METHOD AND APPARATUS FOR PRODUCING TAPERED TUBE
6 Claims, 16 Drawing Figs.

ABSTRACT: A production method of tapered tube comprising the steps of passing a tube blank made of a metal over the surface of a tapered core; placing on the outer surface of said tube blank a die consisting of a material having a plasticity and elasticity, but the resistivity thereof against the plastic deformation being higher than that of said tube blank, and having an inner bore of substantially equal diameter to that of the narrower end of said tapered core; shifting said tapered core and said die against each other so that the die is conveyed from one end to the other end of the tapered core; and forming said tube blank into a tapered tube in accordance with the surface of said tapered core.
METHOD AND APPARATUS FOR PRODUCING TAPERED TUBE

This invention relates to a method and apparatus to be used in the production of tapered tubes, and more particularly to the type wherein seamless tube blank is placed over a tapered core of a desired shape, and both the blank and the tapered core are thereafter passed a die plastically deformable, whereby the tube blank is formed into a tapered tube having the same configuration as the tapered core.

Heretofore, methods as described hereinafter have been known for producing tapered tube from the seamless tube blank:

1. Swaging method; in which a metallic mold divided into upper and lower halves are prepared in a press machine, the tube blank is rotatingly inserted inside of the mold, and the pressing machine is operated so that the tube is formed into a desired configuration between the upper and lower mold halves.

2. Spinning method; in which the tube blank is attached on a lathe or the like machine through a core metal and then rotated, whereby the tube blank is drawn by means of one or more rollers.

3. Pressuring method; such as bulge forming by employing a liquid pressure, or as explosion forming utilizing high energy and high speed at the time of explosion.

Although each of the above-described conventional methods has its own merit, they have also drawbacks as follows:

1. Methods (1) and (2): With these methods, the thickness of the products tends to be thicker at the portion thereof having smaller diameter and thinner at the portions having larger diameter, and the methods also have difficulties in obtaining high precision products.

2. The surface of the products is apt to be rough, and the smoothing thereof requires a considerable amount of additional labor.

3. The carrying out of these methods requires high degree of skill.

4. The formation process in these methods needs considerable length of time period.

5. A significantly large installation is required.

6. The distribution of thickness in each of the products cannot be uniform.

7. In some cases where a certain kind of material is used, wasteful products will be obtained successively.

8. Dangerous operations are involved.

9. Roughening of the surfaces is easily accompanied.

Among all of the drawbacks, unequity of the thickness is the one which should be most obviated in the application for the wind musical instruments, because in the thin thickness tapered tube utilized in the musical instruments, the unequility causes not only the difference in the tone color and timbre but also in the tone pitch and the tone volume of the instrument.

The above described conventional production methods of the tapered tube, with their inherent difficulty in obtaining uniformity in the thickness, have been found to be utterly unprofitable when they are used in the production of such tubes.

Therefore, the primary object of the present invention is to provide a unique production method and the apparatus for carrying out such method, in which no complicated process is required and the tapered tube of uniform thickness is thereby produced with high precision without accompanying the difficulties encountered in the conventional methods.

Another object of the present invention is to provide a novel method, wherein the tapered tube having uniform thickness is easily obtained by one step or repetition of the similar steps with the use of a simple device.

Still another object of the present invention is to provide a novel production method of the tapered tube, which is not only applicable to a straight tapered tube having the diameter monotonously varies, but also to a mildly curved tube wherein the increasing rate of the diameter is always positive and the centerline thereof is in a plane, so that the product is easily taken out of the core member after the completion of the production process.

Further object of the present invention is to provide a novel production apparatus which comprises: a movable plate which is shiftable horizontally in unison with the driving shaft operable in one direction; a fixed plate provided in a position opposing to said movable plate and having a dieholder at the central portion thereof; a core member having a taper and connected with said movable plate so that the member is made movable through said dieholder supported by said fixed plate; and a die having a larger resistivity against the plastic deformation than that of the tube blank to be worked, and the inner diameter thereof is plastically deformed when the core member and the blank are moved through the die; and also to provide a device which automatically takes out the products drawn along the tapped core member by the action of a self-closing catching means at the time the core member retracts from its operating position.

According to the present invention, the above-described objects are accomplished by the provision of a core member of a desired shape having a tapered surface at a suitable angle and a die which is made of a material having plasticity and elasticity and the resistivity against the plastic deformation is larger than that of the tube blank. The tube blank to be worked by these members may consist of annealed metal and the end of the blank fitted with the narrower end of the core member should be folded back to inside so that the blank is firmly held by the core member placed therein.

Then, the blank firmly held at one end by said core member is forcibly passed through the die having an inner bore approximately equal to the diameter of the narrower end of the core member, starting at first from the narrower end, and the tube blank is drawn along the tapered surface of the core member by the compressive force exerted from the inner bore of the die while the blank and the die are relatively shifted in the horizontal direction one against the other.

The movable plate which is horizontally shifted together with the core member and the tube blank is driven by a driving shaft (hereinafter called threaded shaft) which is shifted without rotation by a driving member rotated by a chain around the threaded shaft, said chain being driven by a motor, whereby the movable plate is slidingly shifted on a pair of horizontally extended tiersods between said fixed plate and a pair of supporting plates which are also standing in parallel on the base plate. The movable plate is somewhat loosely coupled with the core member through a coupling means, and the core member is thereby pulled slowly through the die starting at first from the narrower end, so that the tube blank is drawn into a tapered tube between the die and the tapered core member. The die is made of a material having plasticity and elasticity such as soft iron, brass, aluminum, lead, and polyurethane, and the shape thereof may be selected suitably. However, in usual case, it is formed into a disc-like configuration having comparatively less thickness, the outside diameter of which is so determined that some remaining portion not received any plastic deformation is left after the completion of the drawing operation, and the inner diameter of the bore is determined at first approximately equal to the diameter of the narrower end, i.e. smaller diameter end of the core member.

Furthermore, the dieholder may be attached to the fixed plate either stationary or movably depending on the shape of the tapered tube to be produced. That is, the stationary dieholder is used for the production of the straight line tapered tube, and the movable dieholder is employed for the production of the curved tapered tube which has a curved center line.

Because the production method of the tapered tube according to the present invention utilizes a tapered core and a die having plasticity and elasticity for the drawing of the tube blank, the features as described hereinafter can be obtained:
1. The tapered tube thereby produced is not limited to those having circular cross sections, but also the tapered tube having polygonal or elliptical cross sections can be obtained by the use of similar and single process.

2. The tapered tube having the center line slightly curved also can be produced easily.

3. The distribution of the thickness of the tapered tube can be made into surprisingly uniform, and the precision of the products also can be remarkably enhanced because of its tight fitting nature on the surface of the core.

4. No flaw or wrinkles are created on the surfaces of the tapered tube, whereby the labor for finishing the surface can be eliminated.

5. The capability of the capability for drawing the tapered tube of not only the straight line configuration, but also of the curved configuration, when the increasing rate (drawing increment) of the diameter is never negative, the method can be applied in extremely wide range of the production.

6. Not requiring any complicated or high cost installation, and not requiring any high class technique and skill, the processing period also can be significantly economized.

7. In the case where the movable dieholder is used, the angle of the dieholder can be automatically regulated so that it is always maintained at right angle against the centerline of the core, whereby the curved tube can be automatically produced as in the case of the straight line tapered tube.

The method and apparatus for producing the tapered tube in accordance with the present invention will be made apparent from the following description with respect to the preferred embodiments thereof when read in conjunction with the accompanying drawing, in which:

FIG. 1 is a cross-sectional view of the principal part of the apparatus according to the present invention at the time of the tapered tube being produced.

Figs. 2A and 2B are perspective views of a die showing the conditions of before and after of its operation.

Figs. 3A, 3B and 3C are cross-sectional profile views of the principal part of the apparatus according to the present invention, each of the views showing the relative conditions of the blank, core, and the die before the initiation of the drawing operation in each step when the production of the tapered tube is performed in three steps.

FIG. 4 is a cross-sectional profile view of the tapered tube, along its longitudinal axis, which is produced through the steps as shown in Figs. 3A, 3B, 3C.

FIG. 5 is a plan view of the whole apparatus according to the present invention.

FIG. 6 is a profile view of the same apparatus shown in FIG. 5.

FIG. 7 is a similar cross-sectional view of the principal part of the apparatus for drawing a curved tapered tube, which constitutes another embodiment of the present invention.

FIG. 8 is a perspective view showing the coupling relation between the core and the movable plate.

FIG. 9 is a longitudinal cross-sectional view of the core and the movable plate in their coupled condition.

FIG. 10 is a perspective view of the dieholder which is utilized in producing the curved tapered tube according to another embodiment of the present invention.

FIG. 11 is a longitudinal cross-sectional profile view of the apparatus, showing the principal part only, at the time the tapered tube is drawn.

FIG. 12 is a longitudinal cross-sectional profile view of the apparatus, showing the principal part only, at the time of thus produced tapered tube is removed from the apparatus, and

FIG. 13 is a front view of a releasing device of the product out of the core member.

Referring to FIG. 1, there is indicated a tapered core 1 made of a metal such as SK having high rigidity with its surface treated by heat, and on one of the narrower end 2 (of smaller diameter) thereof a threaded hole 3 is provided. For the purpose of coupling the tapered core 1 to a movable plate 6, there are provided an intermediate rod 4 and a coupling jaw 7 fitted on the movable plate 6. On one end of the intermediate rod 4, a threaded projecting portion 3a is provided and this engages with the threaded hole 3 of the tapered core. The other end of the intermediate rod 4 is enlarged into a coupling flange 5 which engages with the coupling jaw 7 fitted on the movable plate 1 driven by a driving mechanism.

A die 8 is made of a material such as soft iron, brass, aluminum, lead, polyurethane, or the like having a plasticity and elasticity, and although the die 8 is shown as a comparatively thin disc, it may be of any desired shape adapted to its own material and the drawing condition of the tube blank. The material of the die 8 should have a stronger resistivity against the plastic deformation than that of the metal forming of the tube blank and preferably made of a different material than the latter, because when the same kind of metals are used for the die 8 and the blank, there is a frequent occurrence of seizure between the two members. The size of the die 8 should be determined in such a manner that the inner diameter of heat thereof is approximately equal to that of the narrower end of the tapered core 1, and the outside diameter of the die 8 is much larger than the wider end of the tapered core 1 so that some portion of the die 8 is left without subjected to the plastic deformation even at the last stage of the drawing operation.

The peripheral area of the inner bore 9 of the die 8 is slightly chamfered or contracted. However, if the die 8 is of a planar configuration, the inner bore may be punched out and the deformation thereby caused around the punched bore may be utilized in the drawing step following thereafter. The die 8 at the initial condition is shown in FIG. 2a and the same at the completion of the drawing step is shown in FIG. 2b.

Numerals 10 designates a dieholder having an inside bore 11 of enough large diameter, and the die 8 is supported inside of a stepped portion 12 of the dieholder 10, which is in turn supported stationary on a fixed plate 13.

A tube blank 14 is made of a metal tube having an inside diameter which is approximately equal to the maximum inside diameter of the desired tube, and one end of the tube blank 14 is folded back inwardly so that this portion of the blank can be seized on the narrower end 2 of the tapered core 1.

Furthermore, according to the method of the present invention, the tube blank 14 is slipped over the tapered core 1 having been prepared beforehand, as shown in FIG. 1, so that the one end of the tube blank 14 is held against the narrower end 2 of the tapered core 1, and at the same time seized between the end face of the intermediate rod 4 which couples the tapered core 1 to the movable plate 6 and the narrower end 2 of the core 1.

When the movable plate 6 is driven, for instance, by a manipulation of a switch, to the direction tensioning the tapered core 1 to the left, the die 8 stationary supported by the dieholder 10 acts on the tube blank 14 as if the die 8 moves over the outside of the tube blank 14. Since in this case, the inside diameter of the bore 9 of the die 8 is so determined as it is less than the outside diameter of the tube blank 14, the tube blank 14 is subjected to a strong plastic deformation, resistance force of the die 8 and collapsed to be brought to contact with the tapered core 1. However, the compressive force of the die 8 cannot overcome the strong rigidity of the core 1 and the inner bore 9 of the die 8 is also deformed to be enlarged. When the tapered core 1 is further driven to the left, the portion of the tube blank 14 coming under the die 8 is successively collapsed and brought to contact with the tapered core 1, and at the same time, the inner bore 9 of the die 8 is subsequently enlarged its diameter, whereby the desired tapered tube is ultimately obtained.

In the course of the above-described operation, if the material and the thickness of the die 8 are suitably selected against the material and thickness of the core, the tube blank 14 can be plastically compressed and deformed with thus compressed material being forcibly elongated in the longitudinal direction only, so that the partial increase or decrease of the thickness is almost nullified throughout the
length of the tube blank 14. It should also be noticed that, because of the champered or compressed peripheral surface of the inner bore 9 of the die 8, there is no chance of damaging the blank tube during the time the die 8 is shifted relative to the tube blank 14, whereby a smooth and shining surface of the product tube can be obtained.

The above described procedure is for the case wherein the tapered tube is produced through only one step of the drawing, such procedure can be divided into two or more steps if the taper of the tube is too steep and it is not practicable to finish it in one step, and by so doing, the tapered tube of steep nature can be obtained with the same advantageous quality as defined above.

Such a procedure is illustrated in FIGS. 3A, 3B, 3C wherein each of the steps indicated by A, B, C, is provided for obtaining a steep tapered tube indicated in FIG. 4. The tapered cores 1, 1a, 1b utilized in these steps have their tapers different between each other by a definite ratio, and the diameters of the inner bores 9, 9a, 9b of the dies 8, 8a, 8b are also different between each other corresponding to the dimensions of the tapered cores 1, 1a, 1b. In the last step in which the difference between the diameters at the narrower end and the wider end of the inner bore 9 of the die 8 is difficult to be expanded and tends to be broken, it is also possible to employ another die 8c having a suitable diameter starting from the middle of the third step, whereby the drawing operation can be continued without rendering any step-wise difference at the portion of the product tube.

By this way, it is apparent that even a steeply tapered tube can be produced by the utilization of different cores and dies having different inner bores in thus separated steps.

The course of the above described drawing operation, an ordinary lubricating agent is provided in the drawing procedure of higher viscosity should be employed to prevent a seizure caused by the fusion of the contacting materials.

Furthermore, the die 8 used in each of the steps is deformed and expanded during its utilization during its drawing procedure, and for this reason, the die 8 will not damage the product tube even when the core 1 and the product tube are shifted to rightward for delivering after the completion of the tube. The die 8 may be discarded after each drawing operation. However, some of the men made of polyurethane and utilizing only its elasticity may be used repeatedly.

Figs. 5 and 6 illustrate an apparatus embodied to the extent adaptable to the practical use. In the drawing, there are provided a fixed plate 13 and parallel extending supporting plates 17 on both ends of a apparatus frame 16. On both of the lateral sides of the described plates 13, 17, a pair of tiers 18 are extended horizontally. Numerals 6 designates a movable plate supported between these tiers 18 so that is is freely slidable in the longitudinal direction of the apparatus. On the surface of the movable plate 6 facing to the fixed plate 13, there is fitted in one of a coupling jaw 7, and on the other side of the movable plate 6, a threaded shaft 19 penetrating the through bores of the supporting plates 17 is fixed not rotatably. This threaded shaft 19 has a driving member 20 mounted thereon freely rotatably and supported between the above described a support of supporting plates 17. On and around of the driving member 20, there is fixedly mounted a sprocket wheel which is rotated by a string of chain 23 spun between the sprocket wheel and another sprocket wheel mounted on a motor shaft 21. By the aid of these two sprocket wheels, the driving member 20 is rotated around the threaded shaft 19, and due to the thread cut inside of the driving member 20 and engaging with the threaded shaft 19, the driving member can shift the movable plate 6 together with the threaded shaft 19 and forth along the tiered 18.

Moreover, in the embodiment shown in the drawing, an intermediate rod 4 provided at the narrow end of the tapered core 1 is attached to the coupling jaw 7 through a pin 23, whereby the tapered core 1 is shifted along the longitudinal direction of the apparatus together with the movable plate 6.

On the other hand, on the dieholder 10 provided on the central portion of the fixed plate 13, a die 8 plastically deformable is attached, and through the inside bore of the die 8, the tube blank 14 and the tapered core 1 are passed.

The above described attachment of the die 8 and dieholder 10 is different by the cases wherein the tapered tube to be produced is of rectilinear or curved configuration. When a curved tapered tube is desired, the dieholder 10 is movably attached on the fixed plate 6 as indicated in FIGS. 7 and 10. In the example shown in FIG. 7, there is provided a inner ring 26 having a convexed outer surface 25 which is concentric with the inner surface 24 of the fixed plate 13, and a dieholder 10 attached with a die 8 is mounted inside of the inner ring 26.

Between the inner surface 24 and the outer surface of the ring 26, there is provided balls or rollers 27 inscribed between retainer rings so that the inner ring 26 is freely rotatable within the inner surface 24 of the fixed plate 13, and the die 8 is always maintained rectangular to the part of the curved center line X—X of the core 1 located at the center of the fixed plate 13.

In the other example shown in FIG. 10, so-called universal joint is used wherein a ring 29 is supported between the inner edges of the fixed plate 13 through the central portion 11 of the dieholder 10. The inner portion of a rod 28 so that the ring 29 is freely rotatably around the vertical axis, and another ring 31 likewise supported by a pair of horizontally extending shafts 30 so that it is freely rotatably around the shafts 30. The die 8 is fixed on the second ring 31 and functions in the similar manner as described above.

The coupling between the coupling jaw 7 and the intermediate rod 4 may be otherwise obtained than with the pin 23, but through a construction of these coupling members in which the coupling jaw 7 is provided with a projected receiving plate 33 having a recessed portion 32, and on the other hand, a neck portion 34, is provided on one end of the intermediate rod 4, whereby the neck portion is inserted into the recessed portion 32, as shown in FIGS. 8 and 9. The neck portion 34 may be so arranged that it engages with a similarly recessed portion 35 of a coupling plate 36 inserted in the receiving plate 33 in such a manner that the coupling plate 36 is somewhat movable in the vertical direction. By this way, the intermediate rod 4 can be coupled with the movable plate 6 with an allowance somewhat movable in the vertical direction.

The above-described apparatus for producing tapered tubes operates as follows:

At first the tube blank 14 one end of which has been bent back inwardly is slipped over the tapered core 1, and the intermediate rod 4 is attached on the narrower end of the tapered core 1. Thus combined tube blank and the tapered core 1 are inserted through the inner bore 9 of a die 8 and the intermediate rod 4 is coupled with the coupling jaw 7 on the movable plate 6. When the motor is started, the driving member 20 is rotated through the chain 22 and the sprocket wheels and the threaded shaft 19 is shifted outwardly (leftwardly in FIGS. 5 and 6) from the supporting plates 17.

When the threaded shaft 19 moves outwardly, the movable plate 6 coupled with the tapered core 1 and the tube blank 14 is shifted together with the threaded shaft 19 along the tierods 18 and pulls the tapered core 1 and the tube blank 14 thereon through the die 8. The die attached to the dieholder 10 acts on the tube blank 14 while these two members are moved each other, and the tube blank 14 is thereby subjected to a strong compressive force from the periphery of the inner bore 9 of the die 8 which is smaller than the outside diameter of the tube blank 14. The tube blank is thus plastically deformed and brought to contact with the surface of the tapered core 1, whereby the desired tapered tube is produced.

FIGS. 11 and 12 illustrate another embodiment of the apparatus according to the present invention in which only the principal parts thereof are shown and automatic products releasing device is provided. In FIG. 11 showing the embodiment at the time the tube blank is being drawn, it is seen that the larger end of the tapered core 1, instead of the narrower
end thereof, is this time coupled to the movable plate 6 (not shown) through the coupling member 7 and the intermediate rod 4 (these are also not shown) so that the larger end 2a of the tapered core 1 is placed inward of the fixed plate 13. The narrower end 2 of the tapered core is now extended through a working portion 27 provided at the center of the fixed plate 13.

The above described working portion 37 is constituted from a die 8 attached on a dieholder 10 and a product removing device 38 self-closing and provided at the outward side (right-hand side in FIG. 11 and 12) of the dieholder 10. The removing device 38 is in itself a removing element, as shown in FIG. 13, which consists of, for instance, a pair of sectors 39 and a pair of coiled springs 40 extended across the sectors 39 so that the sectors may be extended outwardly but close inwardly when released. Such sectors 39 can be obtained by dividing a disc having an inner bore 42 insertable around the peripheral surface of the tapered core 1, and by disposing thus obtained sectors opposing along the divided edges. The pair of sectors 39 are further connected together by means of a pin 41 located at one side of the inner bore 42 and extended in axial direction from the dieholder 10, so that the pair of sectors 39 may be swung open around the pin 41 against the contracting force of the coiled springs 40 by means of an expanded force exerted from the peripheral surface of the tapered core 1 which is inserted inside of the inner bore 42 of the pair of the sectors.

With these constructions, when a tapered tube product 15 which is drawn along the tapered surface of the tapered core 1 is pushed out through the die 8 into the inner bore 42 of the pair of sectors 39, and if the larger end 2a of the tapered core approaches the pair of sectors 39, the sectors 39 are swung open, and at a position where the larger end of the product 15 just passes the inner bore 42, the pair of sectors 39 are pulled back together by the amount corresponding to the thickness of the product 15 through the contracting force of the coiled springs 40 until the sectors contact directly with the tapered core 1.

In this condition, if the tapered core 1 is pulled back to its initial position together with the movable plate 6, the product 15 is prevented from its leftward progress by means of the pair of sectors 39, and when the tapered core 1 returns to its initial position, the product 15 is completely removed from the tapered core 1 and falls down. It should be noticed that, owing to the above described construction of the product removing device 38, the removing force is applied uniformly around the end portion of the product 15, and the removal can be carried out without inflicting any damage on the thin product 15. Furthermore, since the device makes it possible to carry out alternately the drawing operation and the removal of the product by the reciprocating movement of the tapered core, the provision of such device is extremely profitable when the apparatus is employed for the mass production of the tapered tubes.

**PRACTICAL EXAMPLES**

Examples are the examples wherein the production method according to the present invention is carried out in practice.

<table>
<thead>
<tr>
<th>Example 1</th>
<th>Example 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material of the tube blank</td>
<td>0.8</td>
</tr>
<tr>
<td>Thickness of the tube blank</td>
<td>34/35</td>
</tr>
<tr>
<td>Length of tapered portion</td>
<td>500</td>
</tr>
<tr>
<td>Diameter of the tapered core</td>
<td>At the narrower end, m.m. 26</td>
</tr>
<tr>
<td>At the larger end, m.m. 34</td>
<td>26</td>
</tr>
<tr>
<td>Material of die (soft iron)</td>
<td>SPCT</td>
</tr>
<tr>
<td>Thickness of the die, m.m. 15</td>
<td>19</td>
</tr>
<tr>
<td>Inner diameter of the die, m.m. 25</td>
<td>19</td>
</tr>
<tr>
<td>Outer diameter of the die, m.m. 25</td>
<td>19</td>
</tr>
</tbody>
</table>

1 Commercial bronze tube (Cu 99%, Zn 1%).
2 Silver tube.

As described above, since the production method according to the present invention makes it possible to acquire the tapered tube precisely formed in accordance with the outer surface of the tapered core, the method can be profitably utilized in the formation of the tapered tube of minor thickness, or more particularly of the type applicable to a tapered tube: and it is anticipated that this invention will be a great help in the formation of instruments, wherein an extremely uniform distribution of the thickness and smooth surfaces thereof are required. Furthermore, with the simple processes and with the high precision workability of this method, the production cost of the tapered tube is remarkably reduced, and the mass production thereof of uniform quality can be obtained.

What is claimed is:

1. A method of producing a tapered tube comprising the steps of positioning a tapered core within a metal tube blank and relatively advancing along and in engagement with the outer face of said core engaging tube from the tapered toward the opposite end of said core, a die of substantially uniform thickness and having substantially parallel front and rear faces facing respectively the direction of advance of said die and the opposite direction of the tapered core, a central aperture of approximately the diameter of the tapered end portion of said core and formed of an elastic plastic material having a plastic deformation resistivity higher than that of said tube blank to axially inwardly rearwardly flare the section of said die bordering said aperture with the advance of said die and effect the bearing of the front face of said die flared portion on said tube blank whereby said tube blank is formed by said advancing die to a shape corresponding to the outer surface of said core.

2. A method as defined in claim 8, wherein a tube blank, having a constant diameter approximately equal to the maximum inside diameter of the desired tapered tube, is repeatedly drawn in several steps from its least tapered state to the maximum tapered state, employing tapered cores having different taper angles, varied by a predetermined ratio, and a plurality of dies having different inside bores corresponding each of the above mentioned tapered cores, and also having a plasticity and elasticity, but the resistivity thereof against the plastic deformation being higher than that of said tube blank.

3. A method as defined in claim 8, wherein the die is made of soft iron, brass, aluminum, amonium alloy, lead, polyethylene, or the like.

4. An apparatus for producing tapered tubes comprising a movable plate horizontally shiftable under the action of a driving shaft; a fixed plate located oppositely to said movable plate and including a dieholder at the central portion thereof; a tapered core coupled with said movable plate and shifted through said dieholder supported by said fixed plate; and a centrally apertured disc shaped die having substantially parallel, substantially coex tentive front and rear faces extending between the inner and outer peripheries of said die and formed of a material having plasticity and elasticity, but the resistivity thereof against the plastic deformation being higher than that of said tube blank, and having an inner bore plastically deformable according to the taper of the tapered core.

5. An apparatus for producing curved tapered tubes comprising a movable plate horizontally shiftable under the action of a driving shaft; a fixed plate located oppositely to said movable plate and having, at the central portion thereof, a dieholder fitted with die being attached so that the dieholder can be freely rotatably, said die having an inner bore border plastically axially deformable according to the taper of a core and forming thereby a tube blank into the tapered tube; and a tapered core having a curved centerline and coupled to said movable plate through an intermediate rod freely movably, so that the tapered core is shiftable through said die attached on the fixed plate; whereby said curved tapered tube is automatically formed under the existence of said die, the angle of which is gradually changeable in accordance with the shift of said tapered core.
6. An apparatus as defined in claim 4, wherein a tube removing device consisting of a pair of sectors which can be swung around a shaft against the tension of coiled springs spun across the pair of said sectors is provided at an outward position from the die fitted on the dieholder provided on the central portion of the fixed plate, whereby said pair of sectors are swung open along the tapered surface of the tapered core.