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ALLOY STEEL, CHIEFLY FOR USE IN THE MANUFACTURE
OF RAILROAD PARTS, RAILS AND THE LIKE
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Fig. 1

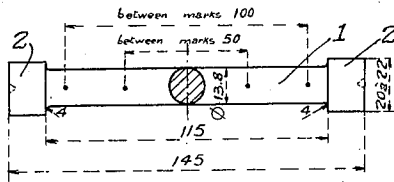


Fig. 2 Fig 2a

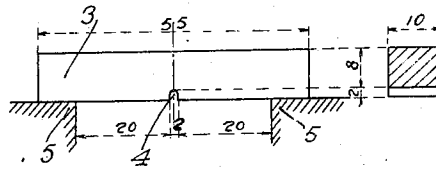


Fig. 3

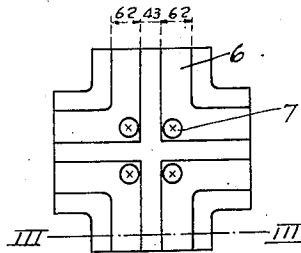


Fig 3a

Fig. 4

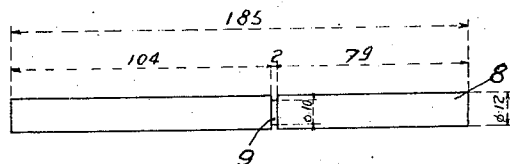


Fig. 5

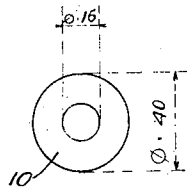
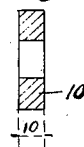


Fig. 5a.



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UNITED STATES PATENT OFFICE

2,012,765

ALLOY STEEL, CHIEFLY FOR USE IN THE
MANUFACTURE OF RAILROAD PARTS,
RAILS, AND THE LIKEPaul Pierre Marthourey, Asnieres, France, as-
signor to Acieries De Gennevilliers, Genne-
villiers, France, a corporation of FranceApplication July 5, 1932, Serial No. 620,933
In France December 11, 1928

5 Claims. (Cl. 148—31)

My present specification is a continuation in part of my prior specification Ser. No. 411,993 filed on December 5, 1929. It has for its object a self-quenching alloy steel the chief property of which is that of being adapted for use when cast after it has received a suitable thermic treatment. This treatment has for its effect an increase in the resistance to wear and to strains whereby it may be used in the same manner as steels of somewhat similar composition which have under-gone forging or rolling.

This heat treatment provides a metal at least as satisfactory as the commonly used wrought hard steel.

The steel according to my invention may thus be used after casting for any kind of constructional parts which are to resist wear or strain, such as rails, railroad or tramway tracks, racks, gear wheels, parts for naval construction and the like. Heretofore only certain steels having high contents of manganese have been adapted for such uses when cast. Such steels show many drawbacks amongst which I may mention a low elastic limit, a small resistance to repeated shocks and the impossibility of being machined when cold or of being welded through an aluminothermic or electric method. Moreover these steels with high contents of manganese cannot be heated as they are not stable when submitted to variations in temperature.

The alloy steel according to my invention has the following composition:

Carbon	0.2 to 0.5%
Chromium	0.6 to 2.0%
Nickel	2 to 5%
Molybdenum	0.1 to 1%
Molybdenum + tungsten	0.1 to 1.5%
Manganese	0.2 to 1.0%
Silicon	0.1 to 0.5%
Vanadium	0 to 0.5%
Titanium	0 to 0.5%
Aluminium	0 to 0.1%
Copper	0 to 5%
Phosphorus and sulphur	as little as possible
e. g. phosphorus	<0.035% (about) and
sulphur	<0.015% (about)
Non-metallic inclusions	as little as possible

The method of preparation should reduce these non metallic inclusions to a minimum, so that the cast steel may be clean and well decanted and thereby free from earthy, i. e. non metallic inclusions, before it is cast in a mould.

The heat treatment capable of giving this cast steel the desired properties consists preferably of

a simple or double heating above its transformation point followed if required by a quenching in quiet or agitated air, in water or in oil and if required by one or more further heatings underneath the point of transformation or even in some cases, above it.

By way of example, I will give hereinafter two examples of this heat treatment.

Example I.—The heat treatment consists of:

(a) A first heating above the point of transformation and underneath about 1250° C., followed by a suitable cooling;

(b) A second heating above the point of transformation and underneath about 1100° C., followed by a cooling in air;

(c) A third heating underneath the point of transformation and above about 150° C., followed by a suitable cooling.

Example II.—The heat treatment consists of:

(a) A first heat treatment above the point of transformation and underneath about 1250° C., followed by a cooling in air;

(b) A second heat treatment above the point of transformation and underneath about 1000° C., followed by a slow cooling in the furnace.

A cast steel thus treated may show a very large range of characteristic properties as disclosed hereinbelow with reference to accompanying drawing wherein:

Fig. 1 is a side view with an inset cross-section of a test used for tractional tests.

Figs. 2 and 2a show respectively in side view and in cross-section a test piece of the so-called Mesnager type used for resiliency tests.

Figs. 3 and 3a show respectively in view from above and in cross-section along line III—III of Fig. 3 a special test piece used for strain tests.

Fig. 4 shows in side view a test piece for tests under repeated hammer blows.

Figs. 5 and 5a are respectively a side view and a cross-section of a test piece used for wear tests.

A test piece for tractional tests (Fig. 1) is constituted by a cylindrical rod 1 ending with two thicker parts 2 which are to be held in the jaws of the testing machine. A Mesnager test piece for resiliency tests (Figs. 2 and 2a) is constituted by a rod 3 provided with a notch 4 in its middle and the ends of which bear on supports 5. The test consists in measuring the work required for the shock due to a drop weight acting on the middle of the bar on the side opposed to the notch to cause the breaking of the bar. The test piece used for strain tests (Figs. 3 and 3a) is constituted by a railroad crossing 6 with hollow grooves. Metal cakes 7 of small diameter are

placed on the points and are submitted to hammering. In Fig. 4 is shown a test piece for tests under repeated hammer blows in a machine of the Cambridge type, said test piece comprising a rod 8 grooved at 9. Lastly Figs. 5 and 5a show a test piece to be used for wear tests in a machine of the Amsler type, said test piece being constituted by a washer of the metal to be tested.

Tractional tests effected on the test piece shown in Fig. 1.

Resistance.....about 75 to 180 kgs. per sq. mm.
Elastic limit.....about 50 to 160 kgs. per sq. mm.
Elongation for 100 mm. length.....about 5 to 16%
Elongation for 50 mm. length.....about 8 to 22%
Striction.....about 15 to 50%

Hardness test

Brinell hardness.....about 200 to 600

20 Resiliency test on a Mesnager test piece shown in Fig. 2

At ordinary temperature and after remaining a certain time at 20/25° C.---- 5 to 14 kilogram-meters (about)

25 At ordinary temperature after four hours between about 475° and 525° C.----- 4 to 13 kilogram-meters (about)

At a temperature of about 500° C. (about 450 to 525° C.)----- 4 to 12 kilogrammeters (about)

30 These figures are moreover the same for temperatures under 475° C. and in particular for the so called "blue temperatures," under the same test conditions.

35 After superheating at about 1100/1300° C.: about 3 to 8 kilogrammeters.

Strain tests with a drop hammer of 1000 kgs. falling through a height of 0.25 to 0.30 meters on a test piece constituted (Fig. 3) by a railroad part. This part provided with a hollow groove is laid on a steel anvil and the hammer is caused to fall in alternation on each of the four corners with the interposition of a plate or punch of small diameter.

45 The metal supports 100,000 shocks without any noticeable crushing, without any cracks and without scaling.

Repeated hammer shock tests on the test piece shown in Fig. 4 in a machine of the Cambridge type at the frequency of 1 blow per second with a hammer weighing 2 kgs. 320 falling through a height of 40 mm.

50 The metal resists about 10,000 to 25,000 blows according to the treatment and to the superheating of the metal.

Wear tests in a machine of the Amsler type, using test pieces such as shown in Fig. 5, the metal according to the invention rubbing on wrought steel of 90 kgs. resistance with a pressure of 100 kgs. at a speed of rotation of 200 to 220 R. P. M. the machine being adjusted for hammering and sliding.

After 110,000 revolutions the loss in weight through wear of the metal according to invention is 0.275 grams and the loss in diameter is $\frac{1}{8}$ of a millimeter.

As to the strain characteristics, I may state for instance that my improved steel shows a resistance against repeated shocks which is on the average about 10 times above that of the commonly used basic steel tested under the same conditions.

Moreover the metal is very stable when the temperature varies and its mechanical characteristics and in particular its resistance to shocks are

sufficiently constant. They remain substantially unaltered after remaining a long time at any temperature between about -20° C. and +525° C.

It will be remarked that these temperatures and more particularly those between 450° and 525° C. generally produce brittleness in the case of the usual nickel and chromium containing steels.

The above results allow welding in all practical cases and particularly welding with an additional metal mass or through contact between two metal parts, whereby the mechanical and electrical continuity between the parts to be welded is ensured while scaling and breaking during service is avoided and the resistance to shocks obtained at the weld is near that of the parts to be welded.

On the other hand, the metal resists very well the propagation of the cracks and its resistance to wear is at least about 10 to 20 times greater than that of the above mentioned basic steel.

20 The special composition of my improved steel allows the application to certain portions particularly subjected to wear of a further hardening heat treatment which modifies the metallographic texture through a certain thickness and which, 25 by reason of the nature of the steel to which it is applied, does not produce like the superficial cementation treatment applied to known steels, any heterogeneity in the metal which would cause breaking up and scaling.

30 This local hardening treatment consists of one or more rapid heatings above the point of transformation up to about 1200° C. Such heatings do not decarburize and burn the metal provided they are effected say by means of the oxy-acetylene blow-pipe.

This local treatment may be followed by air-cooling and if required by heating underneath the point of transformation, which steps may, if desired be performed throughout the mass of the steel parts.

I obtain thus throughout a thickness of about 0 to 30 mm. a Brinell hardness reaching to about 600 and a minimum resiliency of about 3 kgms. for a Mesnager test piece, even in the case of a metal superheated considerably above its point of transformation.

What I claim is:

1. A self-hardening steel for rails and railroad apparatus comprising 0.2 to 0.5% of carbon, 0.6 to 2% of chromium, 2 to 5% of nickel, 0.1 to 1.5% of molybdenum plus tungsten including 0.1 to 1% of molybdenum, 0.2 to 1% of manganese, 0.1 to 0.5% of silicon, less than 0.035% of phosphorus, less than 0.015% sulphur and the balance substantially iron, said steel having been heated at least once above the transformation point and below 1210° C. and air cooled without an mechanical treatment.

2. A self-hardening steel for rails and railroad apparatus comprising 0.2 to 0.5% of carbon, 0.6 to 2% of chromium, 2 to 5% of nickel, 0.1 to 1.5% of molybdenum plus tungsten including 0.1 to 1% of molybdenum, 0.2 to 1% of manganese, 0.1 to 0.5% of silicon, less than 0.035% of phosphorus, less than 0.015% of sulphur, vanadium up to 0.5% and the balance substantially iron, said steel having been heated at least once above the transformation point and below 1250° C. and air cooled without any mechanical treatment.

3. A self-hardening steel for rails and railroad apparatus comprising 0.2 to 0.5% of carbon, 0.6 to 2% of chromium, 2 to 5% of nickel, 0.1 to 1.5% of molybdenum plus tungsten including 0.1 to 1% of molybdenum, 0.2 to 1% of manganese, 0.1 to 75

0.5% of silicon, less than 0.035% of phosphorus, less than 0.015% of sulphur, titanium up to 0.5% and the balance substantially iron, said steel having been heated at least once above the transformation point and below 1250° C. and air cooled without any mechanical treatment.

5 4. A self-hardening steel for rails and railroad apparatus comprising 0.2 to 0.5% of carbon, 0.6 to 2% of chromium, 2 to 5% of nickel, 0.1 to 1.5% of molybdenum plus tungsten including 0.1 to 1% of molybdenum, 0.2 to 1% of manganese, 0.1 to 0.5% of silicon, less than 0.035% of phosphorus, less than 0.015% of sulphur, aluminium up to 0.1% and the balance substantially iron, said steel having been heated at least once above the transformation point and below 1250° C. and air cooled without any mechanical treatment.

5. A self-hardening steel for rails and railroad apparatus comprising 0.2 to 0.5% of carbon, 0.6 to 2% of chromium, 2 to 5% of nickel, 0.1 to 1.5% of molybdenum plus tungsten including 0.1 to 1% of molybdenum, 0.2 to 1% of manganese, 0.1 to 0.5% of silicon, less than 0.035% of phosphorus, less than 0.015% of sulphur, and material taken from a group and within the limit mentioned consisting of vanadium up to 0.5%, titanium up to 0.5%, aluminium up to 0.1% and the balance substantially iron, said steel having been heated at least once above the transformation point and below 1250° C. and air cooled without any mechanical treatment.

PAUL PIERRE MARTHOUREY.

CERTIFICATE OF CORRECTION.

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It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, second column, line 58, claim 1, for "belowy 1210°" read below 1250°; and for "an" read any; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 10th day of March, A. D. 1936.

Leslie Frazer

(Seal)

Acting Commissioner of Patents.