UNITED STATES PATENT OFFICE.

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RAIL-STEEL.

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To all whom it may concern:

Be it known that I, CHILD HAROLD WILLS, a citizen of the United States, residing at Detroit, in the county of Wayne and State of Michigan, have invented certain new and useful Improvements in Rail-Steels, of which the following is a specification.

This invention relates to steels for railway rails and particularly for railroad rails. It has for one of its primary objects the provision of a rail steel which is not only superior in physical properties, whereby breakages and the rapidity of wear and disintegration are reduced, but which also avoids certain of the difficulties and losses ordinarily encountered in the manufacture of such steel. A further object of the invention resides in the provision of an economical steel of such superior quality that it is possible to safely cut down the size of the rails if desired.

Generally speaking, the life of a rail, not only as regards wear but also in so far as its freedom from disintegration and breakage is concerned, is a function of the number of wheel-loads that pass over it. In the last few years in railroad transportation, the average speed has greatly increased, the average wheel-load of cars has almost doubled, the average wheel-load of locomotives has more than doubled, and the volume of traffic, particularly over some roads, has more than trebled. Roughly speaking, the impact and shock on the rail are proportionate to the speed, the stresses on the rail are proportionate to the wheel-loads, and the repetition of stress is proportionate to the volume of traffic. It will, therefore, be readily seen that the service requirements of rails have increased tremendously. To meet these increased requirements the weight per yard of rails has been gradually increased until, at the present time, it is about double what was considered standard practice some few years ago, and in fact the increase in weight per yard has been greater than the increase in wheel-loads. The section of the rails has also been altered in attempts to meet the increase in service requirements, but neither the increase in weight nor the alterations of section has satisfactorily met the changed conditions and, therefore, it follows that the steel itself lacks in properties essential to adequately meet the changes in service requirements. Among the more important factors to which the failure of standard rail steel to satisfactorily meet the increased service requirements may be attributed, are the following, namely, the physical properties such as tensile strength, elastic limit, elongation, resistance to impact and shock, resistance to alternating stresses, etc., are inadequate. Again, segregation, or the formation of pockets of the alloys, is a detrimental factor, which is particularly noticeable with the larger sizes of rails for the reason that with larger ingots there is a tendency to increased segregation, which of course results in detrimental chemical combinations and impairs the physical properties of the steel. It will also be obvious that, where appreciable segregation occurs, the steel is not uniform throughout.

Difficulties are also encountered in rolling, due to section. Thus, for example, where a rail having a relatively thin base and a relatively large head, which is considered desirable practice, is rolled at the critical temperature (point of recalescence) the base cools more rapidly and becomes rigid preventing further work on the head. The head is therefore finished too hot, and is coarse in structure and brittle, with inferior wearing qualities, while the base is fine in structure. To meet this, it has been found necessary to increase the amount of metal in the base, but this necessitates a corresponding reduction in the metal in the head, which is not desirable.

Furthermore, the allowable range within which the rolling temperatures must be confined is narrow, and, as is well known, it is difficult to maintain uniform temperature conditions, with the result that the allowable range is often exceeded, producing overcrystallization and even burning, with consequent weakness and losses in manufacture and service. An additional factor is that standard rail steel is very sensitive to local heat conditions and develops thermal cracks at points of wheel slippage, owing to the local high temperature conditions at such points.

It is the purpose of my invention to provide a steel having greatly superior physical properties adapted to adequately meet the increased service requirements and to overcome the other difficulties hereinbefore mentioned, the steel at the same time being of such a character that the croppage or discard and other blooming mill losses are greatly reduced.

I accomplish the foregoing results by add-

ing to standard rail steel, molybdenum in varying percentages, according to the quality of steel desired and the weight per yard, the preferred percentages of molybdenum being from a substantial fraction of 1% to 1.00%. The chemical specifications adopted as standard practice are as follows, depending on weight per yard, namely: carbon .35 to .55%; phosphorus not to exceed 0.10%; silicon not to exceed 0.20%; and manganese 0.70% to 1.10%. I have found that the addition of relatively small percentages of molybdenum causes a marked increase in tensile strength, elastic limit, elongation reduction in area, resistance to impact and shock and to alternating stresses without crystallization. The wearing qualities are greatly increased, and, in addition, the steel, in contradistinction to standard steels, is not sensitive to heat conditions, and detrimental chemical and structural changes do not take place until a very wide range of temperature (as high as 200° F.) has been exceeded. Stated in other words, it is possible to carry the rolling temperatures far beyond the point at which over-crystallization and burning would take place in standard rail steel, without impairment of the physical properties of the steel. The increase in the allowable range of rolling temperature thus practically eliminates the losses in manufacture and service which result from exceeding the narrow limits of ordinary practice, and the product, also, will run uniformly in quality, notwithstanding wide variations in rolling temperatures, which variations, as has been pointed out, it is impossible to avoid in the absence of complicated and expensive regulating equipment. Even with such equipment it is impossible to secure uniformly satisfactory results.

Furthermore, the molybdenum does not segregate and apparently overcomes the marked tendency of the manganese to segregate. This tends to produce uniformity in the steel and also prevents detrimental chemical combinations from taking place. It is also to be noted, on the score of uniformity of the steel, that the molybdenum has superior depth hardening or penetrating characteristics. In addition, the molybdenum reduces the liability to pipes or seams, and materially cuts down the croppage or discard. Stated in other words, the blooming mill yield is increased and the cost of preparation for rolling reduced.

In so far as the rolling itself is concerned, the increase in temperature range within which no detrimental chemical or structural change takes place may, if desired, be utilized to reduce the number of passes through the rolls, because of the possibility of starting the rolling at a higher temperature. The increase in rolling temperatures may also be utilized to produce a relatively superior rail by giving the rail the usual number of passes through the rolls but with less draw on each pass, and this without increasing the number of heats required. Again, the difficulty hereinbefore mentioned as resulting from section may be obviated. Thus, if a rail is to be rolled having a relatively thin base and a relatively large head, the rolling can be initiated at a higher temperature so that all of the work necessary on the head can be done before the base cools to such a point that the metal becomes rigid. Stated in other words, I am enabled to obtain uniform quality in both the head and the base without increasing the amount of metal in the base and decreasing the amount of metal in the head which otherwise would be necessary to secure uniform results. It might here be noted that with the addition of molybdenum the effect of section on the physical properties is much less marked than is ordinarily the case.

In making rails according to my invention it is necessary to heat treat the rail after it has been rolled in order to obtain the benefits of the molybdenum, and the additional expense incident to this heat treatment is more than warranted by the great increase in physical properties, the elimination of losses in manufacture, the reduction in losses in service, the increased life of the rail, and the greatly reduced cost of maintenance. As will be readily apparent, the saving effected in maintenance will be very large, and it is also to be noted that with the greatly increased physical properties I am enabled, if desired, to cut down the size of the rails, which further offsets the increase in cost due to heat treatment.

In heat treating the rolled rails I prefer to employ a quenching heat of a temperature ranging from about 1500° F. to about 1650° F., and a drawing heat ranging from about 1000° F. to about 1200° F., depending upon analysis, weight per yard, and the particular field of use to which the rails are put.

I do not wish to be limited to the precise proportions herein specified, the analysis given being that which I prefer. It will also be obvious that my invention is equally applicable to rail steels in which the manganese is replaced in part or in whole, or used in combination with chromium and similar elements. A rail steel of the standard specifications herein given, to which one per cent. of molybdenum is added, will have physical properties substantially as follows: namely: tensile strength from 90,000 pounds to 130,000 pounds; elastic limit from 80,000 pounds to 125,000 pounds; elongation from 16% to 25%; and reduction in area from 54% to 70%. It will be readily apparent to those skilled in this art that the foregoing

physical properties show a very great increase over the properties of standard rail steel. As pointed out, such steel has a marked increase in resistance to impact and shock, and to alternating stresses without crystallization, is ductile and can be cold bent without impairment. The heat treatment also insures uniformly excellent product.

I claim:—

A railway rail made of steel containing carbon from .35 to .55%; phosphorus not to exceed 0.10%; silicon not to exceed 0.20%; manganese from 0.70 to 1.10%; and molybdenum from a substantial fraction of 1% to not materially more than 1%; quenched at from 1500° to 1650° F. and drawn at from 1000° to 1200° F.

In testimony whereof I have hereunto signed my name.

CHILD HAROLD WILLS.