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PROCESS FOR MAKING WIRE OR STRIPS

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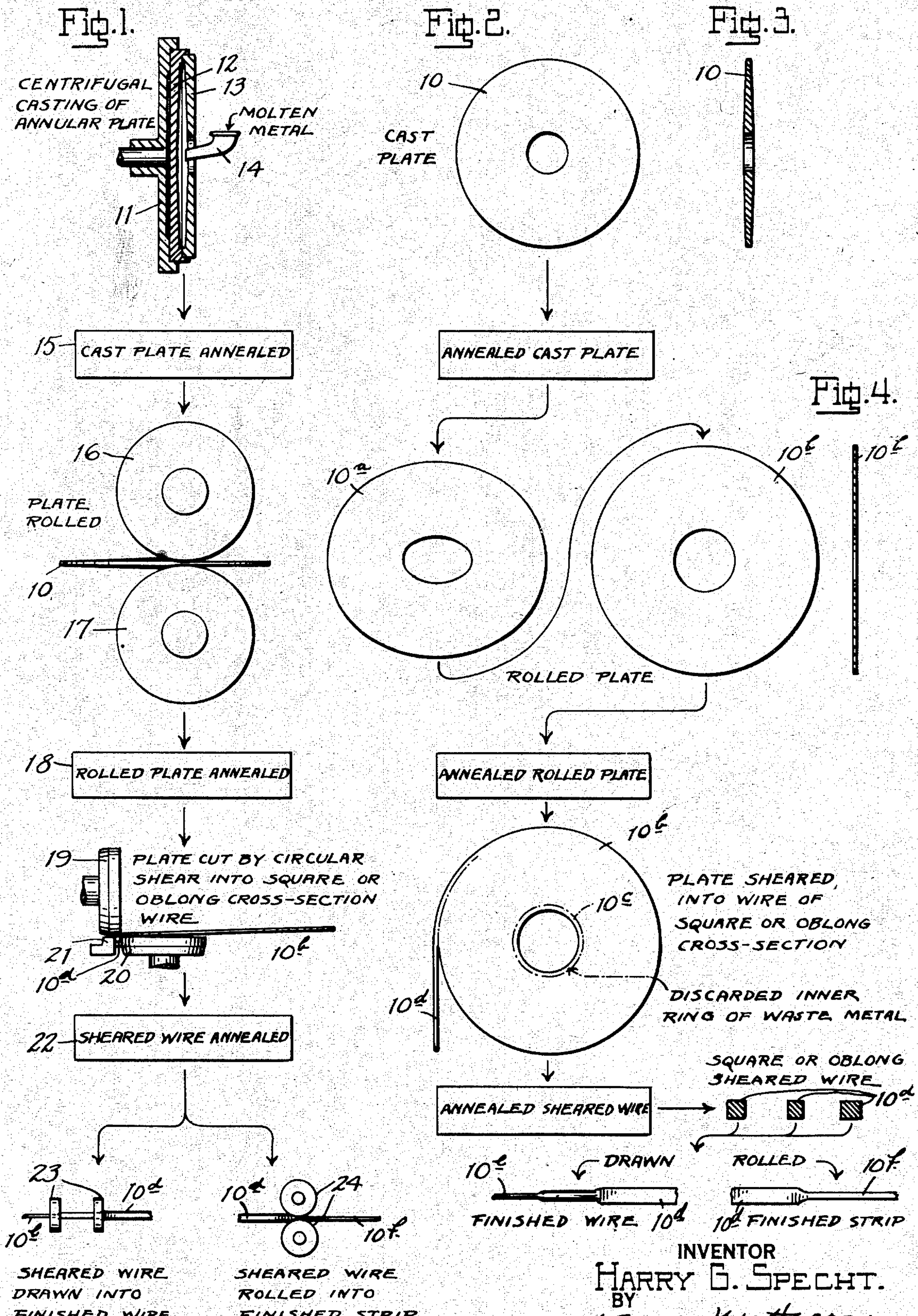

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PROCESS FOR MAKING WIRE OR STRIPS

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5 Claims. (Cl. 29—148)

The present invention relates to an improved process for making wire or strips, and has for an object to provide a process by which wire or strips may be produced rapidly and economically, and which will be of uniform quality as to density, grain, tensile strength, ductility, and surface formation, and will be free from undesirable inclusions and voids.

It is particularly proposed according to the process of the invention to produce wire or strips from molten metal, such for example as copper, aluminum, soft steel, hard steel, stainless steel, phosphor bronze, brass, etc., by first forming the metal into an annular cast discus plate by centrifugal casting in a casting machine of the vertical type, in which the axis of the centrifugal mold is horizontally arranged. According to this method of casting the molten metal flows to the bottom of the rotating centrifugal mold in a downwardly directed column, the volume and rate of flow of which is controlled in relation to the capacity and speed of rotation of the mold, with the result that it is picked up substantially synchronously with the flow of the entering column and rotated by the mold and the gradually forming annular plate in the mold. At the same time the displaced air in the mold is allowed to escape freely without interference or entrapment by the entering molten metal, and due to the continuous pick up of the metal at the bottom of the mold the cast metal is of uniform structure annularly, and is free from air pockets or prematurely cooled and hardened metal particles. In centrifugally casting such plates there is a grain size and texture differential between the metal at the inner and outer peripheries, the cast metal being of greater density radially toward the outer rim of the plate due to the fact that it is subjected to the centrifugal force of the added weight of the metal at the inner periphery, and it is proposed according to the invention to cast the plate with an increasing thickness toward the inner periphery, this thickness being directly related to the differential density, and which in turn depends upon and is determined by the particular metal and the thickness and diameter dimensions of the plate. By a subsequent rolling operation, which rolls the plate to a uniform thickness, the grain differentials are equalized.

The centrifugally cast plate is of relatively thin cross-section, and will therefore cool and contact rapidly, without setting up differentials in grain structure and density, and such as occur in the casting of relatively thick plates or billets where the surface cools and contracts more rapidly than the interior and therefore results in a difference in structure and density between the surface and the interior, as well as fractures and fissures in the surface, which subsequently appear in and weaken the finished wire. In the centrifugally cast plate impurities in the metal collect at the inner periphery, and the small ring of metal containing these impurities is later discarded, this method of centrifugal casting providing a maximum body of metal free from impurities, with a consequent reduction in loss from impure waste metal.

The next step in the process consists in annealing the cast plate if the particular metal requires it, and thereupon rolling it—either cold-rolled or hot-rolled—into a circular plate of uniform thickness, the grain differential between the relatively thick inner part of less density and the relatively thin outer part of greater density becoming equalized as the plate is rolled to uniform thickness.

The next step consists in annealing the rolled plate, if the particular metal requires it, and thereupon cutting it in a circular shear into a wire of square or oblong cross-section, this sheared wire being thereupon annealed or not, depending on the requirements of the particular metal, and finally formed into finished wire or strip stock by drawing or rolling.

In the shearing operation the resultant cross-sectional shape of the sheared wire is rectangular, due to the fact that the shear cut is substantially perpendicular to the upper and lower parallel surfaces of the plate, and this rectangular cross-section may be regulated by spacing of the shear cut from the fixed shoe which supports the edge of the plate during shearing, so that the sheared wire may be of either square or oblong cross-section. This cross-section is determined and regulated according to the particular characteristics of the metal being worked. In drawing the rectangular cross-section wire through dies of circular or other shape to give the desired cross-section to the finished wire, the longer sides of a wire of greater dimension in one direction than the other tend to bulge out to fill the space in the die, while the shorter sides are more forceably compressed into the die, and consequently these shorter sides are subjected to an increased ironing and smoothing action. With certain types of metal, depending upon temper and other characteristics, the surfaces formed by the shear cuts tend to become torn, burred, rough, or crumbly, as compared to relatively smooth upper and lower surfaces of the plate, and in this case the wire is sheared so that the cross-section is of greater dimension transversely, that is, between the shear cuts. With other types of metal the shear will produce a smooth clean cut which may be smoother than the rolled upper and lower surfaces of the plate, and in this case the wire is cut so that the transverse dimension between the shear cuts is less than the vertical dimension. In the case of metal which has a shear cut surface of about equal smoothness with the rolled upper and lower surfaces of the plate the wire is cut to square cross-section. Another factor to be considered in determining the cross-sectional shape is the fact that with certain metals the shear cut tends to produce a concave shear cut surface, while with other metals the shear cut surface may be slightly convex, or straight, or angular. In the case of concave shear cut surfaces the transverse dimension will preferably be the smaller dimension so that in drawing such concave surface will tend to bow outwardly. In the case of rolling into strip stock the concave surface will preferably be engaged with the rolls to become flattened. In the case of a shear cut surface which tends to become convex or angular the transverse dimension will preferably be the greater dimension so that the upper and lower surfaces of the plate will tend to bow outwardly during drawing while the shear cut surfaces are subjected to the increased ironing and smoothing effect of the dies.

The wire or strip stock produced according to the process is of uniform density, grain, ductility and tensile strength, and through the control of the cross-sectional shape of the sheared wire and its action in the drawing dies or strip forming rolls, is free from cracks, creases, overlaps and such other defects.

With the above and other objects in view, embodiments of the process according to the invention and apparatus for carrying it out are shown diagrammatically in the accompanying drawing, and these embodiments will be hereinafter more fully described with reference thereto, and the invention will be finally pointed out in the claims.

In the drawing:

Fig. 1 is a diagrammatic illustration of the various steps in the process, and showing the several elements of an apparatus for carrying it out arranged in the order of the successive steps of the process.

Fig. 2 is a diagrammatic view showing the wire or strip forming material in its various stages, from the cast plate to the finished wire or strip.

Fig. 3 is a sectional view of the cast plate as it is formed in the centrifugal casting machine.

Fig. 4 is a sectional view of the rolled plate in its form preparatory to being cut into wire.

Referring to the drawing, the first step in the process according to the invention consists in centrifugally casting from suitable metal an annular discus plate **10** in a vertical type centrifugal casting machine, consisting in the illustrated example of such machine of a rotary backing plate **11** carrying a two-part circular mold, consisting of an inner mold part **12** and an outer mold part **13**, the latter being provided with a central opening into which the pouring spout **14** projects, the molten metal being poured into this spout and dropping downwardly in the form of a column to the bottom of the centrifugal mold, the rate of flow and the size of the column being regulated according to the size of the mold and the rate of rotation of the centrifugal casting machine. By this method of casting the downwardly flowing column entering the mold is picked up by the rotating mold at substantially the same speed as the rate of flow of the column, so that the metal is built up annularly or spirally in the mold without any chance of pocketing air, or allowing the metal to spatter so that prematurely cooled and hardened drops of metal may enter tinto the mass of metal of different temperature and hardness, and such as is the case with other types of casting, particularly in centrifugal machines of the horizontal type.

Furthermore the arrangement of the column of entering metal is such that the air displaced in the mold by the annular or spiral building up of the metal is allowed to escape freely without interference with or entrapment by the entering column of molten metal. The centrifugal action is such that the centrifugal force is greater at the rim of the mold than at the center and consequently there is a gradual differential in texture and grain of the metal between the inner and outer peripheries. In order to compensate for this the mold is shaped so that the cast plate will be of increasing thickness between the outer and inner peripheries, this increase in thickness being directly related to and determined by the texture, grain and density differential of the plate depending upon the thickness and diameter and the particular metal being worked, this being for the purpose of allowing equalization of the differential through a subsequent rolling operation which rolls the plate into a larger diameter and a decreased uniform thickness.

The next step in the process consists in annealing the cast plate, if the particular metal being worked requires this annealing step prior to the rolling operation. Where such annealing is not required this step is eliminated. The cast plate annealing apparatus is indicated diagrammatically at **15**.

The next step consists in rolling the cast plate to a larger diameter and to a decreased thickness which is substantially uniform throughout the plate, this rolling process resulting in an equalization of the differential in density, grain and texture of the cast plate. This operation may be carried out either as a hot-rolled or a cold-rolled operation, depending upon the particular metal being worked. In Fig. 1 the plate rolls are indicated diagrammatically at **16** and **17**. The cast plate is subjected to at least two rolls, the first roll, as indicated at **10**^{a} in Fig. 2, imparting to the cast plate an oval form and the second roll, which is at right angles to the direction for the first roll, imparting to the oval plate a circular form, as indicated at **10**^{b}. It will be understood that in certain cases the plate may be subjected to a greater number of rolls, and that with certain types of metal which may require it the plate may be subjected to annealing steps between the rolling operation.

The next step consists in annealing the rolled plate prior to shearing the plate into wire form, if the particular metal being worked requires this annealing step, this step being otherwise eliminated. The roll plate annealing apparatus is indicated diagrammatically at **18**.

The next step consists in cutting the rolled plate by means of a circular shear into a continuous length of wire of either square or oblong cross-section, the shearing apparatus, indicated diagrammatically in Fig. 1, consisting of a pair of shearing disc cutters 19 and 20 having their axes disposed at substantially right angles to each other and their peripheral cutting edges substantially meeting, there being a stop plate 21 disposed beneath the periphery of the cutter disc 19 in spaced relation to the periphery of the cutter disc 20, and which supports the edge of the rolled plate during the shearing operation, the spacing of this stop plate from the disc 20 determining the transverse dimension of the sheared wire. The discs are rotated and rotate the disc as it is cut, the cut being substantially spiral. The cut wire is preferably reeled as it is cut, for convenience in annealing, if such annealing step is necessary, depending upon the particular metal being worked. Where such annealing step is not necessary the cut wire may be fed directly into the apparatus for working the sheared wire into finished wire or strip form, as will presently more fully appear. The spiral cutting of the plate into wire form is continued until the relatively small ring of waste metal 10^c is reached, whereupon the end of the wire is snipped from this remaining ring which is discarded, and which contains the impurities in the metal which have been concentrated therein by the centrifugal casting step.

As above pointed out the sheared wire of rectangular cross-section indicated at 10^d is subject to an annealing step if such step is necessary, the sheared wire annealing apparatus being indicated diagrammatically at 22.

The sheared wire is thereupon subjected to either a drawing operation by means of drawing apparatus, indicated diagrammatically at 23, to form the same into finished wire which may be of circular or other desired cross-sectional shape, or to a rolling operation by means of rolling apparatus, indicated diagrammatically at 24, to roll the sheared wire into flat strip form. The finished drawn wire is indicated at 10^e, and the finished rolled strip is indicated at 10^f.

The sheared wire is cut either square or oblong in cross-section, the selection of the particular cross-sectional shape depending upon the particular metal and the effect of the shearing operation thereon, as well as to the action of the drawing apparatus in the case of drawing wire, and the rolling apparatus in the case of rolling strip stock. With certain types of metal, particularly those of soft temper, as lead for example, there is a tendency for the circular shear to tear and throw up burrs upon the sheared surface, and in certain cases a portion of the shear cut may be smooth while other portions may be crumbly, torn or burred. Also with certain metal the shear cut may produce a concave sheared surface while with others the cut surface will be convex or angular. With other types of metal, as stainless steel for example, the shear cut may be relatively smooth, and in some cases may be smoother than the rolled upper and lower parallel surfaces of the plate. It has been found in carrying out my process that in the drawing operation the action of the drawing dies upon a square cross-section is substantially equal upon all sides, whereas in the case of an oblong cross-section the longer dimensioned sides tend to bulge out to fill the side spaces in the drawing die, while the shorter dimensioned sides are subjected to an increased compressing and smoothing ironing action. Consequently, when the particular metal being worked or sheared, an analysis is made of the sheared material to determine whether the long dimension of the sheared material shall be between the shear cuts or between the upper and lower or rolled surfaces of the material. Where the sheared surface tends to be concave, the short dimension is preferably between the sheared sides, while in the case of a convex or angular shear cut, the long dimension is preferably between the sheared sides.

It will be seen from the above that the wire or strip stock produced according to the process of the invention is of uniform quality as to density, grain, ductility and tensile strength, and is free from such imperfections as cracks, creases, overlaps and the like, which have been present in wires and strip stock produced according to previously known processes. The process permits of rapid and economical production of wire and strip stock with a minimum of loss due to waste metal containing impurities. The process furthermore lends itself to working with various metals of widely different characteristics.

I have illustrated and described preferred and satisfactory embodiments of the invention, but it will be understood that changes may be made therein, within the spirit and scope thereof, as defined in the appended claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. The process for making wire or strip stock, which comprises centrifugally casting molten metal into an annular centrally apertured discus plate in a vertical type centrifugal casting machine in which the revolving mold is rotated around a horizontal axis at a speed controlled in substantially synchronous relation to the type, volume, and speed of flow of molten metal poured into the mold in a downwardly directed column from a central entering hole in the mold, the plate being cast of gradually increasing thickness from the outer to the inner peripheries and such thickness being in substantial proportion to the grain size and texture differential between the inner and outer peripheries resulting from vertical centrifugal casting, rolling the cast plate to a larger diameter and an approximate uniform thickness throughout to produce a flat-sided centrally apertured circular rolled plate, cutting the rolled plate into a continuous length of wire of substantially rectangular cross-section by a spiral cut extending inwardly from the outer periphery between the flat sides of said plate, and subjecting the cut wire to a finishing operation to produce finished wire or strip stock.

2. The process for making wire or strip stock, which comprises centrifugally casting molten metal into an annular centrally apertured discus plate in a vertical type centrifugal casting machine in which the revolving mold is rotated around a horizontal axis at a speed controlled in substantially synchronous relation to the type, volume, and speed of flow of molten metal poured into the mold in a downwardly directed column from a central entering hole in the mold, the plate being cast of gradually increasing thickness from the outer to the inner peripheries and such thickness being in substantial proportion to the grain size and texture differential between the inner and outer peripheries resulting from vertical centrifugal casting, rolling the cast plate to a larger diameter and an approximate uniform thickness throughout to produce a flat-sided centrally apertured circular rolled plate,

cutting the rolled plate into a continuous length of wire of substantially rectangular cross-section by a spiral cut extending inwardly from the outer periphery between the flat sides of said plate, terminating the spiral cut short of the inner periphery whereby a ring of metal at the inner periphery containing impurities remains, and subjecting the cut wire to a finishing operation to produce finished wire or strip stock.

3. The process for making wire or strip stock, which comprises centrifugally casting molten metal into an annular centrally apertured discus plate in a vertical type centrifugal casting machine in which the revolving mold is rotated around a horizontal axis at a speed controlled in substantially synchronous relation to the type, volume, and speed of flow of molten metal poured into the mold in a downwardly directed column from a central entering hole in the mold, the plate being cast of gradually increasing thickness from the outer to the inner peripheries and such thickness being in substantial proportion to the grain size and texture differential between the inner and outer peripheries resulting from vertical centrifugal casting, annealing the cast plate, rolling the cast plate to a larger diameter and an approximate uniform thickness throughout to produce a flat-sided centrally apertured circular rolled plate, cutting the rolled plate into a continuous length of wire of substantially rectangular cross-section by a spiral cut extending inwardly from the outer periphery between the flat sides of said plate, and subjecting the cut wire to a finishing operation to produce finished wire or strip stock.

4. The process for making wire or strip stock, which comprises centrifugally casting molten metal into an annular centrally apertured discus plate in a vertical type centrifugal casting machine in which the revolving mold is rotated around a horizontal axis at a speed controlled in substantially synchronous relation to the type, volume, and speed of flow of molten metal poured into the mold in a downwardly directed column from a central entering hole in the mold, the plate being cast of gradually increasing thickness from the outer to the inner peripheries and such thickness being in substantial proportion to the grain size and texture differential between the inner and outer peripheries resulting from vertical centrifugal casting, annealing the cast plate, rolling the cast plate to a larger diameter and an approximate uniform thickness throughout to produce a flat-sided centrally apertured circular rolled plate, annealing the rolled plate, cutting the rolled plate into a continuous length of wire of substantially rectangular cross-section by a spiral cut extending inwardly from the outer periphery between the flat sides of said plate, terminating the spiral cut short of the inner periphery whereby a ring of metal at the inner periphery containing impurities remains, annealing the cut wire, and subjecting the cut wire to a finishing operation to produce finished wire or strip stock.

5. The process for making wire or strip stock which comprises centrifugally casting molten metal into an annular centrally apertured discus plate in a vertical type centrifugal casting machine in which the revolving mold is rotated around a horizontal axis at a speed controlled in substantially synchronous relation to the type, volume, and speed of flow of molten metal poured into the mold in a downwardly directed column from a central entering hole in the mold, the plate being cast of gradually increasing thickness between the outer to the inner peripheries and such thickness being in substantially proportion to the grain size and texture differential from the inner and outer peripheries resulting from vertical centrifugal casting, rolling the cast plate to a larger diameter and an approximate uniform thickness throughout to produce a flat-sided centrally apertured circular rolled plate, cutting the rolled plate into a continuous length of wire of substantially rectangular cross-section by a spiral cut extending inwardly from the outer periphery between the flat sides of said plate, whereby a length of wire of rectangular cross-section is produced having substantially parallel upper and lower rolled surfaces, and controlling the distance between the shear cuts depending upon the comparative differences in the surfaces of the shear cuts and the rolled surfaces, whereby the rectangular cross-section is either oblong with the greater dimension either between the shear cuts or between the rolled surfaces, and subjecting the length of wire to a finishing operation which has a differential finishing action with respect to the longer and shorter sides of the cut wire.

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