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2,584,612

SPRING

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Fig. 1.

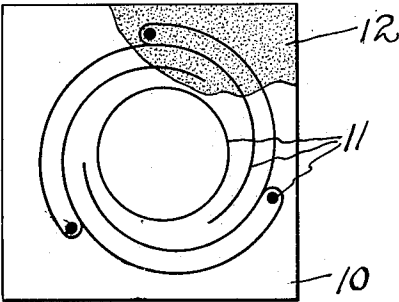


Fig. 2.

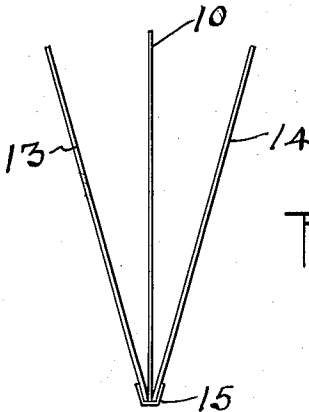
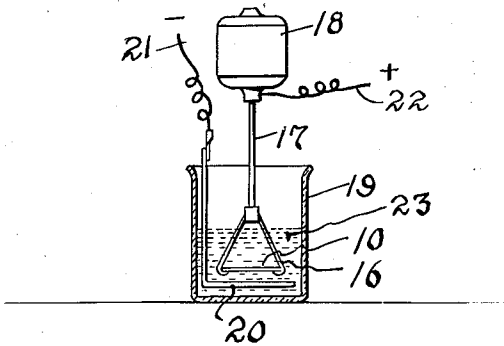


Fig. 3.



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SPRING

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4 Claims. (Cl. 267-1)

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This invention relates to a specialized form of spring.

Another object of this invention is to produce a flat spring of specialized construction of general utility but having use for example in a geophone such as disclosed in my copending application Serial No. 581,472, filed March 7, 1945 for Geophone now Patent No. 2,487,029 issued November 1, 1949.

The detailed objects of this invention will be apparent from the following disclosure of the process and the product.

This invention resides substantially in the combination, construction, arrangement, and relative location of parts, all as hereinafter set forth in connection with the attached drawing.

In the accompanying drawings,

Figure 1 is a plan view of the spring at an intermediate stage in its processing;

Figure 2 is an end elevational diagrammatic view of the spring at a more advanced stage in its processing; and

Figure 3 is a diagrammatic illustration of a still more advanced process and the stage diagrammatically illustrating the etching step.

The subject matter of this invention arose by reason of the difficulty presented in cutting a flat spring of intricate configuration and accurate dimensions such as will be described below in connection with the attached drawing, from a sheet of suitable resilient material without creating stresses therein. The configuration of the finished spring is illustrated in outline in Figure 1, and comprises the areas within the curved lines 11. Thus it is a flat spring having rigidity in the plane thereof and the proper flexibility at right angles to the plane thereof. The spring is made of any suitable resilient material, but for a particular purpose is preferably made from a sheet 10 of beryllium copper of the proper thickness. The large central circular portion and the rectangular portion surrounding the lines 11 represent the waste so that the spring consists of three spirally arranged arms integrally connected.

In making this spring in accordance with this invention a sheet 10 of suitable spring material such as beryllium copper is thoroughly washed to remove all grease and foreign material from both surfaces thereof after it is cleaned with some suitable abrasive such as pumice. The plate is then secured in a suitable clamp such as is illustrated in Figure 3 comprising several spring arms 16 which can clip over the edge of the plate. The exact form of the clamp is immaterial. The wet plate is then whirled at an axis at right angles to the plane thereof to remove

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as much water as possible, although the plate need not necessarily be completely dry. The plate still in the clamp is then dipped in a suitable light sensitive coating which ultimately forms an etching resist after processing. Such a light sensitive coating forms no part of this invention since there are a number of them commercially available and suitable for the purpose having extensive use in the photo-etching art. The coated plate is then whirled as before, while maintaining the plate in a horizontal position so as to uniformly distribute the coating in an even layer on both sides thereof. It is then dried in a blast of warm air from any suitable source, preferably while still revolving on the axis of the supporting clamp.

In dipping the plate 10 to coat it it is preferable to have two trays of coating material so that any dilution resulting from the moisture on the plate occurs in the first tray. Dipping the plate in the second tray of sensitized coating material insures that the coating will have its full light sensitivity. The coating is dried by warm air at a temperature, for example, of about 30° C. for about ten minutes. The drying temperature and time will, of course, vary with the particular sensitized coating used. The dried plate is now ready for exposure and preferably should be exposed at once, although if maintained in a dark dry place it will remain sensitive for at least thirty minutes. A portion of the coating for one side of the plate is shown at 12 in Figure 1, it being understood that the entire surface of both sides of the plate will be thus coated.

A pair of templets 13 and 14 previously prepared are connected in the form of a book by means of a flexible hinge 15 of any suitable material. The templets 13 and 14 are made of any suitable transparent material such as glass, clear Celluloid, cellulose acetate and the like, and there is drawn thereon mirror images of the spring by means of heavy black lines of ink or some other suitable marking material. The lines on the templets will have exactly the appearance and shape of the lines 11 of Figure 1, which include the small circular dots which define the areas which will become holes in the ends of the arms of the finished spring. Mirror images of the springs are drawn on the templets 13 and 14 so that when the plate 10 is placed between them, as illustrated in Figure 2, and the templets 13 and 14 closed on the sides of the plate 10 like a book the pairs of outlines of the spring are exactly aligned in a transverse sense.

The above described structure is a diagrammatic illustration of the well known printing frame frequently used in the photo-etching art, and provides an arrangement for exposing the sensitized coatings 12. In accordance with one suitable practice the sensitized coatings are exposed to No. 2 photo flood lamps placed at a distance of about ten inches on each side of the printing frame for a period of two to three minutes. It is preferable that the light from these sources be transmitted through suitable heat filters such as cells containing the copper sulphate solution with the filter placed close to the printing frame. The preparation of the plate and the exposure thereof may be carried out in a normally lighted room if not delayed too long. At this point it may be well to note that if desired only a single templet could be employed and the plate successively exposed on both sides.

The exposed plate is ready for developing as soon as exposure is complete. Any suitable developing solution may be employed compatible with the particular coating used, all in accordance with knowledge in this art. After development in a suitable solution the plate is removed therefrom and rinsed in running water, during which time it is gently rubbed with absorbent cotton. The result of this treatment is that those portions of the coatings masked by the black lines on the templets are removed, exposing the metal of the plate 10 in a configuration represented by the lines and black dots 11. The plate is then slowly baked, preferably for three or more hours at 150° C., or thirty to forty-five minutes at 170° C. This converts the remaining portions of the coatings 12 to the well known enamel resist used in the etching art.

The plate is now ready for the etching operation. It is replaced in the clamp 16 and mounted on the shaft 17 of a suitable motor 18 so that it will be revolved on an axis at right angles to the plane of the motor. The motor 18 is positioned so that the plate is immersed in the etching solution 23 in a suitable container 19. The etching solution is the usual copper sulfate-sulfuric acid bath. Immersed in the solution is a cathode 20 preferably of copper positioned parallel to the plate 10. A suitable current source, not shown, is connected to the leads 21 and 22, which in turn are respectively connected to the cathode 20 and the motor frame or motor shaft 17 by the lead 22. The motor 18 is preferably a slow speed motor so that the plate 10 revolves slowly as etching progresses. This rotation of the plate tends to prevent polarization.

For the sake of completeness the etching solution may comprise 28 ounces of copper sulfate and 3 to 5 fluid ounces of sulfuric acid to one gallon of water. The voltage of the current source may be of the order of 4 to 6 volts. In one commercial operation it took about ten minutes to complete the etching operation although, of course, the etching period is subject to several variables, as is well known in the art, including, of course, the thickness of the plate. Since the only portion of the plate which is exposed are the lines and dots 11 which are aligned on both sides of the plate, it is clear that the plate is eaten away from both sides. While one face of the plate may be entirely covered with a solid coating 12 and etched from the other side only, it is preferable to proceed

as explained above since etching from both sides of the plate reduces undercutting of the metal.

When the etching is completed the plate 10 separates into three parts comprising the central circular portion, the spring itself, and the rectangular fringe surrounding the spring. The first and third portions are, of course, waste in so far as this operation is concerned. The resulting spring is then treated with a resist enamel remover which will vary with the material of the coating, so as to clean up the final spring.

By this procedure the spring which is etched or cut out of the plate has very clean edges and needs no filing.

There are, of course, many variations that may be employed in this process without departing from the novel method of producing a flat spring as herein disclosed, as those skilled in the art will appreciate. For example, the plate 10 may be large enough so that several springs are etched at the same time. Likewise, a pair of cathodes 20 can be positioned at opposite sides of the plate to increase the efficiency of the etching operation. As already indicated various forms and types of resists are available and for that reason no specific resist developer and cleaning solutions are named since they are not critical in this process.

I do not, therefore, desire to be strictly limited to the details of the disclosure herein given, but only as required by the scope of the appended claims.

What is claimed is:

1. A flat spring having rigidity in the plane thereof and flexibility at right angles to the plane thereof, said spring consisting of a single uniform sheet of flat spring metal having a central opening therein and a plurality of flat spiral arms of substantially uniform width in the plane thereof, each arm extending from a point contiguous to said central opening in an arc substantially concentric to said opening for a total distance of about one-third of the circumference of said spring, each arm being free at its outer end.

2. In the spring in accordance with claim 1 the central opening of the spring being defined by a border substantially as wide as the arms of the spring.

3. In the spring in accordance with claim 2, the terminal ends of the spring arms having apertures therein.

4. The spring in accordance with claim 3 formed from beryllium copper.

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