—2)

This invention relates to methods of manufacturing radially corrugated disks, and with regard to certain more specific features, to methods adapted to commence with uncorrugated blanks.

This invention is an improvement on the invention shown and described in John A. Spencer Patent No. 2,001,553, dated May 14, 1935.

The product obtained by carrying out the method of the present invention is described and claimed in John A. Spencer Patent Nos. 1,895,590 and 1,895,591, both dated January 31, 1933.

Among the several objects of the invention may be noted the provision of a method of manufacturing radially corrugated disks which commences with an uncorrugated disk-shaped blank of either resilient ordinary metal or "composite thermostatic metal" (such as bimetal), and produces snap-acting disks which are thermostatically sensitive if composite metal has been used; a method of the class described which achieves the desired ultimate conformation without in the course of the method subjecting the blanks to any undue localized stresses which might impair the efficiency of the resulting article; the provision of a method of the class described which is independent of the use of rollers, and thereby eliminates the difficulties inherent in suitably dimensioning rollers to produce the desired shape and number of corrugations; and the provision of a method of the class described which is simple and economical in operation, requiring but a minimum of specialized machinery. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly comprises the steps and sequence of steps, and features of operation, which will be exemplified in the methods hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, in which is illustrated one of various possible embodiments of the invention,

Fig. 1 is a plan view of a circular disk, constituting a blank utilized in the present invention;

Fig. 2 is an elevation of the disk of Fig. 1;

Fig. 3 is a plan view of the disk of Fig. 1 after an initial operation has been performed thereon;

Fig. 4 is an elevation of the disk in its Fig. 3 condition;

Fig. 5 is a top plan view of the disk of Fig. 3 after a second operation;

Fig. 6 is an elevation of the disk in its Fig. 5 condition;

Fig. 7 is a vertical cross section taken substantially along lines 7—7 of Fig. 5;

Fig. 8 is a top plan view of the disk of Fig. 5 after a subsequent operation;

Fig. 9 is a plan view of one form of a finished snap-acting disk;

Fig. 10 is a plan view of a second form of a finished snap-acting disk; and,

Fig. 11 is a cross section taken substantially along line 11—11 of Fig. 10.

Similar reference characters indicate corresponding parts throughout the several views of the drawings.

As disclosed in the said John A. Spencer Patents Nos. 1,895,590 and 1,895,591, radially corrugated disks having a slight initial conical conformation, when made of suitable material, are useful as snap-acting elements. If the material is resilient sheet metal, the disk constitutes a valuable over-centering element, while if the material is composite thermostatic metal (such as bimetal), formed of a plurality of united metallic layers having different coefficients of thermal expansion, the disk is a valuable self-actuating, snap-acting unit. The present application is not concerned with the actions and reactions of these disks per se, which are adequately discussed in said patents, but in a preferred method (or methods) of manufacturing the same. The method used, particularly if the disks are thermostatic ones, needs to be such that no excessive localized stresses are produced in any one region of the disk. Otherwise the temperature responsive characteristics of the disk might be seriously impaired. To a lesser extent, the same requirement is imposed on the manufacture of non-thermostatic disks, as localized stresses in such disks mean early failure in operation of that portion of the disk unduly strained, and thus shorter life of the disks, taken on the average.

The method which has now been found to be most advantageous comprises taking an initially circular blank, in the form of a disk, corrugating the peripheral region of the disk in such manner that it is brought to a cup-shape, die-cutting the bottom out of the cup, and then pressing the corrugating sides of said cup into final conformation in a series of die-pressed steps. In this manner, no great stress is introduced into any one part of the disk at any time, but rather, the stresses are more equally distributed throughout the whole disk from step to step and the finished article is thus free of any excessive localized stresses.

Referring now more particularly to the draw-

ings, Figures 1 and 2 illustrate, in plan and elevation, a circular disk blank typical of those which I prefer to use for the manufacture of the disks in question. The blank is indicated by reference numeral 1. It will be seen to comprise a flat, circular disk, which is for example, made of composite thermostatic material. Of course, if the finished disk is not to be a thermostatic one, it is not necessary that the metal be composite. For the latter purpose, any springy, resilient sheet metal such as thin spring steel or spring brass, may be used. Suitable thermostatic metals, if the finished disk is to be a thermostatic one, are those shown in Marshall Patent 1,481,021, Marshall Patent 1,700,173, or Bush Patent 1,870,235, for example. So far as the present invention is concerned, it is inconsequential whether the blank is for a non-thermostatic or for a thermostatic disk.

The initial step of manufacturing the corrugated disk comprises bringing the flat disk of Fig. 1 to the form shown in Figures 3 and 4. This step comprises subjecting the peripheral region of the disk 1, indicated by numeral 2 in Figure 3, to a suitable die-stamping action whereby said peripheral region is bent slightly upward, giving the disk the shape generally of a shallow plate. Inasmuch as the outer periphery of the plate, indicated by numeral 3, is less in total length than the outer periphery of the disk 1, this shaping operation is achieved by initiating the formation of a number of equally spaced, equal sized, radial corrugations 4. The corrugations 4, it will be seen, vary from maximum depth at the periphery 3 to substantially zero depth at a line 5 wherein they join the central, uncorrugated region 6 of the disk 1. It will be understood that the line 5 represents a series of short, straight folds in the metal, which taken together in series, appear as a circle.

This initial step of manufacture may be suitably performed by properly shaped male and female dies which are, in fact, the obverse and reverse prints of the disk 1 in its Fig. 3 condition.

The second step of manufacture comprises bringing the disk from its Fig. 3 condition to its Fig. 5 condition. In the Fig. 3 condition, the corrugations 4 are very shallow having barely been initiated in their form. In the Fig. 5 condition, the corrugations 4 are distinctly marked. In the Fig. 5 condition, the inner edges of the corrugations 4, now indicated by numeral 7, have been brought to substantially a vertical position with respect to the uncorrugated region 6 of the disc 1. This means that the disk 1 now has the approximate shape of a cylindrical cup (see Figures 6 and 7). The corrugations 4, however, have retained their original characteristics in that they vary from maximum depth at their periphery 3 to zero depth at the line of juncture 5 with the uncorrugated portion 6. This conformation of the corrugations 4 is clearly indicated in Fig. 7.

This step in the manufacture of the disk may likewise be performed with suitable male and female dies which are the obverse and reverse prints of the disk in its Fig. 5 condition.

It will be understood that the flat disk in its Fig. 1 condition may be brought to its Fig. 5 condition in any number of steps, the representative number, two, described, being merely by way of example. In fact, the greater the number of steps and the consequent greater number of different-shaped dies provided, usually the less are the strains put in the disk.

When the Fig. 5 condition of the disk is achieved, the next step comprises blanking or cutting out the bottom of the cup which is represented by the uncorrugated region 6 of the original disk. Figure 8 indicates the disk 1 in such condition. The region 6 is preferably cut out so that the line of cutting as nearly approximates the fold line 5 as possible. If this step is carried out with suitable accuracy, the disk 1 in its Fig. 8 condition is substantially all corrugated material, no uncorrugated material being left.

From its Fig. 8 condition, the remaining steps of manufacturing are substantially the same as those shown in the said Spencer Patent 2,001,553. That is to say, this now corrugated, substantially cylindrical body is placed between dies and so compressed that the upper periphery 3 thereof is slowly folded inwardly toward the center of the cylindrical shape, by more and more closely compressing the corrugations 4 at the upper end 3. At the same time, it is desirable to limit the outward expansion of the bottom periphery, represented by the former fold line 5. This flattening operation, if it may be so termed, is carried on until the shape of the desired finished disk illustrated in Fig. 9, is achieved. The Fig. 9 illustration shows a disk which is not entirely flat, that is, the inner periphery is not in the same plane as the outer periphery but is in a plane slightly displaced therefrom, giving the disk a slightly conical conformation. This slight conical conformation is essential for the desired snap-acting characteristics of the disk.

The die-pressing involved in transforming the blank in its Fig. 8 condition to the finished disk of Fig. 9 may be carried out with apparatus identical to that shown in Figures 8, 9 and 10 of the aforesaid Spencer Patent 2,001,553. This die-pressing may be done in any number of steps suitable to the disk being formed, and the shaping characteristics of the metal of the blank. Three steps, such as shown in the aforesaid Spencer Patent 2,001,553 have been found to give excellent results without introducing substantial localized stresses in the resulting disk.

Fig. 9, as has been indicated, illustrates a completed disk. It will be seen that the corrugations 4 are positioned in the desired radial conformation, and it will be apparent that the disk has the desired slightly conical conformation. The corrugations 4 vary from an extreme depth at the center of the disk, or its inner periphery, to a minimum depth which is practically zero at the outer periphery. This arrangement provides that the maximum amount of material, be it simply resilient, metal, or thermostatic metal, is contained in the central movable region of the disk, where it will do the most good.

The disk illustrated in Fig. 9 conforms to the type of disk illustrated in the aforesaid Spencer Patent 1,895,590. A more practical disk is that shown in the aforesaid Spencer Patent 1,895,591, where the outer periphery of the disk, indicated by numeral 8 in Fig. 10, is intentionally flattened. The flattened periphery 8 provides a confining rim which improves the tendency of the central portion of the disk to undergo snap-action in response to suitable actuation. The rim 8 may be formed on the disk of the Fig. 9 embodiment by merely pressing it between suitable dies such as those indicated in Fig. 3 of the aforesaid Spencer Patent 1,895,591. Fig. 11 which is a cross section of the Fig. 10 disk, shows clearly how the corrugations vary from maximum depth at the central periphery of the disk to minimum depth at the

points where they join the intentionally flattened periphery 8. Fig. 11 also indicates the conicity of the finished disk, and in this respect it may be said to represent a cross section of Fig. 9 as well.

Throughout the drawings of this application, the corrugations have been indicated as being formed by sharp folds. In actual practice, such sharp folds are not desired, and it is preferable that the bends be as rounded as is feasible to make them. However, in order to show such rounded folds, it would have been necessary to unduly complicate the drawings of this application; hence, the sharp folds of the drawings are for illustrative purposes only and the actual, practical disk formed in accordance with the present invention should be provided with rounded, instead of sharp, folds.

A particular advantage of the present invention over the embodiment of the aforesaid Spencer Patent 2,001,553, invention shown in Fig. 1 thereof, is that the corrugation is accomplished with dies instead of rollers; and further, that the initial blank is a solid disk rather than an annulus, and hence is more easily handled. Further, the presence of the central, solid portion of the disk herein indicated by reference numeral 6, during the initial corrugating step, has a tendency to minimize stresses and strains in the corrugations as they are initially formed. The reason for this tendency is abstruse and need not be dwelt upon in this application.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As many changes could be made in carrying out the above methods without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. The method of manufacturing radially corrugated snap-acting disks comprising preparing a blank in the form of a flat circular disk, corrugating the peripheral region of said blank in such manner that the blank assumes a cup-shape, cutting the bottom from said cup, and inwardly compressing the walls of said cup at one end thereof until the blank assumes a disk conformation in which the central portion is slightly displaced from the peripheral portion.

2. The method of manufacturing radially corrugated snap-acting disks comprising preparing a blank in the form of a flat circular disk, corrugating the peripheral region of said disk in such manner that it assumes a cup-shape, cutting the uncorrugated bottom from said cup, and inwardly compressing the corrugated sides of said cup at the end formed from the original outer edge of the disk blank until the blank assumes a disk conformation in which the central portion is slightly displaced from the peripheral portion.

3. The method as set forth in claim 1 in which the initial corrugating is performed in such manner that the corrugations vary from maximum depth at the periphery of the blank to substantially zero depth at the point where the said peripheral region joins the central region of the blank.

4. The method of manufacturing radially corrugated snap-acting disks as set forth in claim 1, in which the individual corrugations are provided with a substantially rounded contour.

5. The method of manufacturing radially corrugated snap-acting disks which comprises preparing a blank in the form of a flat disk, corrugating said blank in such manner that it assumes the conformation of a cup, removing the bottom from said cup, and comprising the walls of said cup inwardly until the blank assumes a disk conformation in which the central portion is slightly displaced from the peripheral portion.

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## CERTIFICATE OF CORRECTION.

Patent No. 2,072,847. March 9, 1937.

JOHN D. BOLESKY.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, second column, line 38, claim 5, for the word "comprising" read compressing; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 25th day of May, A. D. 1937.

Henry Van Arsdale
Acting Commissioner of Patents

(Seal)

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2. The method of manufacturing radially corrugated snap-acting disks comprising preparing a blank in the form of a flat circular disk, corrugating the peripheral region of said disk in such manner that it assumes a cup-shape, cutting the uncorrugated bottom from said cup, and inwardly compressing the corrugated sides of said cup at the end formed from the original outer edge of the disk blank until the blank assumes a disk conformation in which the central portion is slightly displaced from the peripheral portion.

3. The method as set forth in claim 1 in which the initial corrugating is performed in such manner that the corrugations vary from maximum depth at the periphery of the blank to substantially zero depth at the point where the said peripheral region joins the central region of the blank.

4. The method of manufacturing radially corrugated snap-acting disks as set forth in claim 1, in which the individual corrugations are provided with a substantially rounded contour.

5. The method of manufacturing radially corrugated snap-acting disks which comprises preparing a blank in the form of a flat disk, corrugating said blank in such manner that it assumes the conformation of a cup, removing the bottom from said cup, and comprising the walls of said cup inwardly until the blank assumes a disk conformation in which the central portion is slightly displaced from the peripheral portion.

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