COMMISSIONER'S DECISION

Obviousness: Terminals for electrical wires.

The end of electrical wires are heated to form a molten ball. These are pear-shaped nodules formed by the combined effect of surface tension and gravity upon the nodule. The nodules can then be shaped to form easily-attached connectors. Claim 1, which was directed to the pear-shaped nodule, was refused in view of the cited references, common general knowledge and the physical phenomena involved in forming such a shape. A claim directed to the novel practical application of the invention, which includes the step of deforming the solidified, pear-shaped nodule, to provide a shaped free-ended terminal on the end of the conductor, was found allowable.

Final Action: Affirmed.

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This decision deals with a request for review by the Commissioner of Patents of the Examiner's Final Action dated March 29, 1976, on application 171,595 (Class 26-134). The application was filed on May 11, 1973, in the name of Gideon A. DuRocher et al, and is entitled "Terminating and Splicing Electrical Conductors." The Patent Appeal Board conducted a Hearing on November 16, 1977, at which Mr. D.N. Deeth represented the applicant.

The application is directed to preparing terminals at the end of electrical wires. The end of the wire is heated to form a molten mass, which is a pear-shaped nodule at the end of the wire due to the combined effect of surface tension and gravity upon the droplet. The terminal can also be shaped to form connectors, so the wire can be easily attached to terminals. Figures 1 and 10 shown below illustrate the invention:

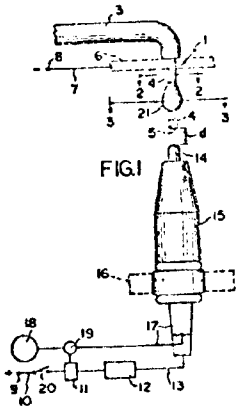


FIG.1

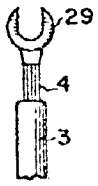


FIG.10

In the Final Action the examiner refused claims 1 to 14 and 18 to 21 for failing to define patentable subject matter over the following United States references:

3,684,474	Aug. 15, 1972	Chisholm
3,561,084	Feb. 9, 1971	Sims
3,397,451	Aug. 20, 1968	Avedissian et al

Each of the cited references discloses the method of obtaining a nodule of metal on the end of a wire by holding a wire with its longitudinal axis vertical, heating the lower end of the wire until it melts and forms a nodule having a diameter greater than that of the wire, and removing the source of heat before the molten nodule drops from the end of the wire. Upon cooling, there will remain at the end of the wire a solidified bulbous nodule.

We note however, that the Chisholm reference was overcome by the presentation of a certified copy of the applicant's corresponding United States application, thereby establishing an effective filing date of May 18, 1972.

In the Final Action the examiner had this to say (in part):

> In claim 1 applicant refers to the combined action of the forces of gravity and surface tension. These forces and their influence have not been discussed in the references. However, they are natural forces acting upon the molten portion of the wire. Whether described or not, the forces are present and will shape the metal immediately upon melting. The shape of the nodule will, in all cases, be determined by the surface tension and density of the molten metal and the shape of the nodule will be that of a teardrop just prior to necking in and detachment from the wire. The failure of the references to illustrate this shape accurately cannot be readily explained. However, it is noted that a draftsman would use a compass to draw such a shape and may take greater or lesser care in attempting to depict a teardrop shape. It is apparent in figure 1 of the Sims patent that more care has been taken to make an accurate representation of the shape than in the other two references. Even applicant's drawings are somewhat inaccurate in their representation of the shape in that they show (in figures 1, 19, 22, 23, 24 and 26) a hemispherical lower portion while, in fact no portion of a teardrop is truly spherical and there is not a proper illustration of the reverse-curved upper portion which is characteristic of teardrop shapes.
>
> Since the references teach the steps of heating the end of a wire to form a molten nodule having a diameter greater than that of the wire, and, in the absence of any teaching of any means to prevent the formation of a <u>natural</u> teardrop shape, the nodules formed by this method <u>will</u> have a teardrop shape.

> In addition to that which is taught in the cited references, applicant has included in claim 1 a description of that which naturally occurs in the method. This does not lend any patentable distinction to the claim. The additional definition of claims 2, 7 and 20 is readily apparent in each of the cited references which anticipate claims 1, 2, 7 and 20.
>
> The use of an oxygen atmosphere or an inert atmosphere as defined in claims 3, 4 and 21 is commonly known in the art and as such does not lend any patentable distinction to the claims. Similarly to perform the method on multi-strand conductors as in claims 5 and 6 is not an inventive improvement over the use of the method of the prior art on single-conductor wires. The use of an electric arc to melt wire as in claims 8 to 11 is commonly known in the art. All of the abovementioned features are known to those skilled in the art and it is to be expected of one skilled in the art to employ such techniques. Further, as employed by applicant they do not provide any unexpected beneficial result upon which to predicate an assertion of patentable ingenuity and novelty. Claims 3 to 6, 8 to 11 and 21 are rejected for failure to define any patentable improvement beyond common knowledge and expected skill as applied to each of the cited references.
>
> ...

In response to the Final Action the applicant made minor amendments to claims 1 and 2, and presented the following arguments:

> ...
>
> One particular advantage of the invention is that with this method, the pear-shaped nodule, as illustrated in figure 1, or figure 31 or figure 32, merges smoothly into the bared or unmelted part of the conductor. This avoids any sharp or abrupt angles in the termination, which are liable to failure under stress, as sharp or abrupt angles tend to concentrate lines of stress in the area of the sharp angle. This feature is also discussed at page 10 of the application, lines 14 to 25.
>
> In an interview granted by the Examiner to the applicant's representative, a point was discussed as to whether the method set out in the claims would give the desired results with all metals. It should first be pointed out that the novelty of the invention does not reside in the nature of the metal used. The invention is a novel procedure which can give advantageous terminations. The nature of the metal used is not of the essence of the invention. The applicants have used various metals, and have not found any metal to be inappropriate for use with the method of the invention. With the amendments proposed above, the claim has been clarified by stating that the metal is normally solid at room temperature.
>
> ...
>
> There is no disclosure in Sims or Avedissian that a pear-shaped nodule may be formed by continuing the heating beyond an initial stage as required by claim 1. Thus, the ball 19 and body 14 temporarily

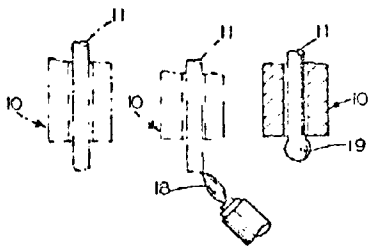
> formed in Avedissian and Sims have a spherical shape, as shown on the enclosed sample of white-covered wire. If, contrary to the teachings of Avedissian and Sims, the ball ends obtained temporarily were used as a termination, such spherical termination would exhibit an abrupt angle between the ball or body and the unmelted part of the wire. This gives rise to problems and disadvantages of stress concentration at the abruptly angled parts, leading to a termination of reduced strength.
>
> In Sims, the body 14 is flattened into bonding contact with the filament 10 and filament post 12, and is then severed from its wire 16. In Avedissian, the ball 19 is flattened into bonding contact with a wafer 12. There is no suggestion in Sims or Avedissian of deforming the solidified end of the conductor so as to provide a free-ended terminal, such as the terminals of applicants Figures 4 to 18, as required by applicants claim 2.
>
> Accordingly, applicant considers that the invention as claimed in claim 1 and its dependent claims provides an advantageous and ingenious solution to the problem of providing a termination on the end of a conductor. This solution is not described or suggested in any of the applied references.

The question to be considered is whether or not the claims in question are directed to a patentable advance in the art. Amended claim 1 reads as follows:

> A method of terminating an end of at least one metallic, electrical conductor which is normally solid at room temperature comprising holding said conductor in a position such that its said end lies in a substantially vertical plane with its free end lowermost; heating said conductor from its free end to a temperature at which the metal at said free end becomes molten, continuing said heating of said conductor for a period of time such that a nodule is formed and continuing heating until the combined forces of gravity and surface tension shape the molten metal nodule into an enlarged, pear-shaped molten mass suspended from said conductor; discontinuing the heating of said conductor prior to the time that the force of gravity acting on said molten mass causes the latter to separate from said conductor; and solidifying said molten mass, thereby forming an enlarged, pear-shaped nodule at the free end of said conductor.

At the Hearing Mr. Deeth argued that claim 1, the only independent claim, is directed to patentable subject matter.

We observe that it is a known procedure to heat an end of a metal wire to form a bulbous shaped portion (nodule) on the end of the wire. The cited patent (Avedissian) uses a flame to heat the lower end of a wire (e.g. gold) which "forms a ball" or nodule on the end of the wire. Figure 5 of that patent is shown below.

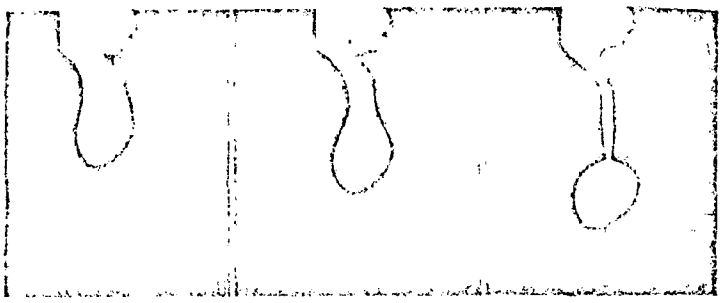


Sims (U.S. patent 3,561,084) also heats a gold wire to form a nodule. In both of these references heat is applied to form a nodule on the end of a wire. The size and shape of the nodule is dependent upon the amount of heat and other factors which we will now discuss.

In considering surface tension it is known that the shape of any collection of molecules in the liquid state is a sphere if the collection is located in a gravity-free space. In other words a liquid will, because of the existence of surface tension, assume the shape for which its area is minimum, namely, a sphere. On the other hand if we consider liquids in a gravitational field, such as the earth, the weight of a liquid acts in addition to the surface tension force. On this point we quote from "Elementary Classical Physics" by R.T. Weidner, at page 445:

> For a sphere of radius r, the effects of surface tension are proportional to the surface area $4\pi r^2$, but the weight, proportional to the mass of liquid, is proportional to its volume, $\frac{4}{3}\pi r^3$. Thus, the weight varies as r^3, whereas the forces of surface tension vary as r^2. As the radius or size of the drop of liquid increases, the weight becomes increasingly more significant than surface tension....

It is clear from this that any nodule, as it increases in size, will be deformed from its original and essentially spherical shape by gravitational force. We do not have pictorial views of a copper wire being heated as in the present application, but we do have a series of high-speed photographs of successive stages in the formation of a drop of milk at the end of a vertical tube ("College Physics" by F.W. Sears - Addison - Wesley Publishing Company, Inc. Reading Massachusetts U.S.A., page 258):



We realize that in the above photos we are dealing with two different substances. It is known, however, that the magnitude of the surface stress depends upon the nature of the liquid and the material composing the wall. We do observe from the photos what takes place when gravity becomes more significant than surface tension. The applicant should not be permitted to claim, per se, any of these naturally known occurring shapes.

At the Hearing Mr. Deeth stressed the importance of a "pear-shaped" end which has a fillet at the junction of the wire and the enlarged end. This is advantageous both to the applicant and to Avedissian. They both disclose nodules having diameters greater than the diameter of the wire. The shape of nodules actually produced will depend on the size and weight of the nodules. In all three disclosures (the application and the cited art) the wires are held vertically and the lower end is heated until a nodule is formed. Since the basic steps are the same, the product must be essentially the same. Any variations will depend upon the kind of metal, its density, surface tension, wetability and rate and duration of the application of heat to the wire. Once heat is applied and a molten nodule starts to form, its development follows the well known sequence in the formulation of teardrops. By stopping the application of heat at any particular moment one can attain a nodule having any of the shapes through which a developing teardrop progresses.

The applicant stressed the need of a fillet to reduce stress, but both references disclose such fillets and in the development of teardrops such fillets will naturally occur. In any event the applicant does not show such fillets in his drawings.

We turn now to a consideration of the claims. Claims 15, 16 and 17 were not refused in the Final Action.

Claim 1 is essentially directed to orienting a metal wire vertically, heating the lower end of the wire, and stopping the heating step when a nodule of the desired shape is attained. We believe that such steps are not directed to patentable subject matter when one considers the references, common general knowledge, and the physical phenomina discussed previously. The applicant did not discover the claimed shape; he merely observed that he could get that shape, one which suited his purpose. The prior workers in this field would at some point however, achieve the same result. We believe that this claim should be refused.

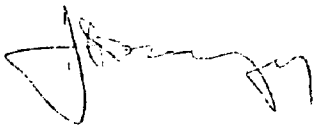
Claim 2, which depends on 1, was amended in response to the Final Action. It is now directed to the novel practical application of the invention, which includes the step of deforming the solidified, pear-shaped nodule, to provide a shaped free-ended terminal on the end of the conductor. This claim should be re-written and presented as new claim 1.

Claims 3 to 14 and 18 to 21, which depend directly or indirectly on claim 1, are directed to variations such as the application and type of heating, make up of the wire and the use of different metals. These claims do not add any patentable features to refused claim 1 and should not be allowed. These claims, however, would be found allowable if made dependent on new claim 1.

In summary, we recommend that the decision in the Final Action to refuse claims 1 to 14 and 18 to 21 be affirmed, but that amended claim 2 be accepted when presented in appropriate form as new claim 1.

J.F. Hughes
Assistant Chairman
Patent Appeal Board, Canada

I have reviewed the prosecution of this application and concur with the recommendation of the Patent Appeal Board. Accordingly, I refuse to grant a patent on claims 1 to 14 and 18 to 21, but I will accept amended claim 2 when presented in an appropriate amendment as new claim 1. The applicant has six months to submit an appropriate amendment, or to appeal my decision under the provision of Section 44 of the Patent Act.



J.H.A. Gariepy
Commissioner of Patents

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Dated at Hull, Quebec

this 20th. day of December, 1977