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S. J. BECKER

2,169,787

SPRING DEVICE

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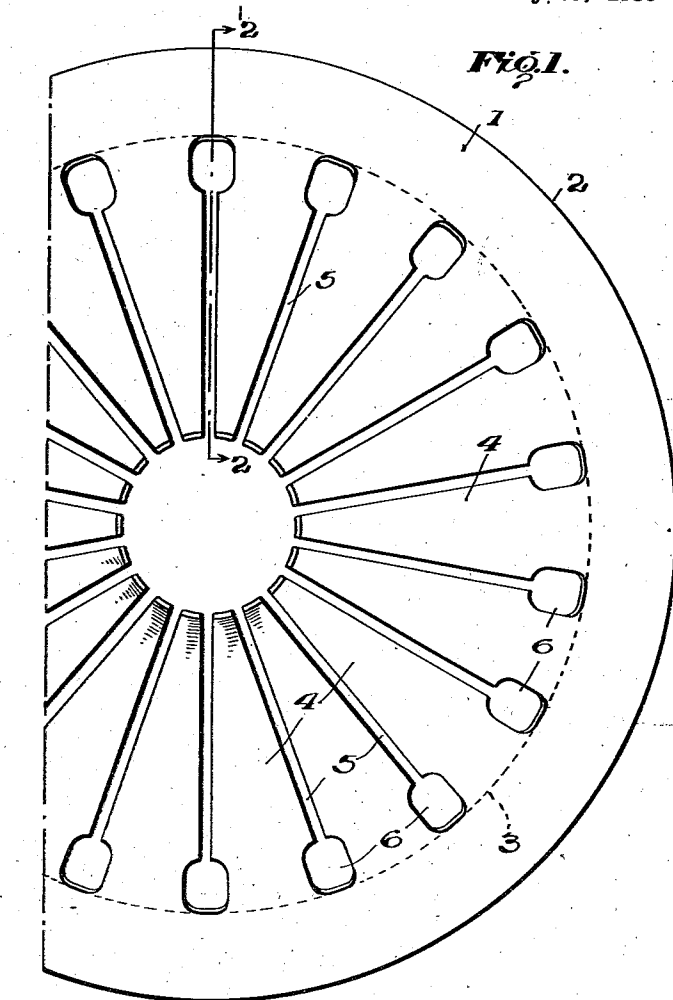


FIG. 2.

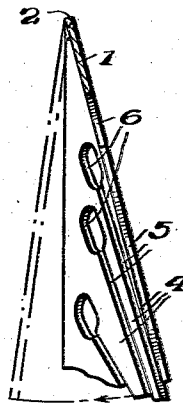


FIG. 3.

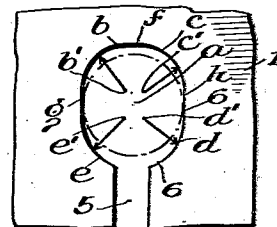
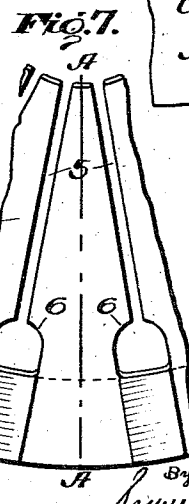
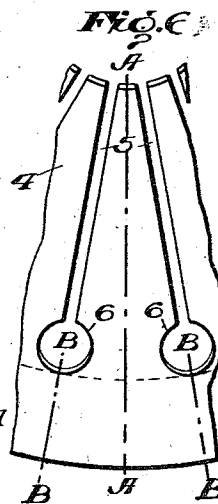
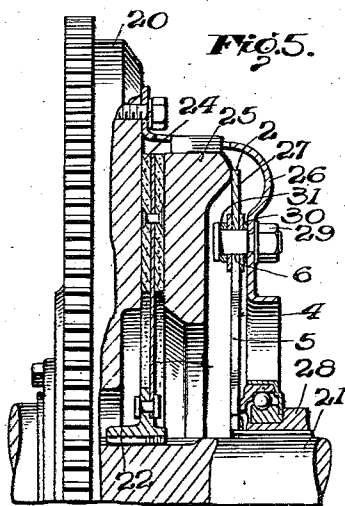
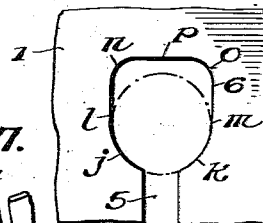


FIG. 4.



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UNITED STATES PATENT OFFICE

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SPRING DEVICE

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8 Claims. (Cl. 267—1)

This invention relates generally to springs and, more particularly, is intended to provide an improved Belleville spring construction.

It has heretofore been known to provide coned Belleville springs and to attach to or form integrally with the inner periphery of the spring elongated fingers which converge toward the geometrical center of the spring and which are employed to operate the spring from its coned, or inoperative, position to its flat or working position. These elongated fingers have, in prior constructions, been separated by elongated apertures terminating adjacent the inner periphery of the spring in openings of substantially circular shape. It has been found that such spring devices are generally lacking in usefulness because of their tendency to fracture along a line extending radially of the spring and lying between the outer periphery thereof and the nearest adjacent point of the circular openings referred to.

It is the principal object of this invention to provide a Belleville spring structure which will be generally similar to that hereinbefore described but which will be so constructed that the aforesaid tendency of these springs to fracture will be greatly diminished or entirely removed.

Other objects and features of novelty of the invention will be apparent from the following description and the annexed drawing, it being clearly understood that such description and drawing are only illustrative of my invention, and that the same is not limited thereby, or otherwise than by the appended claims.

Referring to the drawing, in which similar reference numerals refer to like parts,

Fig. 1 is a plan view, partially broken away, of a spring formed according to this invention;

Fig. 2 is a partial, sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is an enlarged, detail view of one of the openings illustrated in Fig. 1;

Fig. 4 is a view, similar to Fig. 3 and showing a modified form of opening;

Fig. 5 is a partial sectional view of a clutch assembly showing the application thereto of a spring formed in accordance with the present invention;

Fig. 6 is a partial view showing the prior art construction and the disposition of stresses therein, and

Fig. 7 is a partial view, similar to Fig. 6, and showing the disposition of stresses in a construction according to this invention.

In Fig. 1 of the drawing there is illustrated a

Belleville spring comprising the annular spring element 1 having the preferably circular outer periphery 2 and an inner periphery which may be indicated by the dotted line 3. Formed integrally with the spring and extending radially thereof toward the geometrical center of the spring are operating fingers 4 which are separated by elongated, radial slots or apertures 5. This entire spring device is coned as illustrated in Fig. 2 and it will be seen that pressure applied to the inner ends of the operating fingers 4 in the direction of the plane of the outer periphery 2 of the spring will cause the spring to be flexed toward a flattened condition which may be reached if sufficient pressure is applied to the operating fingers.

In prior spring devices formed in the manner described, it has been the practice to terminate the elongated apertures 5 in circular openings, the outermost edges of which were tangential to the inner periphery 3 of the spring. Such prior spring devices have been found to be unsatisfactory in practice because of the fact that they were found to fracture, after only limited use, along a line extending radially of the spring and lying between the outer periphery 2 thereof and the nearest adjacent point of the circular apertures to which reference has been made. Until the present invention no means has been known for remedying this defect, and spring devices of this type have therefore not been widely used, although many advantages are inherent in such devices.

According to the present invention I propose to terminate the elongated apertures 5, adjacent the inner periphery 3 of the spring, in openings or apertures 6, as taught by the prior art. My invention, however, contemplates the extension of the bases of these apertures toward each other on the line of the inner periphery of the spring. Thus, instead of providing circular apertures at the ends of the slots 5, I provide apertures which are broadly extended along the inner peripheral line 3 of the spring. These apertures may be shaped as disclosed in Figs. 1, 3 and 4 or may be shaped in any suitable manner which will extend the bases of the apertures in the line 2.

The broadening of the bases of the openings 6 in the manner taught by my invention will have the effect of increasing the resistance of the spring to fracturing in the manner described. This effect may be better understood by reference to Figs. 6 and 7 of the drawing. In Fig. 6 there is illustrated, in full lines, a portion of a spring

having circular openings 6 therein in accordance with prior art practice. Fractures in such prior art springs invariably occurred along the dotted lines B—B indicated in this figure, i. e. the radial lines joining the outer periphery of the spring and the nearest adjacent point of the opening 6. Obviously, because of the circular shape of the opening 6, the line B—B is much shorter than any other radial dimension of material through which force exerted on the spring is transmitted and the stress along line B—B is accordingly greater than at any other portion of the spring device. It will also be seen that along the radial lines A—A which extend through the centers of the operating fingers 4 the strength of the spring will be greatest. In studying the action of springs formed in the manner illustrated in Fig. 6 I have found that as the spring is deformed from coned position to or through flat position, the portion of the spring along line B—B will deform to a greater extent than the portion along line A—A, indicating that the portion along line B—B is being worked more than other parts of the spring. This effect is indicated by the shape which the inner periphery of the spring assumes as the spring is deformed. Instead of remaining in a single plane as the spring is deformed the inner periphery of the spring assumes an undulating shape, the portions thereof adjacent the section B—B showing greater deformation than other sections. I have determined that the spring is worked unevenly in this manner and that the greatest working occurs at the section of least strength, i. e. along line B—B.

If, now, in the manner taught by the present invention the bases of the openings 6 are broadened or extended along the inner periphery of the spring, as illustrated in Fig. 7, the lines or sections of minimum strength of the spring will be broadened to an extent determined by the width of the bases of the openings 6. Instead of a line or section B—B of minimum strength there is now an area, shown as a shaded area in Fig. 7, where maximum stress occurs. It will be seen that the greatest stress will occur over an area, which is defined by the ends of the elongated side of the opening 6, instead of along a line or section and that the distribution of stresses over the spring will be more uniform. I have found that by reason of the described change in construction springs formed according to this invention have over 100% higher endurance limit than those formed in the manner taught by the prior art. This I have found to be due entirely to the equalization of the stresses over the entire spring.

The openings 6 may, in accordance with the invention, be shaped in any suitable manner in accordance with the principles heretofore stated. For example, they may be formed in the shape illustrated in Figs 1 and 3 or, alternatively, in the shape illustrated in Fig. 4. In Fig. 3 there is illustrated in dot and dash lines a basic circle with center *a*. The aperture shaped according to the invention is illustrated in full lines at 6. This opening may be described as being formed by four arcs *b*, *c*, *d* and *e*, having centers *b'*, *c'*, *d'* and *e'*, respectively, which are symmetrically disposed with respect to center *a*, as illustrated. The arcs *b* and *c* are connected by a rectilinear part *f* which is disposed at right angles to a radius through point *a* and the slot 5. Similar rectilinear parts are formed at *g* and *h*. Any tendency of the spring to fracture between

the outer periphery thereof and the nearest adjacent point of the aperture is minimized by reason of the fact that the stresses operate through the linear portion *f* instead of being concentrated along a single section as is the case when the circular aperture is employed.

In the form of aperture illustrated in Fig. 4, the slot 5 opens directly into the arcuate portions *j* and *k* of the aperture 6. In this form there are two linear portions *l* and *m*, curved portions *n* and *o* and a rectilinear portion *p* which corresponds to, but is of much greater length than, the line *f* of Fig. 3. In both forms there is provided an aperture bounded by a rectilinear wall in that portion of the aperture nearest the periphery of the spring. This rectilinear portion is arranged transversely of the radius extending through the slot 5 and preferably at right angles thereto.

In Fig. 5 of the drawing there is illustrated one possible application of my invention, this being the use of the spring in a clutch assembly such as is used in automotive vehicles. In this assembly there is illustrated a flywheel 20 which is associated with the engine shaft, not shown, and a transmission shaft 21 which carries a hub 22 to which is secured a driven plate 23 having friction facings 24 on the opposite faces thereof. One of these facings engages the flywheel, while the other engages a pressure plate 25 which rotates with the flywheel and its cover 26, but is slidable axially relative thereto. Included in this assembly is a spring 27 which is formed in the manner taught by this invention and which is so mounted that the outer periphery thereof engages the pressure plate 25, while the inner or centrally located ends of the operating fingers are engaged by a throwout collar 7—8 which urges the operating fingers toward the pressure plate, thereby urging the spring toward a flat condition. The spring is mounted in the position described by a series of fulcrum pins 29 which are carried by the flywheel cover plate 26 and which extend through the annular series of apertures 6 in the spring. Each of these pins carries rings 30 and 31 which are disposed, respectively, on opposite faces of the spring 27.

In assembling the clutch described, the height of the cone of the Belleville spring is reduced, the pressure of the flattened cone being transmitted from the outer periphery thereof to the pressure plate and the reaction being taken by the engagement of the spring plate with the ring 30. In releasing the clutch the reaction is taken from ring 30 by the throwout mechanism. The spring plate then fulcrums on ring 31 and becomes further flattened, thereby relieving pressure on the pressure plate and causing release of the clutch.

It will be apparent that in the normal use of such a clutch assembly, as in an automobile vehicle, the spring plate will be operated from its flattened position to its coned position a great number of times and that, in this repeated process, stresses in the spring will tend to develop fractures in the manner hereinbefore described. As stated, the application of the principles of this invention has resulted in the increase of more than 100% in the life of the clutch spring.

While I have illustrated and described certain embodiments of my invention, additional embodiments or improvements may occur to those skilled in the art, all of which may be practised without departing in any way from the spirit or scope of

the invention, for the limits of which reference must be had to the appended claims.

What I claim is:

1. A spring device comprising a coned spring plate having a circular series of radial slots therein, each terminating at its outermost end in an enlarged aperture, the boundary wall of each of such apertures including at least one rectilinear portion, said rectilinear portion being at the radially outermost part of said aperture.

2. A spring device comprising a coned spring plate having a circular series of radial slots therein, each terminating at its outer end in an enlarged aperture, the boundary wall of each aperture including arcuate portions and at least one rectilinear portion, said rectilinear portion being at the radially outermost part of the aperture and extending transversely of the radial axis of the coned spring plate which extends through the center of the aperture.

3. A spring device comprising a coned spring plate having a plurality of radial slots therein terminating respectively at their outer ends in enlarged apertures which are arranged in a circular series, the boundary wall of each aperture including arcuate portions and at least one rectilinear portion, each of said rectilinear portions being at the radially outermost part of the aperture and extending at right angles to the radial axis of the coned spring plate which extends through the center of the aperture.

4. A spring device comprising an annular spring plate, a plurality of operating fingers extending radially inwardly from the inner periphery of said plate, the plate and the operating fingers being of frusto-conical shape, adjacent fingers being separated by elongated slots extending radially of the operating fingers and by apertures formed in the plate adjacent the inner periphery of the plate, each of said apertures being formed with a broad base which is disposed approximately in the said inner periphery of the plate.

5. A spring device comprising an annular spring plate, a plurality of operating fingers extending radially inwardly from the inner periphery of said plate, the plate and the operating fingers being of frusto-conical shape, adjacent fingers being separated by elongated slots extending radially of

the operating fingers and by apertures formed in the plate adjacent the inner periphery of the plate, each of said apertures being formed with a broad rectilinear base which is disposed approximately in the inner periphery of the plate and which extends at approximately right angles to the radial axis of the plate which extends through the center of the aperture.

6. In a clutch, a flywheel, a cover therefor, frictionally engaging members, a coned spring to effect frictional engagement, said spring having a plurality of apertures arranged in a circular series, fulcrum pins carried by said cover and extending through said apertures, said plate having slots extending from said apertures toward the center of said spring plate, each of said apertures having its radially outermost wall portion rectilinear in outline, said rectilinear wall portion extending transversely of a radius of the plate extending through the adjacent slot.

7. In a clutch, a flywheel, a cover therefor, frictionally engaging members, a coned spring to effect frictional engagement, said spring having a plurality of apertures arranged in a circular series, fulcrum pins carried by said cover and extending through said apertures, said plate having slots extending from said apertures toward the center of said spring plate, the radially outermost wall portion of each of said apertures being rectilinear in outline, said rectilinear wall portion extending at right angles to a radius of said plate through the adjacent slot.

8. A spring device comprising an annular spring plate, a plurality of operating fingers extending radially inwardly from the inner periphery of said plate, the plate and the operating fingers being of frusto-conical shape, adjacent fingers being separated by elongated slots extending radially of the plate and which are enlarged adjacent the inner periphery of the plate to provide apertures, each of said apertures being formed with a broadened base which is disposed approximately in the line of the inner periphery of the plate and which extends transversely for a substantial distance on either side of the radial axis of the plate which extends through the elongated slot connecting with the aperture which is bounded by the said base.

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