Aug. 11, 1936. S. J. EVERETT 2,050,298

METAL REDUCING METHOD

Filed April 19, 1935

Fig. 1.

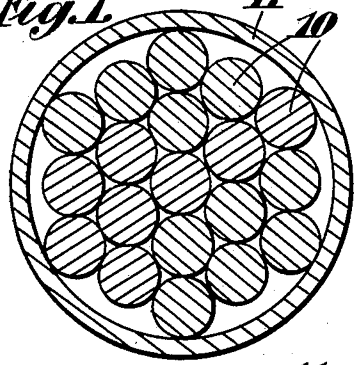


Fig. 3.

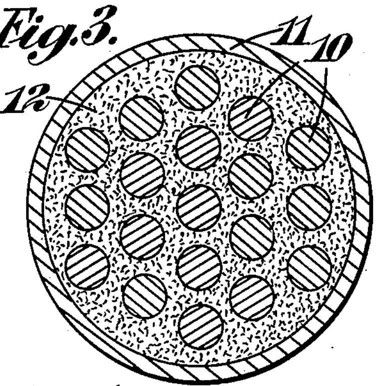


Fig. 2.

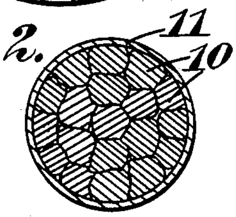


Fig. 4.

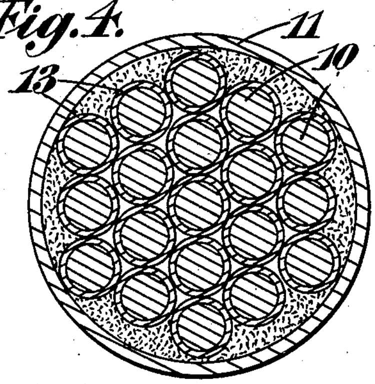


Fig. 5.

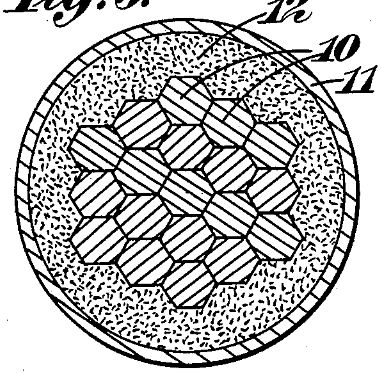


Fig. 6.

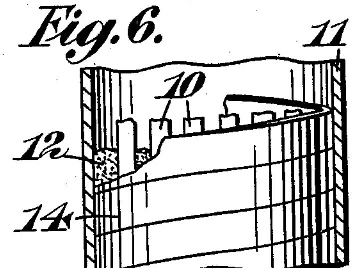


Fig. 7.

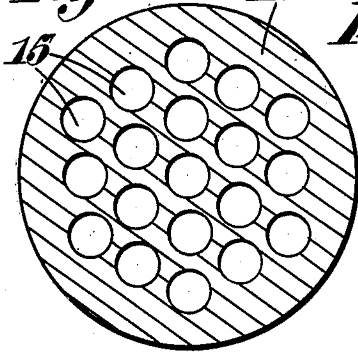
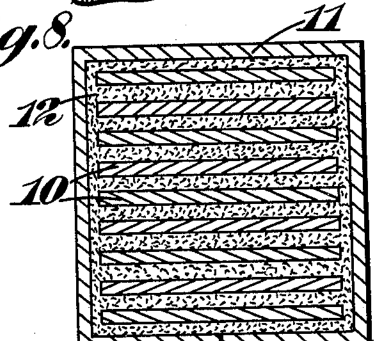


Fig. 8.



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UNITED STATES PATENT OFFICE

2,050,298

METAL REDUCING METHOD

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18 Claims. (Cl. 205—21)

This invention relates to processes for reducing metal rods, wires, strips and the like by drawing, rolling and analogous operations.

The invention is concerned with a process of the type in which a plurality of elements (rods, wires, strips or the like) each of which is to be reduced as aforesaid, is made up as a bundle, i. e. in side-by-side relationship held together, for example by an encasing tube or binding, and then subjected, i. e. as a unit, to drawing, rolling or analogous operations. The present invention provides a process for the production of fine wires by reduction from elements of larger cross section, which comprises the steps of assembling a plurality of said elements in side-by-side relationship, enclosing the assembly of elements in a tubular casing, inserting a packing material within the casing, reducing the bundle thus formed as a unit and then removing the casing and packing material and separating the individual reduced wires.

The term "matrix" as used in this specification is intended to mean a support for the surfaces of the indivdual elements of the bundle which distributes pressure applied to the outside of the encasing tube substantially evenly over the surfaces of the individual elements either throughout the reduction process, or at least during a part of that process, and thereby assists in limiting any distortion of the shape of the elements. The matrix may be formed, for example, by employing a large proportion (e. g. 22% by volume) of packing of a pulverulent or plastic nature, by so shaping the individual elements that they form a support for one another, by embedding the elements in metallic packing introduced into the encasing tube or binding in molten form, or by encasing each of the elements in individual tubes of a material which, during reduction, will readily deform to fill up the interstices in the assembled bundle. When the elements are so shaped as to form their own matrix they may be arranged to fit together without interstices and may all be of similar cross-section and conform to a regular straight-sided polygon—e. g. a square or a hexagon.

According to another feature of the invention, and for the purpose of facilitating the separation of the encasing tube after the reduction process has been completed, the bundle may be bound helically with a wire or the like prior to insertion in the encasing tube, so that in the assembly the inner surface of the tube will be separated from the bundle by the binding wire.

Some examples embodying features of the invention will now be described with reference to the accompanying diagrams, in which:—

Figure 1 is a cross-section showing a bundle of rods of circular cross-section in an encasing tube;

Figure 2 is a section showing the deformation in the section of the individual rods after reduction;

Figure 3 is a cross-section showing one method of providing a matrix according to the invention;

Figure 4 shows an alternative form of matrix;

Figure 5 shows another form of the invention in which the matrix for one element is formed by the contiguous sides of adjacent elements;

Figure 6 is a view illustrating the use of a helical binding between the bundle and the encasing tube;

Figure 7 is a section illustrating a further example of the invention, and

Figure 8 is a section illustrating the application of the process to the reduction of sheets.

Like reference numerals indicate like parts in the various figures.

In Figure 1 a number of rods **10** of circular cross-section are shown packed in an encasing tube **11**. If a composite billet is made up in this way and subjected to reduction, for example by drawing or rolling, the radial compression will tend towards deformation in the cross-section of the rods in directions towards the interstices as indicated in Figure 2. The nature and extent of the distortion varies somewhat according to the location of the individual elements with respect to the circumference of the tube.

For the purpose of minimizing the degree of distortion the invention, according to the example shown in Figure 3, makes use of a packing material of a pulverulent or plastic nature, such as French chalk or metal in powdered form as a separating medium between the individual elements of the bundle. As shown, the rod-like elements **10** are located in separated relationship within an outer tube **11** and the interstices are completely filled in by a packing **12** of the above kind. The packing **12** not only limits the degree of distortion of the sections, but prevents the elements from becoming welded together during reduction and thereby facilitates the splitting up of the bundle when the reducing process has been completed.

In the example shown in Figure 4 each rod-like element **10** is separately enclosed in a tubular metal sheath **13**, and all the elements are then inserted in bundle form within an encasing tube **11**. Here again a matrix is provided for each element of the bundle. Preferably the sheath **13** is of a metal (e. g. copper) which is substantially more ductile than that of which the elements 10 are composed, so that during the initial stage or stages of the reduction process, the sheaths will be deformed to fill in the interstices in the structure. If desired, a packing material in powdered form may also be used. In this example it will be appreciated that upon completion of the reduction process, and after the encasing tube 11 has been removed, each element has to be separated from its protective sheath 13. This can readily be done by dissolving with acid, the selection of the metal for the sheath being made with this end in view. Alternatively if a coated wire is desired the sheath 13 may be left in position.

In the example illustrated in Figure 5 the individual elements 10 are all of hexagonal cross-section, so that they may be assembled, as shown, in interfitting relationship, the matrix for each element being formed by the contiguous faces of adjacent elements. The bundle is as before enclosed in an outer tube 11 and a packing material 12 is located between the periphery of the bundle and the inner wall of the encasing tube. This packing material may, for example, be French chalk, plaster of Paris or powdered metal, or molten metal may be run into the tube to form the packing. Further packing, such as French chalk, is also introduced between the adjacent faces of the individual elements in order to assist in the final splitting up of the bundle into its component elements. This example of the invention may be carried out with bars of any desired cross-section which interfit to form a solid cross-section and the elements need not all be of the same cross-section. Thus rectangles of different dimensions may be used for the different elements or round sections in conjunction with four-sided concave sided sections may be employed. A further example is the combination with square sections of octagonal sections.

In certain cases it may not be desirable or convenient to use a chemical or electrolytic method of removing the encasing tube 11 after reduction, and in such cases the arrangement illustrated in Figure 6 may advantageously be employed. Referring to that figure the individual rods or wires 10 are made up in a bundle as before with a separating medium such as graphite between the individual elements, and the bundle prior to insertion in the outer casing 11 is helically bound with a metal wire or strip 14. After reduction the tube 11 may be cut longitudinally by a machining operation without damaging the drawn elements, since the latter are protected by the binding 14. After the tube 11 has been removed, the wire 14 can be unwound and the individual elements exposed. In some cases where a helical binding is employed this may entirely replace the outer encasing tube 11, the bound bundle being subjected direct to the reducing operations.

In the arrangement shown in Figure 7 the individual rods are inserted in longitudinal holes 15 drilled in a solid billet. In this case the interior portion of the billet constitutes the matrices for the individual elements, and the circumferential portions takes the place of the encasing tube 11 employed in the previous examples.

In the example shown in Figure 8 the invention is applied to the reduction by rolling or the like of individual elements 10 in the form of plates, slabs or the like. As before, these are assembled in the form of a bundle or pack with a separating medium 12 located between adjacent layers. The pack is enclosed in a rectangular metal case 11, the inner walls of which are separated from the adjacent surfaces of the pack by further quantities of separating medium. The case 11 may have a welded seam or may merely be turned over. If, as may be advantageous, it is desired to prevent the access of air to the individual plates, the ends of the case 12 may be closed in. As before, the separating medium may be a metal, for example, where the plates 10 are of carbon steel, the separating metal may be copper or nickel, or again a pulverulent or like packing such, for example, as powdered (not flaked) graphite, or metallic oxide may be used.

In any of the foregoing examples the encased bundle may be subjected to hot or cold working. Where the process is applied to the production of fine wires and the main consideration is to minimize any alteration in the cross-sectional shape of the wires, drawing through dies is the preferred method of reduction. At intermediate stages between successive reduction steps and/or as a final operation, annealing or other special heat treatment may be necessary or desirable, and in this connection it will be appreciated that a process of the type with which the invention is concerned offers substantial practical advantages in that it enables a batch of rods or the like undergoing reduction to be simultaneously subjected to the same heat treatment in the form of a single unit which can be readily manipulated.

The outer binding or casing for the bundle need not necessarily be a seamless tube. For example, a tubular case with a longitudinal seamed or lapped joint may be used, a separating agent—such, for example, as chromium oxide—being introduced between adjacent surfaces at the joint so as to prevent welding up during the reduction process. Upon completion of reduction or after any further desired operations such as heat treatment have been effected, the outer case may readily be split open at the joint and stripped from the bundle.

In reducing individual elements of certain metals or alloys, the separating medium between adjacent elements may be constituted by an oxide layer of substantial thickness, purposely formed at the surface of the elements with this object in view. Again, an oxide layer may be used in conjunction with the other forms of packing already described.

The processes described herein may be used for the reduction of individual elements of any desired metal or alloy, and in each case the form and composition of the matrix and outer binding or case will be selected with due regard to the method which is to be employed for separating the individual elements after the final reduction, the desirability of minimizing distortion of the original section and other factors which have already been considered. In one example where the process was applied to the production of fine wires of stainless steel containing 18% chromium and 8% nickel, a copper matrix was used and an outer tubular casing of high carbon steel was employed. After reduction the outer casing and the matrix were removed by immersion in a hot acid bath. In general it has been found that the volume occupied by the packing should be upwards of 5% of the volume enclosed by the encasing tube or binding to facilitate separation of the individual elements after reduction, and with wires of circular cross-section the volume of packing should be at least 22%, and may be as high as 200% or more, if it is desired to limit distortion of the cross-section.

A further alternative method of removing a high carbon steel outer casing is to bring it into a brittle state by heat-treatment and then to crack it off the bundle.

The present invention has many industrial applications, for example to the manufacture of very fine wires. For example, starting with nine round section wires of 0.65 mm. in diameter, and of stainless steel having the composition given above, encased in a tube it is readily possible by the present method to produce final sections with a diameter approaching 0.002 inch, and still of very nearly round section.

In a further example eighty stainless steel or nichrome (80% Ni, 20% Cr) wires .65 mm. in diameter were each encased in separate copper tubes formed by pressing copper strip around the wires and were then packed inside a half inch diameter copper tube. The composite billet thus formed was then reduced by drawing (in another example by rolling) down to a diameter of .17 mm. The copper was then dissolved off leaving the wires which had a diameter of about 0.0004 inch.

Wires of this fine section may be spun into multiple filament threads, and these may be woven into fabrics. Another application of the invention is to the production of stranded wire, cable or the like. Stranded wire or cable may be produced by reducing a bound or encased bundle of rods or wires by the methods already described and then imparting a helical twist to the reduced bundle and, where necessary, thermally treating the bundle to set the individual elements or strands and/or to impart any desired physical properties. As before, the encasing tube, binding and matrix are finally removed by chemical, electrolytic or mechanical means. If desired, at one or each end of the reduced cable or multiple wire, the matrix, where it is of metal such as copper, may be allowed to remain in position so as to form solid end portions which may be useful for threading, for instance where the final product is a fine stranded wire which is to be woven into a fabric. Where a solid tube is employed for encasing the bundle, it may, if desired, be recovered as a useful commercial product, i. e. a seamless drawn tube. If this end is in view, the composition of the enclosing tube will be selected with regard to the nature and properties of the material in the recovered tube. When the composite billet has been reduced to the desired size, the tube may be freed from the enclosed elements by cross rolling or any other convenient method.

In the selection of packing material those materials which do not extend uniformly or which tend to bind under pressure (e. g. flake graphite or coach-filling) are found not to be so suitable as materials which extend uniformly under the pressure of rolling or drawing (e. g. metallic substances, French chalk or chromic oxide).

It is within the invention to employ the reduced bundle in the production of a brush. In this application a portion of the encasing tube is left in position to hold together the individual wires and form a handle for the brush.

I claim:—

1. A process for the production of stranded wire by reduction from elements of comparatively large cross section which comprises the steps of assembling a plurality of said elements in side-by-side relationship, encasing the assembly of elements, reducing the bundle thus formed as a unit, imparting a permanent helical twist to the reduced bundle and then removing the casing.

2. A process for the production of fine wires, strips or the like by reduction from elements of larger cross section comprising the steps of assembling a plurality of said elements in side-by-side relationship, encasing the assembly of elements in a tube of high carbon steel, inserting a packing material within the tube, reducing the bundle thus formed as a unit and then cracking off the tube.

3. A process for the production of fine wires by reduction from solid elements of larger cross section, which comprises the steps of assembling a plurality of said elements in side-by-side relationship, enclosing the assembly of elements in a tubular casing, inserting a packing material within the casing, reducing the bundle thus formed as a unit and then removing the casing and packing material and separating the individual reduced wires.

4. A process for the production of fine wires by reduction from solid elements of larger cross section, which comprises assembling a plurality of said elements in side-by-side relationship, enclosing the assembly of elements in a tubular casing, providing a matrix for each individual element, reducing the bundle thus formed as a unit and then removing the casing and separating the individual wires.

5. A process for the production of fine wires by reduction from solid elements of larger cross section, which comprises the steps of assembling a plurality of said elements in side-by-side relationship, enclosing the assembly of elements in a tubular casing, inserting a packing material within the casing and in a proportion occupying at least 22% of the volume within the casing, reducing the bundle thus formed as a unit and then removing the casing and the packing material and separating the individual wires.

6. A process for the production of fine wires by reduction from solid elements of larger cross section, which comprises employing elements of cross sections which will fit together without interstices, assembling a plurality of said elements side-by-side in interfitting relationship without interstices, the sides of each element acting directly as a matrix for the contiguous sides of adjacent elements, enclosing the assembly of elements in a tubular casing, reducing the bundle thus formed as a unit and then removing the casing and separating the individual wires.

7. A process for the production of fine wires by reduction from solid elements of larger cross section which comprises employing elements whereof the cross section of each is the same and conforms to a regular straight-sided polygon which will interfit without interstices with contiguous elements of the same cross section, assembling a plurality of said elements in side-by-side interfitting relationship, enclosing the assembly of elements in a tubular casing, reducing the bundle thus formed as a unit and then removing the casing and separating the individual wires.

8. A process for the production of fine wires from solid elements of larger cross section, which comprises the steps of assembling a plurality of said elements in side-by-side relationship, enclosing the assembly of elements in a tubular casing, completely filling the interstices between adjacent elements and between the elements and the inner wall of the casing with a packing material, reducing the bundle thus formed as a unit,

then removing the casing by dissolving with an acid, removing the packing material and separating the individual wires.

9. A process for the production of fine wires by reduction from solid elements of larger cross section, which comprises the steps of assembling a plurality of said elements in side-by-side relationship, enclosing the assembly of elements in a tubular casing, running a molten metal packing into the casing to embed the elements, reducing the bundle thus formed as a unit and then removing the casing and the metal packing to separate the individual wires.

10. A process for the production of fine wires of stainless steel by reduction from solid elements of such material of larger cross section, which comprises the steps of enclosing each element in a separate copper sheath, assembling a plurality of such sheathed elements in side-by-side relationship, enclosing the assembly in a copper tube, reducing the bundle thus formed as a unit and then removing the casing and the sheaths by dissolving off the copper, and separating the reduced wires.

11. A process for the production of fine wires by reduction from solid elements of larger cross section, which comprises the steps of assembling a plurality of said elements in side-by-side relationship, helically binding the assembly, enclosing the bound assembly in a tubular casing, reducing the bundle thus formed as a unit, removing the casing, unwinding the helical binding and separating the reduced wires.

12. A process for the production of fine wires by reduction from solid elements of larger cross section, which comprises the steps of forming layers of oxide of substantial thickness on the surfaces of the elements, assembling a plurality of said oxidized elements in side-by-side relationship, enclosing the assembly of elements in a tubular casing, reducing the bundle thus formed as a unit and then removing the casing and separating the individual wires.

13. An article of manufacture comprising a flexible metal fibre having a surface such as formed on metallic strands when elongated in a bundle with other strands with a separating matrix and of such small cross-sectional area that it may be spun into multiple-filament threads.

14. An article of manufacture comprising a flexible metal fibre of thread-like length having a surface such as formed on metallic strands when elongated in a bundle with other strands with a separating matrix and of a cross-sectional area such that the fibres may be spun into multiple-filament threads capable of being woven into flexible fabrics.

15. An article of manufacture comprising a flexible metal fibre of thread-like length having a surface such as formed on metallic strands when elongated in a bundle with other strands with a separating matrix and of a cross-sectional area such that the fibres may be spun into multiple-filament threads comparable in flexibility to threads formed from organic fibres and capable of being woven into a fabric.

16. An article of manufacture comprising a fabric woven from stranded multiple-filament threads of metal, the threads being spun from metal fibres having a diameter of an order ranging from 0.002 inch to 0.0004 inch and having a surface such as formed on metallic strands when elongated in a bundle with other strands with a separating matrix.

17. An article of manufacture comprising a helically twisted cable consisting of a bundle of flexible fibres of small cross-sectional area, all of which fibres are reduced in cross-sectional area in a bundle.

18. An article of manufacture comprising a flexible and ductile metal fibre of a diameter of an order ranging from 0.002 inch to 0.0004 inch and having a surface such as formed on metallic strands when elongated in a bundle with other strands with a separating matrix.

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