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MANUFACTURE OF STEEL OR ALLOY TUBES

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1 Claim. (Cl. 148—12)

This invention relates to the manufacture of steel or alloy tubular articles and, more particularly, to the manufacture of steel or alloy tubular articles having improved machining qualities.

Tubular articles are now applied as substitutes for solid bar stock for numerous uses, such as bearing races, chain links, roller cages and bushings, and such parts usually are machined on high speed automatic cutting machines. The parts thus manufactured from tubing must possess good machinability in order to maintain a uniform product and high production rates, and it is desirable in many instances that the machined article have a good surface finish.

Investigation of many different kinds of steel manufactured in the tubular goods field and later machined on high speed automatic cutting equipment, has demonstrated that the different steels require special heat-treating and cold-drawing operations in order to develop the best cutting characteristics.

Manufacturing practice employed in making a tube from one grade of steel is often entirely unsuitable for making the tube from some other type of steel. It has been found that, by adding the improvement of slow cooling, medium carbon steels after heating the pierced blank to a temperature above the upper critical point of the metal thereof prior to cold-drawing, the machining qualities of the finished tube are highly improved, both as regards tool life in high speed cutting operations and also in the surface finish of the machined article.

It is accordingly an object of the present invention to provide an improved method of heat-treating cold-drawn tubular articles during the process of production.

It is a further object of our invention to provide a process for producing tubular articles having improved machining properties.

Cold-drawn seamless tubing is ordinarily produced by piercing a billet while hot, hot-rolling the pierced shell over a plug and then cold-drawing it to size. Prior to cold-drawing the shell is annealed and, if more than one cold-draw pass is necessary to obtain the desired reduction, the shell is generally annealed between each cold-draw.

In accordance with the present invention which is particularly applicable to the production of tubing from medium carbon steels, i. e., steels containing from .15 to .45 per cent. carbon and alloy steels of the same carbon content, the alloying agents of which may vary over a wide range, a billet of such composition is pierced in accordance with conventional seamless practice. The pierced billet or shell is then heated to a temperature above the critical range, slowly cooled, preferably in the furnace, as the rate of cooling can be more accurately regulated, to a temperature substantially below the lower critical point, and cold-drawn a predetermined amount to secure the best results. In order to secure the best machining qualities, which has been found to depend on the structural condition of the steel or alloy, a definite structural state must be maintained. For medium carbon steel tubing containing from .15 to .45 per cent. carbon, regardless of the alloy additions, it has been found that the best structural state for free cutting and smoothest finish is that which is produced by heating the steel to a temperature above the upper critical point, that is, between 1500 and 1750 degrees Fahrenheit, holding it at this heat for at least one hour, and then causing a slow furnace cooling at a rate not greater than 25 to 50 degrees per hour until the steel has reached a temperature in the furnace at least below 900 degrees Fahrenheit. The higher the temperature reached in heating and the slower the cooling, the better the structure obtained in medium carbon steels of the class described. Slow cooling from above the upper critical range enables the excess ferrite to precipitate from the austenite in a uniformly dispersed condition, and also promotes the formation of the carbide constituents in the form of lamellar pearlite. Steels with a carbon content at the lower end of the above range, when so treated, usually develop a banded structure of alternating bands of ferrite and pearlite.

After having been heat-treated in the manner described, the tube is ready for the finishing cold-draw pass. Cold-drawn tubes are, in conventional practice, cold-drawn to the desired size, but, in order to achieve the optimum results for machining on these medium carbon steels, the reduction in area should be between 20 and 70 per cent. The effect of cold-drawing within these limits is to elongate, in the direction of the tube axis, the definite constituents which comprise the steel structure. The combination of the the slowly cooled structure and the cold-drawing promotes the formation of two definite constituents, one hard and one soft, which tends to give a continuous chip in cutting across these elongated constituents and permits easier machining and a smoother finish. The cold-working reduces the elongation and reduction of area

of the steel, as measured in the conventional testing. This combination of slow cooling and cold-working also tends to increase the machinability of the steel so treated.

As a specific example of producing tubing with a carbon content at the lower end of the above mentioned range our practice, as applied to the following type of steel, known as S. A. E. 4620, is given:

	Per cent
Carbon	.15– .25
Manganese	.40– .70
Nickel	1.65–2.00
Molybdenum	.20– .30
Silicon	.15– .30
Phosphorus	.04 maximum
Sulphur	.05 maximum

A billet of this analysis is pierced and rolled to produce a hot-forged section. The hot-forged tube is then heated to a temperature of 1675 degrees Fahrenheit, held at that heat for at least one hour, and cooled in the furnace at a rate of 25 to 50 degrees Fahrenheit per hour to a temperature below 900 degrees Fahrenheit. The tube so treated is then pickled, lubricated and cold-drawn to obtain a 60 per cent. reduction in area. The tube so produced has highly improved cutting characteristics over tubing produced by any heretofore known method.

When applied to steels having a carbon content at the upper end of the aforementioned carbon range such as, for example, the type known as S. A. E. 3140 which has the following analysis:

	Per cent
Carbon	.35– .45
Manganese	.60– .90
Nickel	1.00–1.50
Chromium	.45– .75
Silicon	.15– .30
Phosphorus	.04 maximum
Sulphur	.05 maximum

the tube is heated to a temperature of 1550 degrees Fahrenheit and cooled in the furnace at a rate of 25 to 50 degrees per hour to a temperature below 900 degrees Fahrenheit. The tube so treated is then pickled, lubricated and cold-drawn to obtain a 25 per cent reduction in area. It will be noted that the heat-treating temperature of this higher carbon content steel is somewhat lower than for the steel of lower carbon content above mentioned.

While we have described several embodiments of our invention, it will be understood that we do not wish to be limited exactly thereto, since various modifications may be made within the scope of our invention, as defined by the appended claim.

We claim:

In the manufacture of cold-drawn steel tubing containing from .15 to .45 per cent carbon, from .40 to .90 per cent manganese, from 1.0 to 2.0 per cent nickel, from .20 to .75 per cent chromium, from .15 to .30 per cent silicon, a maximum of .04 per cent phosphorus, a maximum of .05 per cent sulphur and the remainder substantially iron to produce tubing having a high degree of machinability, the method comprising heating the tubular blank to a temperature of between 1500 and 1700 degrees Fahrenheit, holding the blank at said temperature for approximately one hour, percipitating the excess ferrite from the austenite in a uniformly dispersed condition and promoting the formation of carbide constituents in the form of coarse lamellar pearlite by slowly cooling said blank at a rate approximately of from 25 to 50 degrees per hour to a temperature below 900 degrees Fahrenheit, and finally cold-drawing the blank an amount sufficient to effect a reduction in area of between 20 and 70 per cent so as to form hard and soft layers therein which are freely machinable.

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