(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
31 March 2016 (31.03.2016)

WIPO | PCT

(10) International Publication Number
WO 2016/046844 A2

(51) International Patent Classification:
C22C 21/04 (2006.01)

(21) International Application Number:
PCT/IN2015/050113

(22) International Filing Date:
17 September 2015 (17.09.2015)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
3077/MUM/2014 25 September 2014 (25.09.2014) IN

(71) Applicant: **SIDDHI ENGINEERS** [IN/IN]; "Siddhi House", 6, Virkunj Society, Near Vidyanagar School, Usmanpura, Ahmedabad, Gujarat 380 014 (IN).

(72) Inventors: **PATEL, Bhagwat Ramanbhai**; 2, Sampann Bungalows I, Behind Jalsa Party Plot, S.G.Road, Thaltej, Ahmedabad, Gujarat 380 059 (IN). **GANDHI, Prashant Ramniklal**; 9 B, Indraprasth Bunglows, Opp. Management Enclave, Vastrapur, Ahmedabad, Gujarat 380 015 (IN).

(74) Agents: **ACHARYA, Rajeshkumar H.** et al.; H K Acharya & Company, HK Avenue, 19, Swastik Society, Navrangpura, Ahmedabad, Gujarat 380009 (IN).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to the identity of the inventor (Rule 4.17(i))*

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *of inventorship (Rule 4.17(iv))*

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

(54) Title: PROCESS FOR MANUFACTURING OF ALUMINIUM ALLOY CHEESE TUBE, CHEESE PIPE OR BOBBIN FOR WOVEN SACK

(57) Abstract: The present invention relates to a process for manufacturing of aluminium alloy cheese tube/ cheese pipe or bobbin for woven sack. The present invention provides light weight, strong and accurate product made from specific aluminum alloys (i.e. 6082 or 6061) duly cold drawn and heat treated to achieve very high strength to weight ratio. The primary billets of aluminum alloys are subjected to a porthole extrusion process sequentially it is subjected to cold drawn for reducing the cross sectional area of the tube. After cold drawn, tubes are further solution treated by special quenching of fog or water. Solution treated porthole extruded aluminum alloy tube can also be used as feed stock. After successive cold drawing, the tubes are straightened on the straightening machine to relieve stress and subsequently the age hardening is carried out to achieve desired tensile strength and percentage elongation in the product.

WO 2016/046844 A2

PROCESS FOR MANUFACTURING OF ALUMINIUM ALLOY CHEESE TUBE, CHEESE PIPE OR BOBBIN FOR WOVEN SACK

Field of the invention

The present invention relates to a process for manufacturing of aluminium alloy cheese tube or bobbin more particularly it relates to manufacturing of aluminium alloy cheese tube, Cheese Pipe or bobbin for woven sack application.

Back ground and prior art of the invention

HDPE (High Density Poly Ethylene) or PP (polypropylene) oriented strips are becoming increasingly popular and have caught the eye of many end users for their requirement of packing materials. They have become popular on account of their inertness towards chemical, moisture and excellent resistance towards rotting and fungus attack. They are non toxic, lighter in weight and have more advantages than conventional bags. These sacks are much clear and resist towards fungal attack. Jute prices are very unstable in the market since Jute is an agriculture product. These sacks have many advantages over other conventional sacks materials and are quite competitive in price.

For manufacturing HDPE/PP woven sacks an extrusion plant is used which produces flat yarn from the P.P. (polypropylene) and HDPE (High Density Poly Ethylene). The flat yarn which is also known as flat tape yarn is continuously wound on tube/bobbins called Cheese tube/ Cheese pipe or Jumbo tubes/ Jumbo pipe. Large numbers of tubes (i.e. more than 300) are used simultaneously for the purpose of winding. Such flat tape yarn which is wound on the cheese tube/ cheese pipe or jumbo tube/ jumbo pipe is then taken to circular winding machine from which the woven sacks product comes out for further sewing, lamination etc.

The cheese winding process which involves winding of more than 300 tubes at a time with same number of electric motors makes the process very high energy consuming. If the tube does not have accurate dimension then fitment of the tube on spindle is not accurate which lead to poor winding and vibration to the cheese tube/ cheese pipe. If the tube does not have enough strength then the same will bulge leading to loss of yarn and also blocking of such spindles leading to productivity issues.

The pressure of the P.P and HDPE flat yarn is much higher which lead to tendency of cheese tube/ cheese pipe or bobbins to bulge from the centre resulting into stoppage of the whole winding panel. It is also important to have excellent dimension control for exact fitment on the cheese spindle.

Steel tubes as well as aluminium tubes have been traditionally used for manufacturing cheese tubes/ cheese pipe or jumbo tubes/ jumbo pipe. Aluminium is most advantageous suitable and advisable metal because of its high electric conductivity, non magnetic, high heat conduction, light weight, excellent ductility, malleability and easy continuous extrusion. Moreover, the aluminium is strongest metal compared to other metals considering weight to strength ratio. Furthermore, a considerably maximum tensile stress can be expected for aluminium, though not as high as that of iron and it is possible to obtain a tube that can withstand a considerably high pressure. Although aluminium has excellent properties, pure aluminium doesn’t have a high tensile strength. However, the addition of alloying elements can increase the strength properties of aluminium and produce an alloy with properties tailored to particular applications. Hence, aluminium alloys have been widely used particularly for application where strength requirement are fairly high and weight of the aluminium tube is to be fairly low to meet the field application needs.

Conventionally, various methods for manufacturing of cold drawn aluminium products are available. For example, in US 5342459, a method for producing cold worked aluminium products from aluminium alloy is disclosed. In this process, extruded aluminium products such as wire, rod and bar are cold drawn for reduction in size of the aluminium products and then aluminium products are subjected to artificial age hardening to strengthen it. But the resultant aluminium products obtained by this process haven’t sufficient tensile strength and better dimension control suitable for manufacturing of woven sack application. Further indirect extrusion is employed in this process. In indirect extrusion, also known as backwards extrusion, the billets and container move together while the die is stationary. The die is held in place by a "stem" which has to be longer than the container length. The maximum length of the extrusion is ultimately dictated by the column strength of the stem. Because the billets move with the container the frictional forces are eliminated. This lead to 25 to 30% reduction of friction, which allows for extruding larger billets, increasing speed, and an increased ability to extrude smaller cross section. Although above described method has an advantageous feature, still it leaves the scope for solving various problems. During indirect extrusion, impurities and defects on the surface of the billets affect the surface of the extrusion. These defects may ruin the resultant products. Hence, in order to get around this, the billets may be wire brushed, machined or chemically cleaned before being used. This process isn't as versatile as direct extrusions because the cross-sectional area is limited by the maximum size of the stem.

Hence, to overcome above mentioned problems (i.e. bulging of the tube, non accurate fitting of the tube, very high electricity consumption and very high maintenance), it is desperately needed to invent a method of manufacturing aluminium alloy cheese tube/ cheese pipe or bobbin for woven sack industry which is not subjected to aforesaid problems so that the finally obtained aluminium bobbin has desired mechanical properties, lower maintenance and high level tolerance that is suitable for using in woven sack industry.

Object of the invention

The main object of present invention is to provide a method of manufacturing bobbin or cheese tube/ cheese pipe made up of aluminium alloy suitable for woven sack.

Another object of present invention is to provide a method of an aluminium alloy having excellent ductility, suitable tensile strength and proof stress for manufacturing aluminium tubes for woven sack.

Another object of the present invention is to provide a method of manufacturing bobbin or cheese tube/ cheese pipe made up of aluminium alloy with a low maintenance, lesser electricity consumption and precise fitting for end products.

Yet another object of the present invention is to provide a light weight aluminium bobbin or cheese tube/ cheese pipe with high tensile strength.

Further object of present invention is to provide a method of manufacturing cheese tube/ cheese pipe or cheese tube/ cheese pipe made up of different aluminium alloys (i.e. 6082 and 6061).

Summary of the Invention

The present invention relates to a process for manufacturing of aluminium alloy cheese tube/ cheese pipe or bobbin for woven sack**.** The present invention provides light weight, strong and accurate product made from specific aluminium alloys (i.e. 6082 or 6061) duly cold drawn and heat treated to achieve very high strength to weight ratio. The primary billets of aluminium alloys are subjected to a porthole extrusion process sequentially it is subjected to cold drawn for reducing the cross sectional area of the tube. After cold drawn, tubes are further solution treated by special quenching of fog or water. Solution treated porthole extruded aluminium alloy tube can also be used as feed stock. After successive cold drawing, the tubes are straightened on the straightening machine to relieve stress and subsequently the age hardening is carried out to achieve desired tensile strength and percentage elongation in the product.

Brief description of drawing

Fig. 1 describes perspective view of essential steps of the present invention.

Detail description of the Invention

Before explaining the present invention in detail, it is to be understood that the invention is not limited in its application to the details of the construction and arrangement of parts illustrated in the accompany drawings. The invention is capable of other embodiments, as depicted in figure as described above and of being practiced or carried out in a variety of ways. It is to be understood that the phraseology and terminology employed herein is for the purpose of description and not of limitation.

Dimension and weight of cheese tube/ cheese pipe used conventionally are 40mm OD × 35 mm × 218 mm and 165 gm respectively wherein product manufactured by this process provides 38 mm OD × 35 mm × 218 mm and 100 gm. Dimension and weight of cheese tube/ cheese pipe for jumbo bags used conventionally are 98 mm OD × 90 mm × 270 mm and 800 gm respectively wherein product manufactured by this process provides 95 mm OD × 90 mm × 270 mm and 500 gm.

The method for manufacturing aluminium tubes for woven sack industry, primarily porthole extruded aluminium tubes are manufactured from billets formed from aluminium alloy. The aluminium alloy 6061 contains magnesium 0.8 to 1.2, manganese 0.15, iron 0.7, copper 0.15 to 0.40, silicon 0.4-0.8, zinc 0.25%, titanium 0.15% and chromium 0.04-0.35%, the balance substantially aluminium and incidental elements and impurities. The aluminium alloy 6082 contains magnesium 0.7 to 1.2, manganese 0.2-0.8, iron 0.6, copper 0.15 to 0.40, silicon 0.4-0.8, zinc 0.2%, titanium 0.2% and chromium 0.2%. These alloys also have better drawn ability while combining high mechanical strength so that a very close dimension tolerance can be achieved at internal diameter as well as thickness. Extruded porthole aluminium tubes can be used as raw material (i.e. feed stock) in this process. Extruded porthole aluminium tubes can be used as feed stock in two conditions (i.e. T4 and M) for both aluminium alloy (i.e. 6061 and 6082). “T4” condition means solution treated porthole extruded tubes which doesn’t requires solution treatment in later stage while condition “M” means porthole extrusion of alloy without solution treatment. To make shape of material suitable for further proceeding, the alloy is solidified into working stock by continuous casting or semi continuous casting into shape suitable for extrusion. It’s always difficult to achieve uniform thickness in cheese tube with all conventional methods.

After said extrusion, tensile strength of the aluminium tubes is achieved on particular level from 140 to 235 MPa and percentage elongation is achieved in range of 16 – 21%. However, these mechanical properties are not sufficient for making aluminium tubes deserve to achieve desired eventual product (cheese tube). Further, during extrusion, the level of dimensional tolerance achieved is also fairly wider. Hence to counter these issues, the extruded aluminium tubes are subsequently cold drawn at room temperature. This cold drawing process serves to reduce cross section area of the aluminium tubes without damage to the surface finish and also to achieve close dimensional tolerance on internal diameter. In drawing process tensile strength of the aluminium tubes can be elevated to a level of 185 – 283 MPa while percentage elongation is increased to about 7.2 to 10 % with reference to extruded aluminium tubes.

During the cold drawn step, an undesirable stress is developed in the aluminium tubes. Hence, to relieve supposed stress, the cold drawn aluminium tubes are then straightened on hyperbolic 6 rolls machine. This process is done with tubes inputs from one end and if required the tubes direction is reversed to again pass through the straightening machine with a view to make sure that straightness achieved is exceptionally good to extent of about 1/1500.

Then after, to move towards for achieving desirable mechanical properties in resultant aluminium tubes, final heat treatment step is carried out by artificial age hardening process to generate fine grains in the recrystallization thereby enduring strength of aluminium tubes can be effectively recovered. In artificial age hardening process, the aluminium tubes are heated at about 165 °C for soaking time of about 6 to 18 hours, the time generally depends upon the dimension and thickness of the tubes, after which tensile strength shall go beyond 320 MPa and percentage elongation is elevated to a level of 11.2 to 12.31 % with reference to cold drawn aluminium tubes. The resultant aluminium tubes obtained by the foregoing method of the invention from aluminium base alloys having higher ductility and less breakable than conventional aluminium tubes are substantially suitable for woven sack.

The invention is illustrated more in details in the following example. The example describes and demonstrates embodiments within the scope of the present invention. This example is given solely for the purpose of illustration and is not to be construed as limitations of the present invention, as many variations thereof are possible without departing from spirit and scope.

Example 1

a) The porthole extruded tubes of aluminium alloy 6082 having T4 condition are taken as feed stock.

b) The porthole extruded aluminium tubes were sequentially cold drawn.

c) The cold drawn aluminium tubes were straightened on hyperbolic straightening machine to provide desired straightness.

d) The straightened aluminium tubes were sequentially subjected to artificial age hardening process at 165 °C for about 6 hours.

Table – I

Sequence of Process	Tensile strength (MPa)	% Elongation	Internal diameter tolerance
After Extrusion T4	235	16.3	±0.3 mm
After Cold Drawing	273	7.3	±0.1 mm
After Age hardening	335	12.31	±0.1 mm

Table – II

Type of Cheese Tube/ Cheese Pipe	Extruded Tube weight in gms	Drawn tube weight in gms	Effective weight reduction in gms
Cheese Tube/ Cheese Pipe	165	100	65
Cheese tube/ Cheese pipe for Jumbo bags	800	500	300

Example 2:

a) The porthole extruded tubes of aluminium alloy 6082 having M condition are taken as feed stock (manufactured without any solution treatment).

b) The extruded aluminium tubes were sequentially cold drawn.

c) The cold drawn aluminium tubes were subjected to solution treatment in a furnace for about 60 minutes at temperature 515 °C followed by efficient water quenching straightened on hyperbolic straightening machine to provide desired straightness.

d) The straightened aluminium tubes were than subjected to artificial age hardening process at 165 °C for about 6 hours.

Table – III

Sequence of Process	Tensile strength (MPa)	% Elongation	Internal diameter tolerance
After Extrusion "M" as of manufactured	140	21	±0.3 mm
After Cold Drawing	185	10	±0.1 mm
After solution treatment	280	9	±0.1 mm
After Age hardening	335	12.31	±0.1 mm

Table – IV

Type of Cheese Tube/ Cheese Pipe	Extruded Tube weight in gms	Drawn tube weight in gms	Effective weight reduction in gms
Cheese Tube/ Cheese Pipe	165	100	65
Cheese tube/ Cheese pipe for Jumbo bags	800	500	300

Example 3

a) The porthole extruded tubes of aluminium alloy 6061 having T4 condition are taken as feed stock.
b) The extruded aluminium tubes were sequentially cold drawn.
c) The cold drawn aluminium tubes were straightened on hyperbolic straightening machine to provide desired straightness.
d) The straightened aluminium tubes were than subjected to artificial age hardening process in electrically heated furnace at 160 °C for about 18 hours.

Table – V

Sequence Of Process	Tensile strength (MPa)	% Elongation	Internal diameter tolerance
After Extrusion T4	242	17.3	±0.3 mm
After Cold Drawing	283	7.2	±0.1 mm
After Age hardening	330	11.2	±0.1 mm

Table – VI

Type of Cheese Tube/ Cheese Pipe	Extruded Tube weight in gms	Drawn tube weight in gms	Effective weight reduction in gms
Cheese Tube/ Cheese Pipe	165	100	65
Cheese tube/ Cheese pipe for Jumbo bags	800	500	300

Example 4

a) The porthole extruded tubes of aluminium alloy 6061 having M condition are taken as feed stock.
b) The extruded aluminium tubes were then cold drawn.
c) The cold drawn aluminium tubes were subjected to solution treatment in a furnace for about 60 minutes at temperature 515 °C followed by efficient water quenching straightened on hyperbolic straightening machine.
d) The straightened aluminium tubes were sequentially subjected to artificial age hardening process at 165 °C for about 18 hours.

Table – VII

Sequence of Process	Tensile strength (MPa)	% Elongation	Internal diameter tolerance
After Extrusion "M" as of manufactured	140	21	±0.3 mm

After Cold Drawing	185	10	±0.1 mm
After solution treatment	280	9	±0.1 mm
After Age hardening	335	12.31	±0.1 mm

Table – VIII

Type of Cheese Tube/ Cheese Pipe	Extruded tube dimension and weight in gms	Drawn tube dimension and weight in gms	Effective weight reduction in gms
Cheese Tube/ Cheese Pipe	165	100	65
Cheese tube/ Cheese pipe for Jumbo bags	800	500	300

Advantages of the process:

Aluminium Cheese tube, Cheese pipe or bobbin produced by this process provides close tolerance, exceptional tensile strength with percentage elongation which provides ductility and lesser weight product. Thickness of said product is reduced by 1.5 – 3 mm in cheese tube and in case of cheese tube used for jumbo bags the reduction is in the range of 2.5 – 3.5 mm. Reduction in weight by this process is 60 % with respect to conventional methods. If the improvement is calculated on practical basis then 65 gm weight reduction for each cheese tube will reflect in ultimate reduction of 20 kg of cheese winder which makes process economical in terms of lower maintenance, lower electricity consumption and lower handling efforts.

The manufactured aluminium cheese tubes, cheese pipes or bobbin by method according to present invention have excellent ductility, reduced weight, suitable tensile strength and proof stress in resultant product for woven sack application.

While various embodiments of the present invention have been described in details, it is apparent that modification and adaptation of those embodiments will occur to those skilled in the art. It is expressly understood, however, that such modifications and adaptations are within the spirit and scope of the present invention as set forth in the following claims.

We Claim,

1. A process for manufacturing of aluminium alloy cheese tube/ cheese pipe or bobbin for woven sack comprising following steps:

   a) manufacturing porthole extruded aluminium tubes from billets formed by aluminium alloy;
   b) cold drawing said extruded aluminium tubes at a room temperature to reduce the cross section area and thickness of said extruded aluminium tubes;
   c) straightening the cold drawn aluminium tubes at a room temperature to remove stress generated during step b);
   d) carrying out artificial age hardening treatment to further improve the mechanical strength and percentage elongation (ductility) in straightened aluminium tubes.

2. The process for manufacturing of aluminium alloy cheese tube/ cheese pipe or bobbin for woven sack as claimed in claim 1 wherein aluminium alloy is selected from alloy 6061 and alloy 6082.

3. The process for manufacturing of aluminium alloy cheese tube/ cheese pipe or bobbin for woven sack as claimed in claim 1 or 2, wherein, at step (a) extruded porthole aluminium alloy tube is solution treated (T4 condition) or without solution treated (M condition).

4. The process for manufacturing of aluminium alloy cheese tube/ cheese pipe or bobbin for woven sack as claimed in any of claim 1 to 3 wherein for M condition porthole extruded aluminium alloy is sequentially solution treated by fog or water quenching after straightening the cold drawn aluminium tubes.
5. The process for manufacturing of aluminium alloy cheese tube/ cheese pipe or bobbin for woven sack as claimed in claim 1 wherein the step (c) is carried out by hyperbolic 6 roll machine.

6. The process for manufacturing of aluminium alloy cheese tube/ cheese pipe or bobbin for woven sack as claimed in claim 1 wherein the step (e) is carried out at 165 °C for 6-18 hours.

7. The process for manufacturing of aluminium alloy cheese tube/ cheese pipe or bobbin for woven sack as claimed in claim 1 wherein weight reduction in product is 40%.

8. The process for manufacturing of aluminium alloy cheese tube/ cheese pipe or bobbin for Woven Sack as claimed in claim 1, wherein the mechanical properties includes improvement in tensile strength and percentage elongation, reduction in cross section area, reduction in weight and achievement of the precise dimensional tolerance includes tolerance on internal diameter and uniform thickness of the aluminium tubes.

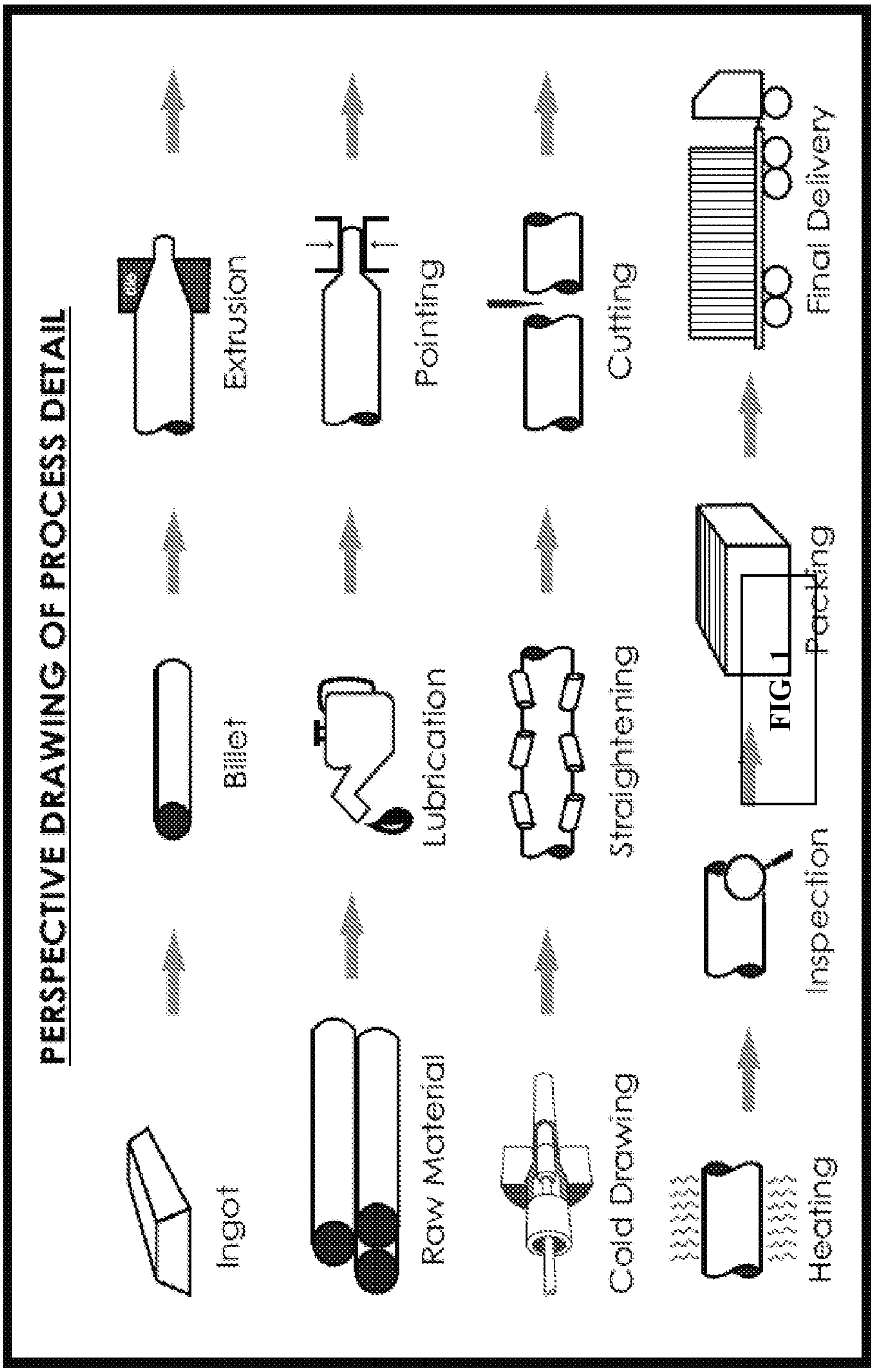
PERSPECTIVE DRAWING OF PROCESS DETAIL
Ingot
Billet
Extrusion
Raw Material
Lubrication
Pointing
Cold Drawing
Straightening
Cutting
Heating
Inspection
Packing
Final Delivery

FIG 1