Patented Oct. 14, 1941

2,258,935

UNITED STATES PATENT OFFICE

2,258,935

ALLOY STEEL ROLL

Harold A. Lomax, Wyomissing, Pa.

No Drawing. Application May 18, 1939,
Serial No. 274,446

5 Claims. (Cl. 80—58)

The invention relates to rolls for use in the production of plates, bars and strips, as well as in the rolling of blooms and ingots.

To this end the principal object of my invention, generally considered, is to produce a roll of alloy steel having great strength and shock resisting power, being also super-wear resistant. and the surface of which is resistant to fire cracks.

Another object of the invention is to provide an alloy steel roll having a surface which is not brittle nor subject to glazing and of a quality substantiallly equal to that of a mildly chilled cast iron roll heretofore produced.

It is of course well known that chilled cast iron rolls, due to the metal adjacent their periphery being intensely hard, are capable of being highly polished to have a finer surface than that generally found on cast steel rolls but cast iron rolls cannot be used in the rolling of steel at high temperatures where heavy duty produces excessive shocks to rolls as this process would destroy the rolls by breakage or the chill surface by fire cracking and materially decrease the efficiency and usefulness of the rolls. Furthermore, cast iron rolls are extremely brittle and are often cracked and broken if an attempt is made to use the same in place of the softer or less fragile steel roll.

It has been found in previous attempts that as the surface hardness of an alloy steel roll is increased the tendency for such surface to fire crack or check is also increased with every added increment of hardness and that as a result where the surface of the roll is hardened to a point where it possesses long wearing qualities it will, after a comparatively short space of time, present a maze of fire cracks and checks varying in width and depth from microscopic cracks to cracks of appreciable width and of a depth of a quarter of an inch or more and consequently producing upon the steel passing beneath the roll periodic impressions or a corresponding pattern which will remain on the steel throughout the successive rolling steps and which requires the grinding of the surface of the steel in order to remove the fire cracks and check marks placed thereon during the early rolling operation.

I have found, however, that I can produce a roll of alloy steel including manganese, silicon, chrome, nickel and molybdenum, and by so proportioning the elements to the carbon, sulfur and phosphorous I am able to obtain a roll which is much harder than the usual cast alloy steel roll and in which the surface approaches in texture the scleroscope hardness of the surface of a mild chill cast iron roll and at the same time I have eliminated or at least minimized to a point of substantial elimination the fire cracks and checks which heretofore have been the limiting factor in connection with the hardness of the roll surface.

In carrying out the invention I preferably employ for heavy duty rolling proportions of the above mentioned compounds so that the finished product will approximate the following analysis:

	Per cent
Carbon	.90 to 1.20
Manganese	.80 to 1.00
Silicon	.35
Chrome	.40 to 50
Nickel	1.60
Molybdenum	.35
Sulfur	.05
Phosphorous	.045

It will be noted that for cast steel heavy duty rolls the percentage of carbon is unusually high and it would generally follow that such a high percentage of carbon would tend to produce a brittle roll. However, by the addition of nickel, chrome and molybdenum in substantially the percentages named above the tensile strength of the casting has been raised to over one hundred and ten thousand (110,000) pounds per square inch. This is vastly in excess of the strains to which the roll is subjected in mill operations and, therefore, the roll is practically unbreakable under ordinary uses.

I have found that by a variation in the quantity of nickel to silicon and/or chrome content I am able to control and maintain the desirable characteristics of the roll which I have pointed out heretofore.

When it is realized that the immediate area of the surface of a roll that is in intimate contact with steel being rolled may at times be subject to a temperature between two thousand and twenty-five hundred degrees while the area of the roll surface diametrically opposed therefrom may be of a temperature not exceeding two hundred degrees, and when it is realized that the surface temperature of the roll may undergo a number of rapid changes from one extreme to the other within a relatively short period of time, one will appreciate the tremendous surface expansion and contraction strains to which the roll is being continually subjected.

It is believed that the fire resisting qualities of this roll are obtained by the low silicon and chrome content and by maintaining the balance between the silicon and chrome relative to the nickel content. Thus, in the roll which is produced in accordance with this invention it will be observed from the analysis given above that both the silicon and chrome are maintained at a comparatively low point, namely approximately from .30% to .50%, whereas the nickel content is from three to four times as great as the percentage of either the silicon or chrome.

Where this percentage arrangement has been followed it is found that the surface of the roll does not fire or water crack to either large horizontal or circumferential fire cracks as has heretofore been customary in other alloy rolls but merely crazes and that there appears to be no tendency for the crazes to increase either in the horizontal or vertical magnitude so that a new surface can be produced on the roll by removing as little as from 1/16 to 1/8 of an inch from the surface of the roll. As rolls of the instant type are usually of considerable diameter they may be easily machined to remove the shallow crack forming crazes without materially reducing the diameter of the roll. This is another distinct advantage over cast iron rolls for if rolls of the latter type are machined to remove the fire cracks the thickness of the chill is materially decreased to the utter detriment of the roll. It will, of course, be obvious that this characteristic of the instant roll greatly lengthens its life and maintains the roll at full strength throughout its life and the absence of horizontal or circumferential fire cracks enables the roll to produce a finished product free from fins, seams and laps which has been common practice in the alloy steel rolls heretofore produced.

While the general proportions as set forth will produce a roll having a hardness measured by the Shore scleroscope from forty-eight (48) to fifty-eight (58), depending upon the percentage of nickel, silicon and chrome as well as the percentage of carbon, the extreme hardness of the roll surface does not affect the frictional gripping qualities of the roll surface and there is, therefore, no tendency for the surface to glaze which is a common defect in previous alloy steel rolls where an attempt has been made to increase the surface hardness through even the lower figure of the Shore scleroscope reading.

By changes in the ratio of the nickel, silicon, chrome and carbon I may increase or decrease the hardness of the roll surface and in this manner am able to produce a roll which is particularly adapted for the use to which the same is to be put. As an example, where I wish to produce an extremely hard roll surface, having reference to a Shore test between fifty-four and fifty-seven, I have found that by using the following percentages this result may be obtained:

	Per cent
Carbon	1.72
Manganese	.95 to 1.10
Silicon	.41
Chrome	.36
Nickel	1.83
Molybdenum	.42
Sulfur	.034
Phosphorous	.045

Other changes in percentages may be made without departing from the scope of my invention, the main novelty of which would appear to be the use of a comparatively high percentage of carbon and maintaining the silicon and chrome at approximately one third of one percent and maintaining the nickel content between three and four times the percentages of either chrome or silicon with slight variations, either plus or minus, in amounts herein given.

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

1. A mill roll for rolling hot metal comprising a steel alloy containing from .80% to 1.90% of carbon, from .80% to 1.10% of manganese, .35% silicon, .45% chrome, .35% molybdenum, and from 1.25% to 1.90% nickel.

2. A mill roll for rolling hot metal comprising a steel alloy containing between .75% to 1.90% of carbon, approximately 1% to 1.50% of manganese, .33⅓% silicon, chrome and molybdenum, and a nickel content of between three and four times the percentage of silicon.

3. A mill roll for rolling hot metal comprising a steel alloy having between 1% and 1.90% carbon, approximately 1% manganese, less than .50% silicon, chrome and molybdenum, and approximately 1.50% nickel.

4. A mill roll for rolling hot metal comprising a steel alloy containing approximately 1% of carbon, 1% of manganese, less than .50% of silicon, chrome and molybdenum, and a nickel content varying from 1.25% to 1.90% of the total composition.

5. A mill roll for rolling hot metal comprising an unquenched steel alloy having a surface hardness between 47 and 57 Shore and containing carbon and manganese in substantially equal percentages, also containing a small percentage of silicon and a substantially equal percentage of chrome, and between 2% and 3% nickel, the percentage of nickel being greater than the combined percentages of silicon and chrome.

HAROLD A. LOMAX.