June 18, 1935. G. H. AUPPERL 2,005,358

ROLL AND METHOD OF MAKING THE SAME

Filed Dec. 14, 1931

Fig. 1.

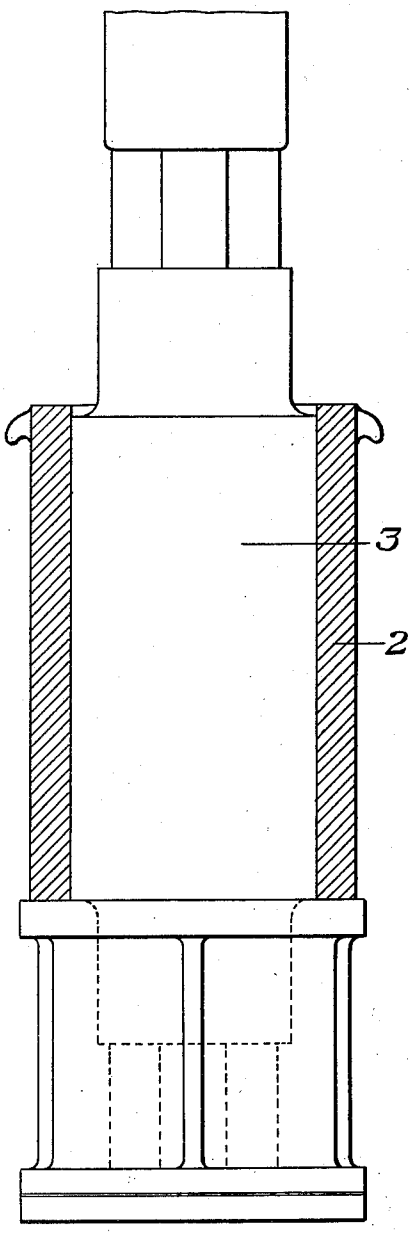
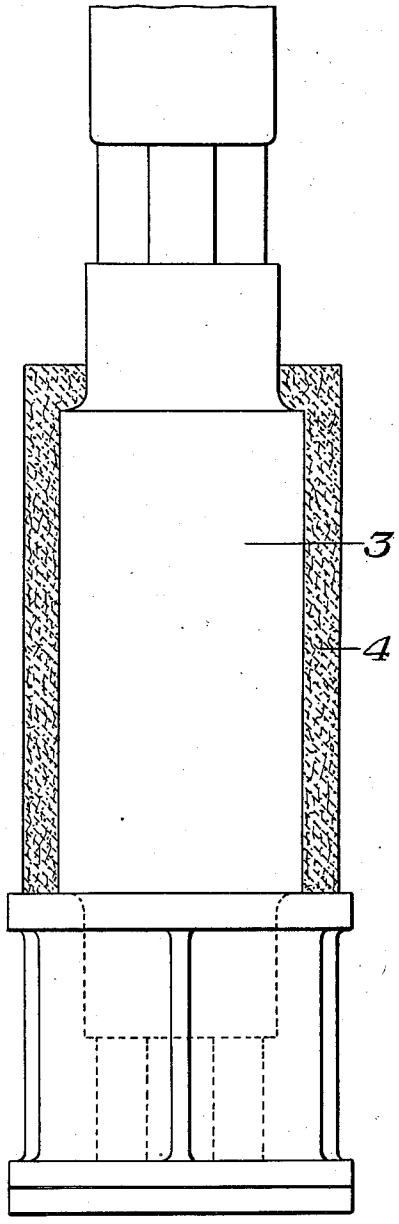


Fig. 2.



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Patented June 18, 1935 2,005,358

UNITED STATES PATENT OFFICE

2,005,358

ROLL AND METHOD OF MAKING THE SAME

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Application December 14, 1931, Serial No. 580,795

3 Claims. (Cl. 148—3)

The present invention relates broadly to rolls, such for example as iron, or iron alloy rolls utilized in the rolling of metal, paper, linoleum and the like where the rolls are formed by a casting operation in a metal mold from which they are subsequently removed.

In the casting of iron, steel or alloys into a metal mold, the metal forming the outer portion of the casting which is in intimate contact with the mold body tends to solidify or chill much more quickly than the center portion of the casting. In many cases the molds are of special construction adapted to effect a rapid dissipation of heat from the outer portion of the casting, and thereby produce a hard outer skin or zone referred to as a chill. The life of cast rolls, such as those used in the rolling art, is more or less dependent upon the thickness or depth of the chill. Attempts have therefore been made to produce deep chilled rolls, but such rolls have not been altogether satisfactory due to the tendency to rupture or fire crack. While this objection exists with respect to any roll cast in a metal mold, such tendency is less pronounced.

In accordance with the present invention there is provided an improved roll and method of making the same, whereby the existing defects are obviated and the length of life of the roll increased.

In the accompanying drawing, which is largely diagrammatic, there is illustrated one embodiment of the present invention, it being understood that the drawing does not define the limits thereof, as changes in the construction and characteristics of the roll as well as in the construction and type of the mold and the heat retaining enclosure subsequently applied thereto may be made without departing either from the spirit of the invention or the scope of my broader claims. In the drawing:

Figure 1 is a view partly in section and partly in elevation of a roll as constructed by a usual casting operation; and

Figure 2 is a view of the same roll subjected to treatment in accordance with the present invention.

In the production of cast rolls, it will be apparent that due to the tendency of the casting to solidify from the outside inwardly, due at least in part to the rapid conduction of heat away from the outer surface of the casting by the material of the mold, there is produced a body which, after it has become hard and cold, has an outside portion under a state of more or less severe compression, and an inside portion under a state of comparatively great tension. The compressive forces in the outer portion of the casting act both radially or diametrically of the roll, and longitudinally thereof. In similar manner, the tension strains in the inner portion of the roll exist in almost every direction, focussing at substantially the center point of the roll. Due to this condition, it will be apparent that the entire body of the roll is subjected to such strains that rupture thereof may be easily produced.

During the use of the roll, and particularly under such conditions that require the application of heat to the outer portion thereof, as in metal rolling, there is a tendency for this outer portion to rapidly enlarge, due to expansion, before the inside of the roll is materially effected by such temperature conditions. This enlargement or expansion of the outer portion of the roll very materially increases the tension strains on the inner part, thereby increasing the unbalanced condition existing within the roll, this unbalancing being frequently sufficient to cause the roll to rupture or burst from the inside. Also, this tendency of the outer portion of the roll to expand, increases or magnifies the compression existing therein, inasmuch as such outer portion tends to compact itself into a smaller space by reason of its integral connection with the inner or colder part which is under tension and therefore tends to resist such expansion. This added compression in the outer portion tends to crush the roll, thereby producing minute ridges which later develop into fire cracks checkerboarded over substantially the entire rolling surface of the roll. This causes the roll to gather or roughen on the surface during the initial period of its operation.

To those skilled in the art, it will be apparent that this condition of compression and tension becomes more and more serious as the depth and hardness of the chill is increased, since the relative compression and tension strains in such cases are correspondingly increased. On rolls of this kind, the tension strain is sufficiently great at times to effect fracturing thereof before the rolls have actually been put into service, this fracture sometimes being longitudinally and sometimes transversely of the roll body. This condition naturally increases as the hardness and depth of the chill increases, because invariably the deeper the chill on the outside surface, the harder the material in the body of the roll, and therefore the greater the tension strains on the inside of the casting.

After a roll has been in use and has become heated, and further use is temporarily suspended, the outside of the roll tends to radiate heat much

more rapidly than the inside, and therefore tends to contract or assume a smaller shape than it should compared to the hotter inside portion of the roll. This in turn places the outside of the roll under tension, and the inside under compression. In solid rolls this tension on the outside or chilled surface is sometimes overcome by the severe compression on the inside, thereby resulting in a fracture commonly referred to as a fire crack. Such a fire crack invariably results in the breaking of a roll within a short time if it is continued in service.

From the foregoing general statement, it will be apparent that any condition of roll formation tending to produce a roll which, at the outset, has minimum tension and compression strains existing therein, constitutes a distinct advance in the art, inasmuch as a roll which is initially substantially free from strains, is much better able, in service, to take care of the strains incident to its use.

In the drawing I have illustrated in Figure 1 a mold 2 of conventional design such as utilized for the casting of a roll body 3. In accordance with present methods, a roll after having been cast is either removed from the metal mold after it has become cooled sufficiently to be self-supporting and to an extent sufficient to permit handling thereof, or is retained in the mold until at such a temperature as to permit machining thereof.

If the first method is practiced, there is much external strain induced from the working part of the roll abnormally contracting, due to the much lower temperature of the metal at this point in comparison with the center part of the roll which is still at an appreciably higher temperature, the temperature difference amounting to several hundred degrees. This operation is therefore responsible for compression and tension strains of the character before referred to.

If the second method is practiced, the roll has a tendency to cool more slowly after the mold has absorbed a considerable amount of heat therefrom, but even in this case the difference in temperatures between the working face and the center of the roll, until such time as the roll has completely solidified, may amount to several hundred degrees. In any case the difference is sufficient to result in an unbalanced strain condition such as heretofore described.

In accordance with the present invention, the roll, as soon as the outer portion thereof has become self-supporting, is stripped from the metal mold in which it is cast, and placed in a protective sheathing or covering 4 of heat retaining or heat insulating characteristics such as sand, asbestos or the like. Such a protective covering around the roll is effective for shielding it against undue loss of heat by conduction, the envelope acting as a heat retaining medium from which the principal loss of heat is by way of radiation only. Such an envelope, by reason of its tendency to retain heat in the outer portion of the roll, enables this outer portion to appreciably reheat under the influence of the hot central portion, the reheating being sufficient to bring the outer and inner portions of the roll to within a comparatively small difference of temperature.

This reheating condition having been obtained, the entire mass of the casting tends to give up its heat more or less uniformly, whereby the body of the roll is under a state of substantially balanced strain conditions. The reheating of the outer portion may take place after the initial compression strains have been partly or completely formed therein by reason of the casting in the metal mold, but before any tension strains have developed within the inner portion of the roll. It will be obvious that such reheating is effective for substantially eliminating the compressive strains, and thereafter preventing the formation of any appreciable strains either in tension or compression.

It will thus be apparent that my invention lends itself to the production of an improved roll characterized by the substantial elimination of unbalanced strains therein and therefore a roll having a much greater inherent stability and consequently insuring a much longer life in service, regardless of the conditions to which such a service subjects it.

While I have referred to sand and asbestos as specific examples of the heat retaining medium which may be employed, it will be apparent that the utility of the invention is not limited in this respect, many other materials, such as refractory clays and the like, being adaptable for the accomplishment of the desired reheating.

Other changes will likewise suggest themselves, both with respect to the manipulative procedure and the materials used, such changes being within the scope of my invention.

I claim:

1. In the method of forming iron roll castings, the steps comprising forming the casting in a chill mold to chill the outer portion only thereof, and thereafter, substantially when the outer portion becomes self-supporting, closely jacketing the casting with heat retaining sheathing having surface contact with said casting, whereby the outer portion of the casting is subjected to a reheating operation from the heat of the inner portion without destruction of the chill in the outer portion.

2. In the method of forming iron roll castings, the steps comprising casting the body portion of the roll in a chill mold for chilling the outer portion thereof, and thereafter, substantially when the outer portion becomes self-supporting, removing the chill mold and closely jacketing the body of the roll with a heat retaining sheathing, whereby the outer portion of the casting is subjected to a reheating operation from the heat of the inner portion of the casting without destruction of the chill in the outer portion.

3. As a new article of manufacture, a cast ferrous roll having a body portion having a molecular structure and physical properties characteristic of those obtained when an iron casting is formed in a chill mold and the chill mold removed immediately the casting becomes self-supporting, and a heat retaining mold substituted therefor to obtain a reheating of the chilled portion of the casting at the expense of the heat in the inner portion thereof.

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