March 3, 1970 MINORU MISHUKU 3,498,097

WIRE DRAWING APPARATUS AND METHOD

Filed April 28, 1967 2 Sheets-Sheet 1

Fig. 1

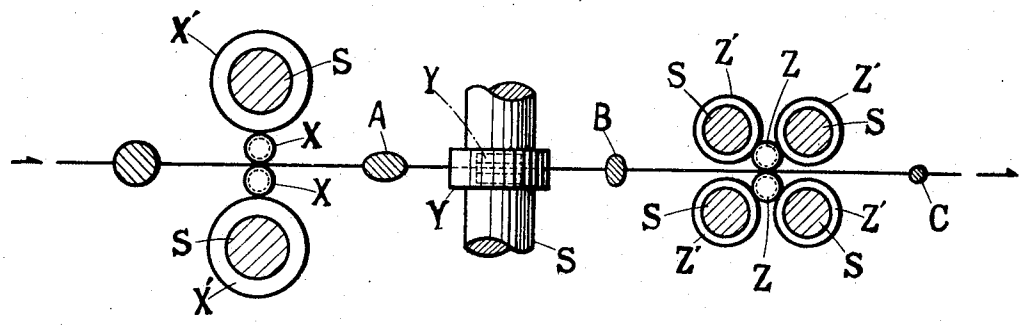


Fig. 2



Fig. 3



INVENTOR
MINORU MISHUKU
BY Steinberg & Blake
ATTORNEY

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FIG. 4

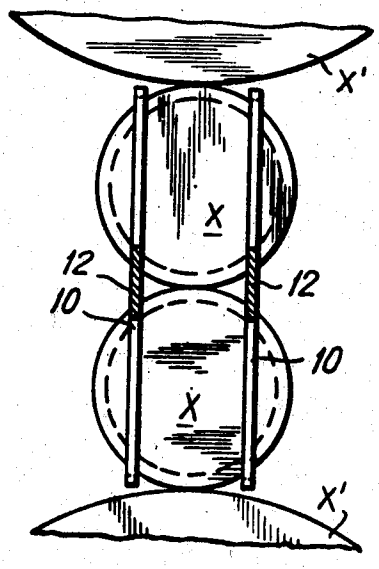


FIG. 5

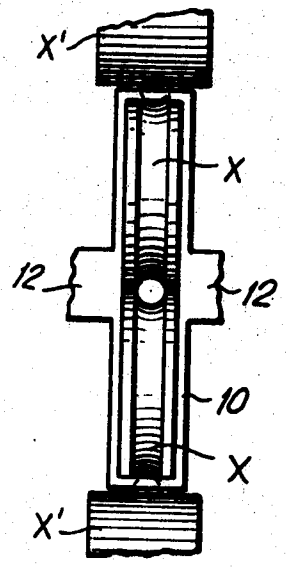


FIG. 6

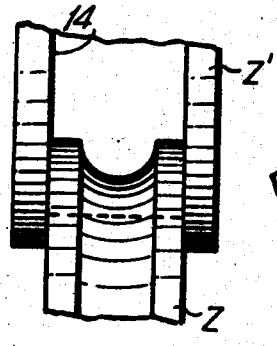
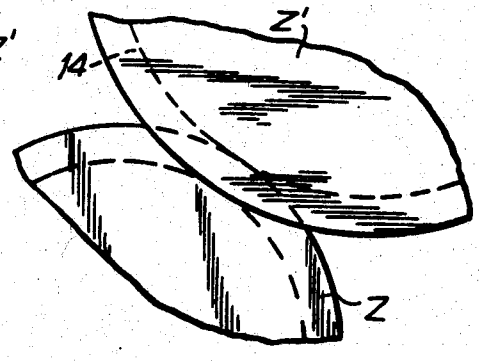


FIG. 7



INVENTOR.
MINORU MISHUKU

BY

Stanley & Blake
ATTORNEYS

United States Patent Office

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WIRE DRAWING APPARATUS AND METHOD

Minoru Mishuku, Tokyo, Japan, assignor to Fuji Dies Co., Ltd., Tokyo, Japan and Nissho Ltd., Tokyo, Japan

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12 Claims

ABSTRACT OF THE DISCLOSURE

A wire drawing apparatus wherein the cross section of the wire is reduced by successive pairs of roller dies. Each pair of roller dies are respectively provided with grooved peripheries which abut each other and define between themselves, where they butt against each other, the cross section which is provided for the wire when it passes through each pair of roller dies. Each pair of roller dies is engaged by at least one pair, respectively, of pressure rolls respectively having diameters substantially greater than those of the roller dies and serving as the exclusive means for pressing the roller dies of each pair against each other, these pressure rolls themselves being operatively connected with shafts of relatively large diameter, respectively, through which pressure is transmitted to the pressure rolls so that the latter will then transmit the pressure to the smaller roller dies. The plurality of pairs of roller dies and the pressure rolls coacting therewith are successively arranged along a drawing path with each pair of roller dies and the pressure rolls coacting therewith respectively having parallel axes which are perpendicular to the axes of the next following pair of roller dies and pressure rolls coacting therewith, so that the successive sets of roller dies and pressure rolls are angularly displaced about the drawing path by 90° one with respect to the other. While the final pair of roller dies can provide the wire with a circular cross section of a given diameter smaller than its initial cross section, the pair of roller dies which immediately precede the final pair of roller dies provide the wire with an oval cross section whose minor diameter is approximately equal to the diameter of the final circular cross section, and where additional pairs of roller dies are provided each pair provides the wire with an oval cross section the minor diameter of which is approximately equal to the major diameter of the oval cross section provided by the next following pair of roller dies. The roller dies have no shafts connected thereto and they are supported exclusively by the pressure rolls which serve as the exclusive means for transmitting pressure to the roller dies.

BACKGROUND OF THE INVENTION

The present invention relates to the drawing of wire. In particular, the present invention relates to the drawing of relatively hard wire.

In the drawing of hard metal wire, in order to reduce the diameter thereof, it is well known that the rate of wear of drawing dies is exceptionally high and this latter high rate of wear is unavoidably independent of the material of the wire drawing dies or the shape of the aperture through which the wire is drawn. These factors particularly apply to the working of hard metals, and these latter operations are also accompanied by the disadvantages of large consumption of lubricants, high consumption of power, and a low rate of reduction of the cross section of the wire, usually less than 25%. With these known constructions it is impossible to increase the traction force or the drawing speed beyond certain limits.

When dealing with soft metals, however, it is known that it is possible to use a pair of rotatably supported grooved roller dies which have grooved perpheries butting against each other to define between themselves the cross section of the drawing aperture which determines the cross section of the soft metal wire passing through such roller dies. Such pairs of roller dies are arranged in succession along the drawing path to provide the wire with successively reduced cross sections at the successive pairs of roller dies, and each pair of roller dies can be angularly displaced by 90° about the drawing path with respect to the next preceding and the next following pair of roller dies.

Also, the final pair of roller dies which determine the final cross section of the wire will have at their peripheries grooves of semi-circular cross section so as to provides the wire with a final circular cross section, whereas the other pairs of roller dies have grooved peripheries providing the wire with non-circular cross sections such as cross sections of oval configuration. With such roller dies which successively reduce the cross section of the wire it is possible to carry out the drawing operations far more easily than in the case where the wire is drawn through a stationary die, and at a single pass it is possible to achieve an area reduction which in some cases is more than 50% without any particular difficulty. As a result, with such constructions the wear of the roller dies and other components of the apparatus are greatly reduced while the required power is also reduced and practically no lubricant is required.

Furthermore, it is possible to achieve with such roller dies working on relatively soft metal wire, relatively high drawing speeds which may be increased practically by 100% over conventional drawing rates which can be achieved with drawing dies which are stationary. However, when dealing with hard metals, the pressure which is required to be applied to such hard metal wire by the roller dies becomes so great that it becomes necessary to increase the diameters of the shafts and bearings associated with the roller dies so that they will be equal to the stresses involved in the transmission of the required high pressure. It is possible to reduce the pressure applied to the roller dies when working metal wires if the diameter of the roller die is reduced, while maintaining the same rate of reduction of the cross section of the wire. However, in this case where the diameter of the roller dies is reduced, the rotating shafts which are operatively connected thereto for rotating them and for transmitting the pressure thereto necessarily become of a diameter which is so small that when the required large pressures are applied these shafts break and the required operations can no longer be carried out.

SUMMARY OF THE INVENTION

It is accordingly a primary object of the present invention to provide a wire drawing method and apparatus which will avoid the above drawbacks.

In particular, it is an object of the invention to provide a method and apparatus capable of drawing hard metal wire at a relatively high rate of production while using roller dies of relatively small diameter without any danger of breaking shafts, for example.

A further object of the present invention is to provide an apparatus according to which relatively small roller dies have applied thereto a pressure as great as required without requiring this pressure to be transmitted to the dies by shafts connected thereto.

Thus, the objects of the present invention include the provision of an apparatus which will transmit to the roller dies the required pressure without excessively stressing the roller dies themselves.

In accordance with the present invention each pair of successive roller dies has coacting therewith at least one pair of pressure rolls which respectively engage each pair of roller dies and which are of a diameter substantially larger than that of the roller dies, so that through these pressure rolls, which serve as the exclusive means for pressing the roller dies against each other, it is possible to apply large pressures to relatively small roller dies without requiring any shafts to be connected to the roller dies themselves. The successive sets of roller dies and pressure rolls coacting therewith are angularly displaced one with respect to the other about the drawing path by 90°, and each pair of roller dies except the final pair can provide the wire with an oval cross section whose minor diameter is approximately equal to the major diameter of the oval cross section provided for the wire by the next following pair of roller dies. The final pair of roller dies provides the wire with a circular cross section whose diameter is equal to the minor diameter of the oval cross section provided by the immediately preceding pair of roller dies. More than one pressure roll may coact with each roller die, and the shafts which are operatively connected to the pressure rolls to transmit the required forces thereto are themselves of relatively large diameters so that they are capable of withstanding the large forces which are transmitted.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is illustrated by way of example in the accompanying drawings which form part of this application and in which:

FIG. 1 is a schematic partly sectional longitudinal elevation of one possible wire drawing apparatus according to the invention;

FIG. 2 diagrammatically illustrates one method of wire drawing according to the invention;

FIG. 3 diagrammatically illustrates another method of wire drawing according to the invention;

FIG. 4 schematically represents in a fragmentary partly sectional side elevation cage means for preventing axial displacement of roller dies;

FIG. 5 is a fragmentary end elevation of the structure of FIG. 4 as seen from the right of FIG. 4;

FIG. 6 is a fragmentary front elevation of another means for preventing axial displacement of roller dies; and

FIG. 7 is a fragmentary side elevation of the structure of FIG. 6 as seen from the right of FIG. 6.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to FIG. 1, the first wire drawing stage is illustrated at the left of FIG. 1 where the cross section of the wire as initially fed to the wire drawing apparatus is indicated. At this first stage there are a pair of roller dies X which have grooved peripheries which abut against each other at the place where they are tangent to the drawing path which extends in a straight horizontal line, as viewed in FIG. 1. The grooved peripheries of the roller dies X define an aperture of oval cross section where they abut against each other, and the oval cross section A which is provided for the wire by the roller dies X is indicated in FIG. 1 schematically between the first and second stages. In accordance with the invention the roller dies X do not have any shaft connected thereto. They are engaged by a pair of pressure rolls X' whose diameters are substantially greater than those of the roller dies X, respectively, and these pressure rolls X' are operatively connected with shafts S of relatively large diameter, as indicated in FIG. 1. Any suitable rotary drive is connected to one or both of the shafts S for rotating the latter, and these shafts S are supported in suitable bearings which are urged toward each other with the force required to press the roller dies X against each other with the required pressure. For example, the bearings of the shafts can be situated in suitable casings which are connected with screw spindles which can be turned to press the rolls X' toward each other with the required force. While the roller dies X are supported exclusively by the pressure rolls X' and have the pressure force transmitted thereto exclusively by the pressure rolls X', these roller dies X can be guided for rotary movement by any suitable cage structure, for example, such as a pair of stationary plates formed with slots through which the roller dies X extend so as to be guided by such a cage structure for free rotary movement while being supported and pressed against each other exclusively by the pressure rolls X'. Thus, as may be seen from FIGS. 4 and 5 the stationary plates **10**, which are held stationary by suitable structure fixed to lateral extensions **12** thereof, are formed with the slots through which the roller dies X extend. Thus, the cage structure formed by the stationary plates **10** acts as a means coacting with the opposed side surfaces of the disc-shaped roller dies X to prevent axial movement thereof.

The second stage of the wire drawing apparatus shown in FIG. 1 includes a pair of roller dies Y and a pair of pressure rolls Y' operatively connected with relatively large shafts S. Except for its size, the components of this second stage may be the same as those of the first stage, and the abutting grooved peripheries of the roller dies Y provide the wire with the cross section B which is schematically indicated in FIG. 1, this cross section also having an oval configuration. While the size of the cross section provided for the wire by the roller dies Y is smaller than that provided by the roller dies X, it will be noted that in addition the roller dies Y and the pressure rolls Y' which have their axes parallel to those of the roller dies Y are angularly displaced by 90° about the drawing path with respect to the roller dies X and the pressure rolls X' and the shafts S operatively connected thereto.

At the final stage the wire is given the circular cross section C by the final pair of roller dies Z whose grooved peripheries abut against each other to provide the circular cross section C. It will be noted that these roller dies Z have their axes parallel to the roller dies X. At this final stage, however, it will be noted that a pair of pressure rolls Z' coact with each roller die Z, and each of the pressure rolls Z' has a shaft S of relatively large diameter operatively connected thereto. With an arrangement as shown at the final stage, it is unnecessary to provide any additional cage structure or the like for guiding the roller dies for rotary movement since they can be maintained in the position shown in FIG. 1 by the pressure rolls which, if desired, for this purpose may be provided at their peripheries with shallow grooves into which the outer peripheries of the roller dies extend so that axial movement of the roller dies with respect to the pressure rolls at the final stage will be avoided. Thus, referring to FIGS. 6 and 7, it will be seen that the upper right pressure roll Z' of FIG. 1 is fragmentarily shown formed at its outer periphery with a shallow groove **14** which receives the periphery of the upper roll C. In the same way the remaining pressure rolls C' are respectively formed with the grooves **14** which receive the peripheries of the roller dies Z. Thus, in this case it is the grooved peripheries of the pressure rolls which form the means coacting with the opposed side surfaces of the roller dies to prevent axial displacement thereof.

The particular number of pressure rolls which coact with each pair of roller dies is optional, and any desired arrangement may be provided. For example, at the first and second stages a pair of pressure rolls can coact with each roller die, as indicated at the third or final stage in FIG. 1, while at the final stage it is possible to provide only one pressure roll pressing against each roller die. In those cases where a particularly large pressure is required at the first stage, for example, where the first reduction in the cross section of the wire is effected, three more pressure rolls of large diameter can be placed

outwardly beyond two pressure rolls which engage each roller die and which need not be provided with shafts, so that in such a case there can be at this particular stage a total of ten pressure rolls acting on the pair of roller dies to press them toward each other.

The apertures provided by the coacting pairs of roller dies may all have an oval configuration except the aperture provided by the last or final pair of roller dies, and the major diameters of the oval cross sections have a predetermined proportion to the minor diameters thereof. Thus, the diameter of the circular cross section provided by the final pair of roller dies is substantially equal to the minor diameter of the oval cross section provided by the immediately preceding pair of roller dies, so that in the case of FIG. 1, for example, the diameter of the cross section C is substantially equal to the minor diameter of the oval cross section B. In the same way, the major diameter of the cross section B is substantially equal to the minor diameter of the cross section A, and the major diameter of the cross section A can be substantially equal to the initial diameter of the wire which is to be drawn. Thus, in no case is the wire widened at any stage of the apparatus and method of the invention. With the apparatus of the invention used to carry out a wire drawing method as shown schematically in FIG. 2 in accordance with the invention, the initial wire W will have the circular cross section indicated at the left of FIG. 2 and at the first stage it will be provided with the oval cross section A whose major diameter is substantially equal to the diameter of the initial wire W. At the next stage the cross section B has a major diameter equal to the minor diameter of the cross section A, while the final circular cross section C has a diameter equal to the minor diameter of the cross section B. If desired at the final drawing stage the diameter may be increased by 5–10%.

In the case of FIG. 3 where a relatively soft wire is drawn, the wire initially has the cross section W, and in a single pass it is reduced to the oval cross section A' having a major diameter substantially equal to the initial diameter of the wire while at the final pass the wire is again provided with a circular cross section C whose diameter is equal to the minor diameter of the oval cross section A'.

Thus, with the apparatus of the invention the roller dies themselves are not connected to any shafts and therefore they are capable of withstanding the tremendous forces which are applied thereto without any difficulty, enabling relatively hard wire to be drawn at a high rate of speed with substantially large rates of reduction of cross sectional area and without requiring excessive use of power or excessive consumption of lubricants. Thus, by applying a pressure on an adequate number of shafts of relatively large diameter operatively connected with a number of relatively large pressure rolls which act on the roller dies, a large pressure can be achieved while maintaining the diameters of the roller dies as small as possible, so that the drawing of hard metal wire can be achieved in a highly advantageous manner. For example, hard steel wires such as that used for pianos may be drawn with the apparatus and method of the invention in a comparatively easy manner, so that it becomes possible to supply such wire for industrial purposes at relatively low cost.

What is claimed is:

1. In a wire drawing apparatus, a plurality of pairs of roller dies arranged in succession along a predetermined drawing path for successively reducing the cross section of a wire which is advanced along said path, each pair of roller dies respectively having grooved peripheries which butt against each other to define between themselves the cross section to which the cross section of the wire is reduced upon passing through each pair of roller dies, at least one pair of pressure rolls respectively engaging the roller dies of each pair for pressing the latter toward each other with a pressure transmitted thereto exclusively through said pressure rolls, said pressure rolls respectively having diameters substantially larger than the diameters of the roller dies to which they transmit pressure to urge each pair of roller dies against each other with a pressure greater than that which could be applied directly to said roller dies, said roller dies each having substantially the configuration of a disc-shaped body having opposed side surfaces to which no shafts are connected and said roller dies being supported exclusively by said pressure rolls, and means coacting with said opposed side surfaces of said roller dies for restraining the latter against axial displacement.

2. The combination of claim **1** and wherein more than one pressure roll coacts with each roller die for transmitting pressure thereto.

3. The combination of claim **2** and wherein a shaft of relatively large diameter is operatively connected with at least one of the pressure rolls coacting with each roller die for transmitting pressure thereto.

4. The combination of claim **1** and wherein the roller dies of each pair and the pressure rolls coacting therewith all have parallel axes, respectively, while said axes of one pair of roller dies and the pressure rolls coacting therewith are angularly displaced by 90° about said drawing path with respect to the next following pair of roller dies and pressure rolls coacting therewith.

5. The combination of claim **1** and wherein the pair of roller dies which provide the wire with its final configuration define a circular cross section of given diameter at their grooved peripheries while the immediately preceding pair of roller dies define an oval cross section at their grooved peripheries, said oval cross section having a minor diameter approximately equal to the diameter of the circular cross section.

6. The combination of claim **5** and wherein said immediately preceding roller dies and the pressure rolls coacting therewith all respectively have parallel axes which are angularly displaced by 90° about said path with respect to the axes of the roller dies which provide the wire with its final circular cross section, the pressure rolls which coact with the latter roller dies respectively having axes parallel to the axes of said latter roller dies.

7. The combination of claim **6** and wherein said immediately preceding pair of roller dies are themselves immediately preceded by a third pair of roller dies respectively having grooved peripheries which provide the wire with an oval cross section the minor diameter of which is approximately equal to the major diameter of the oval cross section provided by said pair of roller dies which immediately precede the final pair of roller dies.

8. The combination of claim **7** and wherein said third pair of roller dies and the pressure rolls which coact therewith all have parallel axes, respectively, which are parallel to the axes of the final roller dies and the pressure rolls coacting therewith.

9. The combination of claim **1** and wherein said means which coacts with said opposed side surfaces of said roller dies is in the form of a slotted plate structure having a slot through which the roller dies extend and forming a cage for said roller dies.

10. The combination of claim **1** and wherein said means which coacts with said opposed side surfaces of said roller dies includes peripheral portions of said pressure rolls respectively formed with grooves which receive peripheral portions of said roller dies to prevent axial displacement of the latter.

11. A method of drawing wire in a plurality of stages from an initial circular cross section of a given diameter to a final circular cross section of a diameter smaller than said given diameter, comprising the step of reducing the cross section of the wire in at least one stage between said initial and final cross section thereof while providing the

wire at said one stage with an oval cross section whose minor diameter is approximately equal to the diameter of the final cross section of the wire.

12. The method of claim 11 and wherein the wire is reduced from its initial to its final cross section in a plurality of stages wherein each of said plurality of stages provides the wire with an oval cross section and the major diameters of the oval cross sections at the successive stages being respectively perpendicular with respect to each other while the minor diameter of the oval cross section of any one stage is approximately equal to the major diameter provided for the wire at the next-following stage.

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MILTON S. MEHR, Primary Examiner

U.S. Cl. X. R.

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