

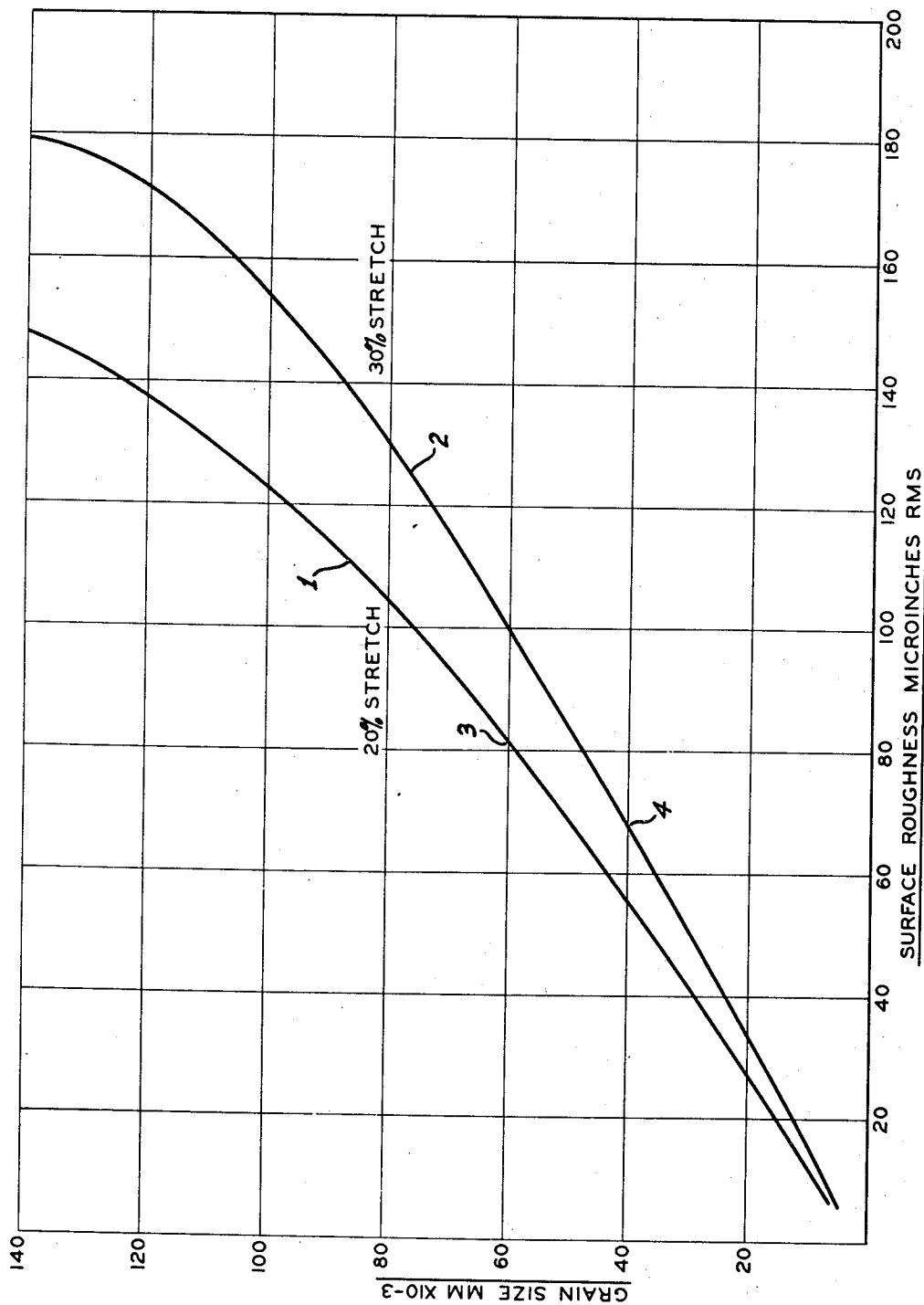
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METHOD OF EVALUATING COPPER BASE ALLOYS

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METHOD OF EVALUATING COPPER BASE ALLOYS

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4 Claims. (Cl. 73—432)

This invention relates to a method of determining various properties of metals and alloys having definite polyhedral structure.

Various properties of metals having polyhedral structure and capable of deep drawing are related to each other and to the surface roughness of the metal. These properties include tensile strength p. s. i., elongation percentage in 2", and grain size. Such metals include austenitic stainless steels, low alloy steels, deep drawing grades of aluminum, copper and copper base alloys. By way of description the following specification will be directed to determining grain size of copper base alloys, but the invention is not limited to these alloys, and can also be employed for determining the other factors mentioned.

Fabricators of brass, bronze and other copper base alloys desire to secure material from the rolling mills which will require the least amount of polishing to produce a high lustre on the finished product. The ideal material is that having the smallest average grain size which can be drawn or otherwise formed without breakage. The smaller grain size results in the smoothest formed surface in the fabricated product. As some tolerances must be allowed for manufacturing variables, the specifications are generally established as the minimum grain size which the fabricator can use with an upper figure or spread to allow for such manufacturing variables.

Grain size has heretofore been determined by one of several methods. When determined by estimate, the specimen is viewed in a microscope at a magnification of 75 diameters and compared with pictures of standard grain sizes published by the A. S. T. M. A second, and more accurate, method is to count the number of grains intersecting a line of known length. This is known as the Heyn intercept method. Both of these methods are open to the objection that they depend upon the skill of the operator. A more accurate method is the Jeffries modified planimetric method. This requires counting of grains within an area and is, therefore, more cumbersome than either of the other methods.

My invention comprises a method of measuring grain size of these metals and alloys by mechanical means whereby more accurate results are obtained and in which the accuracy of the results does not depend upon the skill of the operator. I have discovered that upon stretching, the surface of a sample of a rolled alloy becomes roughened in proportion to the size of the grains it contains and that a curve of surface roughness plotted against grain size is a substantially straight line. I, therefore, stretch a specimen of the material a predetermined amount, measure the roughness of the surface by apparatus available for that purpose, such a profilometer, and then convert the value obtained to grain size by means of charts or tables made available from experimental determinations.

In practicing the invention a specimen strip is first cut from the rolled sheet. The specimen is of a uniform width, and of a width that can be handled in the various

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apparatus. In actual practice I have employed specimens $\frac{3}{4}$ inch by 5 inches.

The specimen is marked with a one inch or two inch gauge length to facilitate determination of percentage of stretch. The specimen is then stretched to the desired percentage in any suitable stretching apparatus. It is then placed in a Profilometer, an apparatus manufactured by Physicists Research Corporation, to quantitatively measure surface roughness. This apparatus traces the surface and averages the roughness as the root means of the square of the distance from the "valleys" of the surface to the "hilltops." It is indicated on the dial of the instrument as microinches R. M. S. (root means square). Any other apparatus capable of measuring the surface roughness may be used in place of the Profilometer.

By means of previously prepared charts or tables, the value thus obtained may be converted to grain size. In the accompanying drawing I have shown a chart prepared from data I have determined in which surface roughness in microinches, R. M. S., is plotted against grain size.

Curve 1 represents the values of a copper base alloy that has been stretched 20 percent; and

Curve 2 the values of such an alloy that has been stretched 30 percent.

By way of example with 20 percent stretch, if the surface roughness reading is 82 microinches, as indicated by point 3, the grain size is 60 microns. Similarly with a 30 percent stretch, and a surface roughness of 68 microinches, as indicated by point 4, the grain size is 40 microns.

As a result of the experimental work performed, I have determined that the gauge of copper base alloys has little effect on surface roughness-grain size relationship. The procedure herein described is best suited for grain sizes below .080 mm., but is satisfactory up to .140 mm. The relationship does not hold good for very thin metal or relatively thin metal with very large grain size, but these constitute a very minor part of commercial production of copper base alloys. Separate curves or tables may be used to advantage for material over .100 in. thick and under .006 in. thick. I have also found that small variations in the amount of stretch do not appreciably affect the results.

Experiments have been made in which the specimens were stretched 40 percent to secure maximum roughness. Many samples broke before being stretched to that point. A 30 percent stretch has been found to be satisfactory in most instances. The exceptions to this are the very large grained, relatively thin sheets referred to above. I have also found that for practical purposes a 20 percent stretch gives reliable results.

Instead of grain size the usefulness of an alloy of the type discussed for fabricating is determined by its tensile strength p. s. i. or an elongation percentage in 2". These properties all indicate the ductility of the metal, and the amount of polishing it will require after fabricating. By means of tables grain size may be translated into either of these values or these values may be translated into grain size. With copper base alloys differences in composition of the alloy and differences in gauge have little effect on the relation of surface roughness to grain size. In determining properties other than grain size with metals or alloys other than copper base alloys, and of different gauges, separate charts or tables must be used to convert the Profilometer readings to the desired values.

Among the many advantages of the invention are its simplicity of operation, minimizing of variation when work is done by different operators, relatively large area of specimens covered as compared to micro examination, and area traced not arbitrarily selected by the operator. I have also found that it makes substantially no

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difference whether the stretching is done in the direction of the grain or across the grain.

I claim:

1. The method of determining the grain size of a test sample of a rolled metal having a polyhedral structure which comprises stretching the test sample by a predetermined amount and quantitatively measuring the surface roughness of the sample after such stretching, whereby the grain size of such test sample may be determined by converting the so measured surface roughness into grain size by means of experimentally determined data on the relation between grain sizes and corresponding surface roughnesses of rolled specimens of such a metal which have been stretched such predetermined amount.

2. The method according to claim 1, in which the test sample is stretched substantially 20%.

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3. The method according to claim 1, in which the test sample is stretched substantially 30%.

4. The method according to claim 1, in which the metal is a copper base alloy.

References Cited in the file of this patent

UNITED STATES PATENTS

2,397,923 Cross ----- Apr. 9, 1946

OTHER REFERENCES

"Grain Size Symposium" held during the Sixteenth Annual Convention of the Society in New York city the week of October 1, 1934. A. S. M. Pages 1100-1104, inclusive.