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METHOD OF TREATING STRIP METAL

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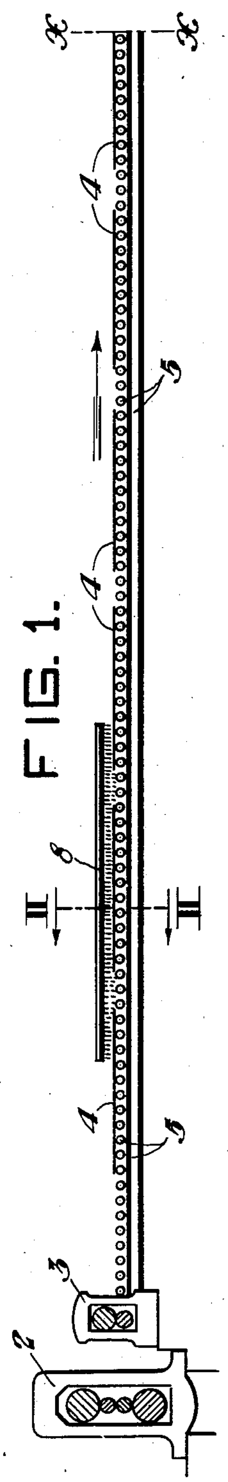

FIG. 1.

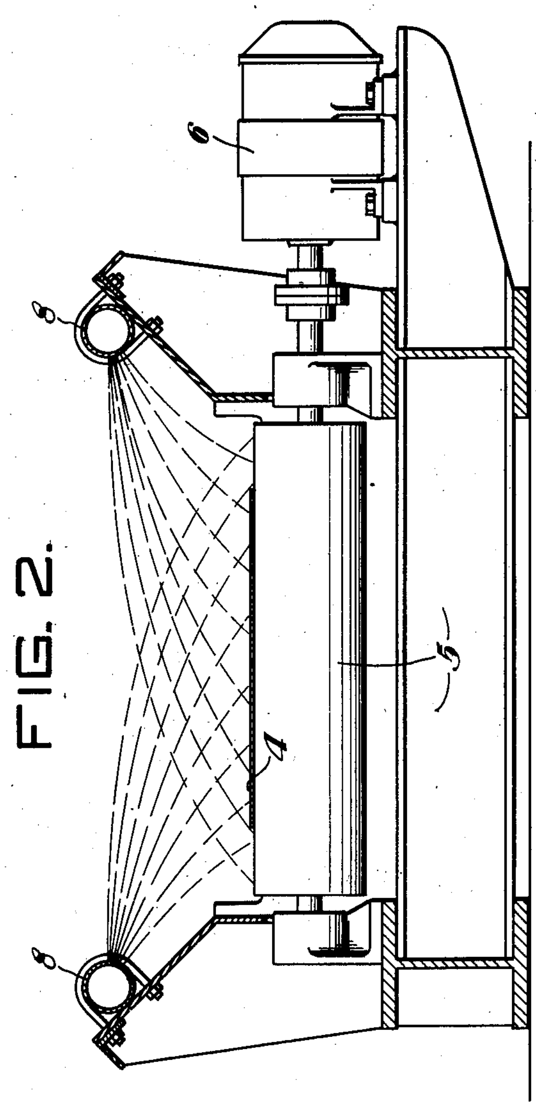

FIG. 2.

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FIG. 1B.

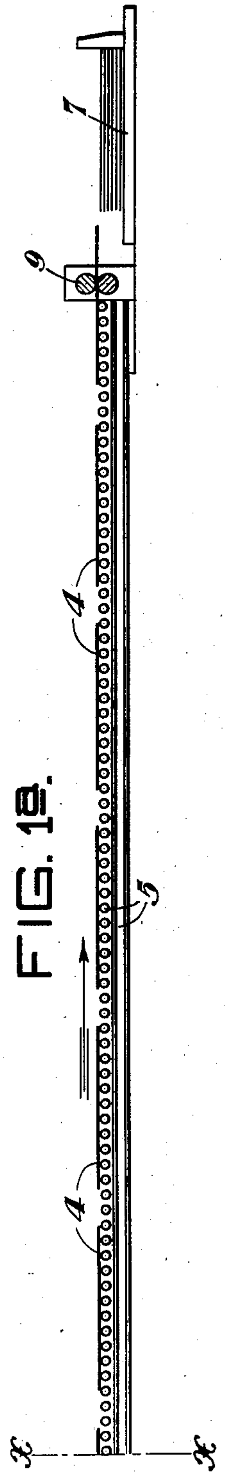
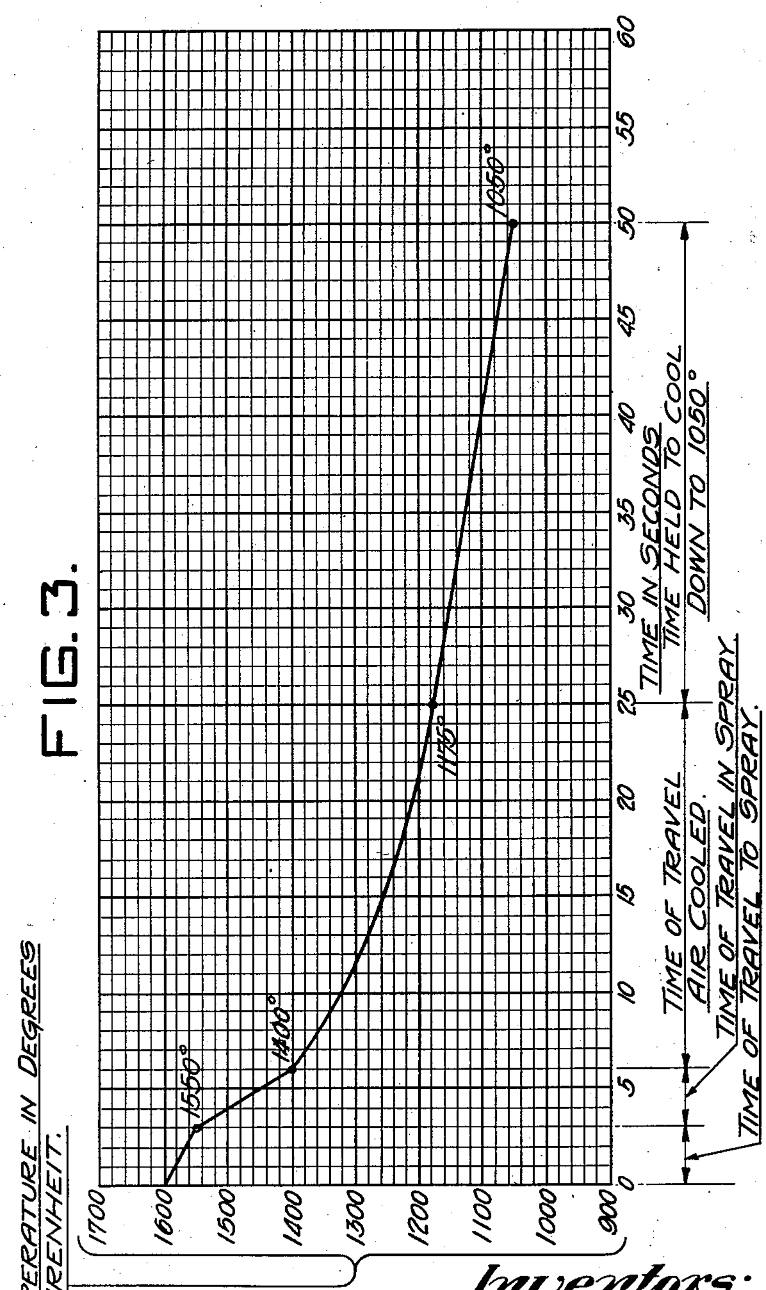


FIG. 3.



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METHOD OF TREATING STRIP METAL

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2 Claims. (Cl. 148—4)

This invention relates to the manufacture of steel, and, particularly, to a method of treating hot rolled strip steel whereby improved finished strip steel is obtained.

In fabricating strip steel to various forms and shapes, and particularly in the pressing of various steel products to shape, the manufacturer desires a steel that will be sufficiently ductile in his power presses and a steel that will retain its homogeneous structure and continuity of surfaces as it is cold-drawn by the machine or press, and, further, a steel that possesses the defined required strength to withstand the use intended of the finished fabricated product. Therefore, the steel manufacturers must provide steel conforming to definite qualities and properties for use of the fabricating industry in order that these requirements may be met.

Oftentimes, the fabricating industry will specify a certain grade of steel to test at a definite percentage of elongation and a stress yield consistent with its use and, of course, these factors become a basis on which the finished steel must be produced. Generally, the steel produced by the steel industry to meet these requirements is a low carbon bearing metal, analyzing under .25 per cent, and metallurgically compounded with ingredients of manganese, phosphorus, and sulphur, best known to those skilled in the art. However, when such steel is rolled in the conventional manner, the steel will test in a latitude too variable and broad in its limits for optimum ductility. For example, in any given grade of steel or tin plate, the yield stress may be from 41,000 to 50,000 pounds per square inch, which is quite a wide variation with similar fluctuations in ductility inversely with the strength. As is commonly known, steel or tin plate of excessive strength and accompanied low ductility results in fractures of the material when it is subjected to forming and deep-drawing operations, which, of course, are objectionable to the fabricating industry.

According to the present invention, the strip steel is treated by a method whereby the yield point thereof is definitely controlled and the steel produced thereby has a yield stress within 2,000 to 3,000 pounds per square inch of that desired of the steel for any particular use, and, in consequence thereof, the maximum degree of ductility thereof is definitely controlled, and a steel having uniform physical properties and characteristics to meet the manufacturers' requirements is consistently obtained.

Accordingly, it is one of the objects of the present invention to provide a method of treating strip steel which produces steel having certain predetermined physical properties and characteristics within a narrow range and, at the same time, producing consistently a steel having all the necessary requirements of a good steel.

It is another object of the invention to provide an improved method of treating strip steel so as to produce finished steel having certain predetermined physical properties and characteristics by controlling the rate of cooling thereof.

Various other objects and advantages of this invention will be more apparent in the course of the following specification and will be particularly pointed out in the appended claims.

In the accompanying drawings there is shown, for the purpose of illustration, one embodiment which our invention may assume in practice.

In these drawings:

Figures 1 and 1[a] are side elevations of a roller conveyor and associated apparatus that may be used in the practice of our invention;

Figure 2 is a section taken on the line II—II of Figure 1; and,

Figure 3 is a graph illustrating the relation between the temperature and time of cooling for a certain strip steel.

It has been found that the required physical properties and characteristics of strip steel can be confined within a narrow range by accurately controlling the cooling of the finished steel strip. For the ideal grain structure of the steel by the hot finishing method, an upper critical temperature at which the steel is to be finished has been established by means of considerable research and experimentation. Similarly, a definite temperature at which the strip steel should be stacked or piled has also been established, and, further, it has been found that the rate of abstraction or cooling of the steel between its hot finishing temperature and that at which it is to be piled must be definitely controlled in order to obtain the required physical properties within a narrow range.

It has also been found that strip steel piled at a given defined temperature and allowed to cool normally in air at atmospheric temperature results in no appreciable change in its physical properties or characteristics.

According to the present invention, the hot finished strip is rapidly cooled by means of a liquid through the upper critical range at a definite rate of cooling so as to insure an equiaxed, uniformly sized and refined grain structure in the steel, thus increasing the hardness and the accompanying physical properties thereof. The strip steel is then cooled by means of compressed air or by exposure to air at atmospheric temperature down to a definite temperature at which the strip is to be piled or stacked at a similarly predetermined controlled rate of cooling to keep these required physical properties within the desired limits. The strip steel is then piled or stacked and pile-annealed at a given definite temperature by cooling the same in air at atmospheric temperature at a predetermined controlled rate of cooling so as to keep the metal within the desired limits of the required physical properties.

The method of treating the strip steel so as to control the rate of cooling thereof may be practiced by conventional apparatus as that shown in Figure 1 of the drawings, or other suitable apparatus. There is shown therein the last or finishing rolling mill stand 2 of a train of mill stands and a rotary shear 3 for cutting the continuous steel strip into predetermined lengths 4. The lengths of strip steel 4 pass successively from the rotary shear 3 onto a power driven roller table 5, which may be driven in any suitable manner such as by a motor 6, for conveying the strips therefrom to a piler 7 or to other suitable means for stacking the lengths of steel arranged at the opposite end of the conveyor. There is arranged above the conveyor rolls 4 at a predetermined distance from the rotary shear 3, a cooling liquid or water spraying means, such as spray pipes 8, which are adapted to direct a cooling liquid spray, preferably a water spray, upon the lengths of strip steel as they pass along the conveyor thereunder.

In operation, the lengths of strip steel pass successively from the rotary shear or cutter 3 onto the rollers 5 of the conveyor, under the water spray 8 where they are rapidly cooled by means thereof, and along the roller conveyor 5 where they are slowly cooled in the atmosphere to the pinch rolls 9 and thence to the piler 7 where they are pile-annealed at a predetermined definite temperature. It will be understood that the amount of time at which the strip steel is cooled in the water spray and at which it is cooled in the atmosphere is predetermined and controlled by the speed of the conveyor. That is, the time of travel from the time the strip steel leaves the rotary shear until it is finally piled at the other end of the conveyor is determined by the physical properties and characteristics desired of the finished strip.

The present method of treating the strip as shown in Figures 1 and 2 is illustrated further in Figure 3 of the drawings by a graph illustrating the relation between the temperature and time for the cooling of the strip steel for a certain grade of steel in which the abscissa is the time of travel in seconds of the strip along the conveyor and the ordinate is the temperature in degrees Fahrenheit showing the change in temperature of the lengths of strip steel as they travel along the conveyor. From this graph it will be noticed that the strip is hot finished in the finishing stand at about 1600 degrees Fahrenheit, which is above the upper critical temperature of the steel. A slight drop in temperature occurs in the lengths of strip steel as they pass from the rotary shear 3 to the spray 8, namely, a temperature drop of about 50 degrees. In passing through the cooling liquid or water spray, the cooling of the lengths of strip steel is, of course, quite rapid and the lengths are cooled therein down through the upper critical temperature to a temperature of approximately 1400 degrees Fahrenheit, namely, a drop of about 150 degrees therein. After the strip lengths leave the liquid or water spray and pass along the conveyor, they are cooled in air at atmospheric temperature as they pass therealong to a predetermined temperature at which the strip steel can be piled without resulting in any material change in its physical properties thereafter. In the present instance, as shown in the graph, the strip steel is cooled in the atmosphere to a temperature of 1175 degrees Fahrenheit. The strip is then held on the conveyor table for a sufficient time to cool the same to a temperature of about 1050 degrees Fahrenheit before it is stacked or piled.

It will be seen from the graph that, for the particular grade of steel selected as an example, it was found that it was necessary to hold the strip on the table for 25 seconds before piling to provide steel having a definite yield stress point and a prescribed ductility and this time of holding has been found to be a critical time factor. For example, if the time of holding before piling had been 30 seconds, the material would be too weak and excessively ductile and it would then be necessary to adjust the water spray for more stringent cooling of the strip therethrough until the cooling time has been reduced to 25 seconds. Similarly, if the time of holding had been only 15 seconds, the material would be too hard as a result of the drastic liquid or water cooling and undesirable for best forming operations thereon. It would then be necessary to adjust the water cooling until the cooling time has been increased to 25 seconds.

As a result of this invention, it will be seen that the predetermined definite rate of cooling and the time of holding a particular grade of rolled steel strip before piling at a predetermined definite temperature produces a steel which is consistent and uniform within a narrow range of limits in yield point and ductility. For example, a particular grade of steel, cooled as above described, will consistently test with a yield point between 41,000 and 44,000 pounds per square inch as compared with 41,000 to 50,000 pounds per square inch for steel produced in the conventional manner or any other method heretofore known.

While we have shown and described one embodiment of our invention, it will be understood that this embodiment is merely for the purpose of illustration and description and that various other forms may be devised within the scope of this invention, as defined in the appended claims.

We claim:

1. In the manufacture of hot rolled strip steel, the method which comprises cutting the strip into lengths immediately after it leaves the rolling mill finishing stand at a temperature above the critical temperature of the steel, conveying the cut lengths successively through a cooling liquid spray so as to rapidly cool the same down through their upper critical temperature to a temperature slightly therebelow, then further cooling said lengths in air which is at atmospheric temperature to a temperature of approximately 1050 degrees Fahrenheit in a predetermined time and finally piling said lengths one on the other and permitting them to cool freely in air which is substantially at atmospheric temperature.

2. In the manufacture of hot rolled strip steel,

the method which comprises cutting the strip into lengths immediately after it leaves the rolling mill finishing stand at a temperature above the critical temperature of the steel, conveying the cut lengths successively through a cooling water spray so as to cool the steel down through its upper critical temperature to a temperature of approximately 1400 degrees Fahrenheit, then further cooling said lengths in air which is at atmospheric temperature to a temperature of approximately 1050 degrees Fahrenheit in a predetermined time and finally piling the lengths one on the other and permitting them to cool freely in air which is substantially at atmospheric temperature.

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